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THE PROBLEM OF OIL

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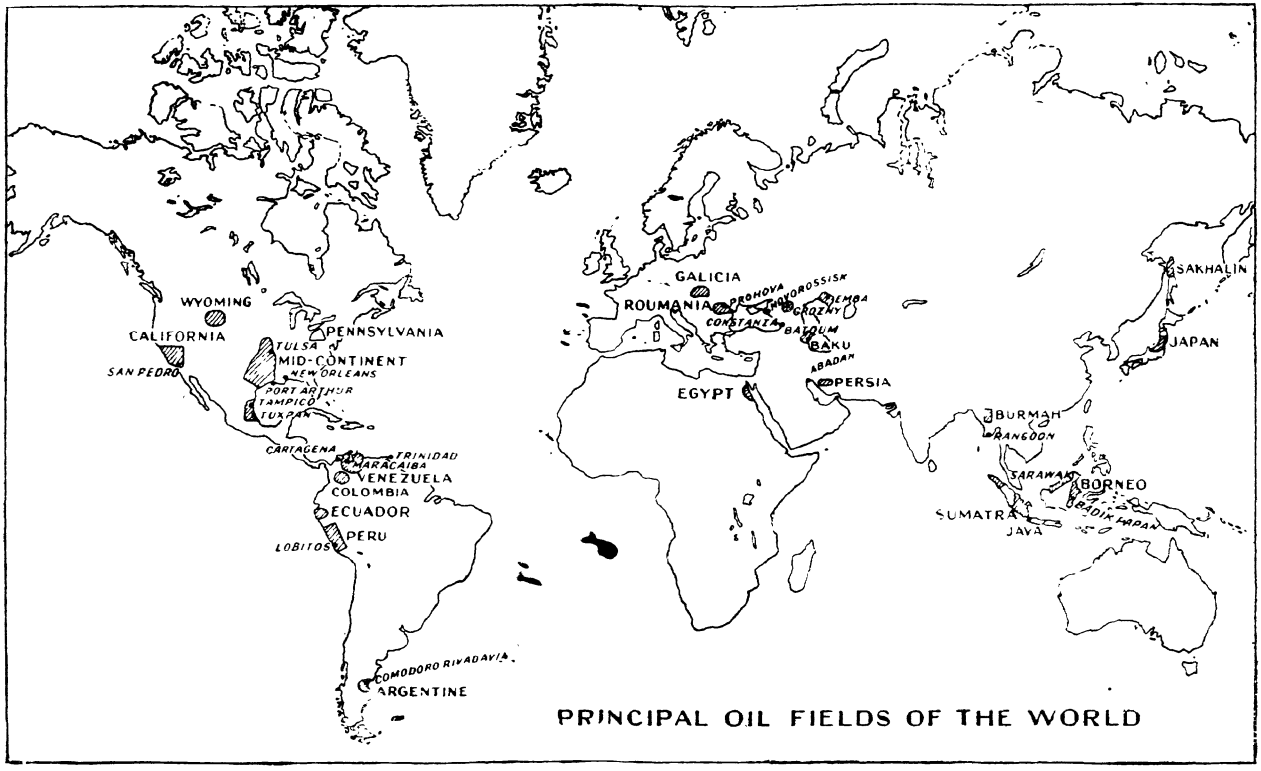
THE PROBLEM OF MOTOR TRANSPORT: AN ECONOMIC ANALYSIS.

ROAD VERSUS RAIL: THE CASE FOR MOTOR TRANSPORT.



[Frontispiece.

THE PROBLEM OF OIL

by

CHRISTOPHER T. BRUNNER

1930
ERNEST BENN LIMITED
Bouverie House Fleet Street E.C.4

PRINTED IN GREAT BRITAIN

Richard Clay & Sons, Ltd., Printers, Bungay, Suffolk

PREFACE

THE attention of the world has been focused upon oil since the end of the War, and in consequence a considerable new literature on the subject has grown up. Most of these books, however, fall into one of two categories. Some are frankly sensational, purporting to describe the intrigue and secret moves which the authors allege are going on behind the scenes, and to forecast the future wars which these conspiracies may be expected to bring about. The other class consists of technical books dealing mainly with problems of oil-field development and drilling, and oil refining. The excuse for the present book is that the author ventures to consider that the most important side of the industry, the problem of distribution, has been rather badly neglected, and deserves a much fuller treatment than it has hitherto received, both from the narrower view-point of the actual processes involved, and also from the wider aspects of the economics of the industry and its place in the industrial structure of Great Britain.

To-day the industrial importance of oil is incalculable. Oil and transport are inextricably entwined. Transport interests, whether on land, sea or air, depend mainly on oil in one form or another as the source of their power, while even the roads, which carry so large a part of modern traffic, are surfaced with a derivative of oil, bitumen. The uses to which the various derivatives of oil are put, the methods by which they are placed in the hands of the consumer, and the organisation of the industry and firms undertaking the service of distribution, form the subject of this book.

I am indebted to many kind friends and colleagues for their assistance in collecting much of the information contained in this book, and in particular I wish to thank

Mr. J. E. S. Boden for his invaluable help in elucidating many obscure points in the early history of the British oil industry. His long and in many respects unique experience has made possible the inclusion of a chapter on the history of the industry which would otherwise have been very difficult to write. I wish also to thank my wife for her great help both in revising the manuscript and in reading the proofs, and for her many useful suggestions. I am indebted to the courtesy of Messrs. Shell-Mex, Limited, for all the photographs which have been reproduced.

C. T. BRUNNER.

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THE PROBLEM OF OIL

CHAPTER I

INTRODUCTION

The Uses of Oil

"THE Allies floated to victory on a wave of oil."—This much-repeated statement of Lord Curzon serves to show the importance of oil in modern warfare. Since it was said, America has certainly floated to prosperity on a wave of oil, and the rest of the world is striving hard to follow her example. Plentiful and cheap supplies of petroleum are as necessary to industrial armies in time of peace as to military and naval forces in war. To-day the world literally runs on oil. Petroleum, in one form or another, plays its part in almost every kind of transport. An increasing proportion of shipping either burns oil or is fitted with Diesel engines; fishing-boats have kerosene motors or oil engines, and land transport is more and more coming within the sphere of the petrol-using motor vehicle. Even the railways in many countries are using oil fuel, and in some cases are running motor vehicles on rails for their branch-line services. The roads on which the motors run are, to an increasing extent, being given a surface of asphaltic bitumen, which, in the opinion of many authorities, is the most suitable material yet discovered for roads carrying a large proportion of motor traffic.

In industry benzine is used for cleaning, and in various manufactures, especially of rubber and rubber preparations; white spirit is employed in paint, polish, wallpaper and linoleum manufacture, and oil fuels of various kinds for furnaces, ovens and boilers. Oil fuel is even finding its place in private houses for central heating. Wherever there is machinery, lubricating oil must be used; to such an extent is industry dependent on lubricating oil that its sales are probably one of the most reliable indications of

fluctuations in the state of trade. Other miscellaneous uses for petroleum are almost endless, including medicines, hair restorers, petrol-lighters and insecticides.

Oil has made headway primarily, whether directly or indirectly, as an alternative to coal. Compared with coal in the crude state it is clean, compact, easy to handle and economical. The use of coal in the crude state, however, appears to be declining; it is being steadily displaced by oil, water-power, lignite and more economical methods of use. There is a promising future for electricity produced from coal and also for gas for cooking and heating purposes, but, apart from these, the demand for coal will decline, except in so far as new uses can be found for it, and the most hopeful avenue for research in this direction is along the line of low-temperature carbonisation and the production from coal of substitutes for petroleum products at competitive prices.

The changes in the method of using coal will, if introduced, have the effect of increasing employment in the mining districts, where it is most needed, through the establishment of undertakings for the production of electricity and petroleum substitutes, near the source of supply of the raw material. This, although helpful to the mining industry, will materially reduce the amount of railway transport required in Great Britain. Coal forms a substantial part of the railway traffic of all lines, and in some areas the collieries are actually responsible for the greater part of the railway traffic, but, although it is unfortunate that an industry like the railways, which has already suffered considerably since the war from trade depression and road competition, should be further hit by technical changes, it is nevertheless an insufficient reason for encouraging the continuance of the barbarous method of transporting coal long distances in its crude state, and burning it in the same form on millions of domestic hearths and in thousands of works and factories, a process which is responsible for the smoke nuisance, a goodly proportion of the fogs, and the sunlight deficiency of our large cities.

The steadily growing popularity of oil makes it possible to look forward to a cleaner, healthier civilisation in which the worst evils of city life and a good deal of dirty and rather degrading work associated with coal will have become obsolete. All social reformers will gladly welcome the change, but there is one drawback to such a state of affairs

which must be faced frankly. The coal used in Great Britain is British-produced, and would still be available in adequate quantities even in the event of war. Although a large part of the world's resources of oil is controlled by British capital, the proportion of oil used in Great Britain which is actually produced in the country, or even in the whole of the British Empire, is negligible. Germany, who is in a still weaker position, because her capital has practically no oilfields under its control, has been driven to experiment on a large scale in the production of oil from coal, mainly by the Bergius and allied method of low-temperature carbonisation. Her production from this source was 300,000 tons in 1928, a figure which the Chemical Trust hope to increase to 2,500,000 tons in some eight or nine years. Great Britain must also ensure adequate supplies of fuel in case of emergency, but for her it is not necessarily a question of obtaining the oil within the country; it may be sufficient to ensure supplies which cannot be tampered with in the event of war with any possible enemy. To-day it is no longer possible for a country with any claim to industrial pre-eminence to attempt to stem the rising tide of oil and return to the low-water level of an earlier and less efficient age.

The greatest single factor in making the present the oil age par excellence has undoubtedly been the invention, and subsequent development and perfection, of the internal combustion engine, which, in the form of the ordinary petrol motor, has revolutionised road transport. The internal combustion engine was invented in 1885. By 1893 the first motor cars were to be seen on the roads, and they have been growing in numbers and popularity ever since. At first only regarded as interesting freaks, they rapidly came into demand as rich men's toys; they next gradually superseded horse vehicles more and more for transport work, and are now finally making big inroads into the traffic which up to a few years ago was looked upon as the monopoly of the coal-using railway companies. The growth of motor transport has, however, been largely one aspect of a genuine increase in the travel habit on the part of the public, as it has made it possible for large numbers of people to move from place to place pleasantly, conveniently and fairly cheaply, who otherwise would not have wished to travel at all.

In addition to the use of the petrol motor as the medium

for the relatively new and extremely important recreation of motoring, and to the inroads made by it into functions performed by horse vehicles or railways, there is a further point to be considered which has a bearing on its growing popularity. The rise of large cities has created a demand, previously non-existent, for transport facilities between the centre and the suburbs both for persons and for goods for domestic and other consumption. The petrol motor to a great extent meets this demand, and, more than that, it has a cumulative effect, because, by its efficiency, it encourages the further growth and decentralisation of cities. It is difficult to realise the changes of the past twenty years which may be attributed to the internal combustion engine, and the extent to which the habits and way of life of ordinary people have been modified by it.

Almost equally great are the changes which have been made in marine transport. The saving of time and labour on the fishing fleets through the fitting of kerosene motors and oil engines, and the elimination of the dirty and disagreeable work of the old-time coal-stoker on most ocean liners through the use of oil fuel or Diesel engines, are changes which are still having far-reaching effects on marine transport, and which have enormously increased the demand for petroleum. Oil fuel is also much in demand for many industrial processes, from baking bread to pottery manufacture—in fact, wherever a steady even temperature is essential.

Air transport—an industry still in its infancy—is, of course, entirely dependent for fuel on petroleum products or substitutes, as it is only through the development of the internal combustion engine that commercial air transport has become practicable at all.

Among the most interesting of other changes made possible through the use of petroleum are those in agriculture, where machines, mainly using kerosene as fuel, are steadily limiting the sphere of the horse on the larger arable farms, as the methods of the more up-to-date agriculturists tend to approximate more and more to those in use on the American and Canadian prairies. The small farmer still uses horses, as it is not worth his while to invest in expensive machinery which must lie idle during the greater part of the year, but grain-growing is an industry suitable for large units of production able to make a full use of machinery and to try out every improvement in technical processes.

World Production of Oil

Petroleum is produced widely in most parts of the world, but in large quantities only in a relatively small number of places. Commercial production began in the United States about the middle of the nineteenth century, the first use being mainly as a medicine, although several attempts were made to refine it for use as an illuminating oil. In 1854 the possibilities of refining petroleum for use as both a lubricant and an illuminant were opened up more fully, and shortly afterwards the idea of artesian drilling for oil was hit upon. By 1859 oil was being produced in quantities in this way at a place called Titusville in Pennsylvania. The United States was thus the first country to produce petroleum on a large scale, and has continued to produce a great part of the world's production ever since. The earliest oilfield to be developed was in Pennsylvania, but the field is no longer of great importance, and has been comparatively worked out, although historically it is a fact of interest that the price of Pennsylvanian crude oil is still quoted over the world as the basic figure regulating the world-price of crude petroleum.

Since the early days of the industry the place of Pennsylvania has been taken by the two great oil-producing regions of the United States, the mid-Continental field, including a large area in central and northern Texas, Oklahoma and Kansas, and connected by pipe-line both with Chicago and with the Gulf ports, and the Californian field in central California. There are small fields also in a number of other States, including Wyoming, Illinois, Ohio, Arkansas and Louisiana, but these are not of great importance even in total, for the bulk of the American output still comes from the mid-Continental and Californian oilfields, and is likely to continue to do so for many years.

The world's production of petroleum amounted to 1,279,220,000 barrels in 1928, or, at six barrels to the ton, 213,207,000 tons. The proportion accounted for by the United States has on the whole been tending to increase in the years since the war. From little over 60 per cent., it has risen to nearly 70 per cent. of the total. It is, however, doubtful whether it can long continue to remain at such a high level as the older wells dry up and new oilfields are exploited in other parts of the world.

In addition to the United States, with 70 per cent. of the

world's production, there are seven smaller producers which among them accounted for nearly 27 per cent. of the total output in 1928. These are Venezuela, Russia, Mexico, Persia, Roumania, the Dutch East Indies and Colombia. Other producers are still quite negligible, although the two next on the list, Peru and Argentina, may become of more importance in the near future if the demand for petroleum should be sufficiently keen to make their development worth while; they are at any rate potentially large producers.

The most disquieting feature about these statistics is that no country in the British Empire figures in the first ten on the list. The only countries within the Empire which are producing at all are Burmah, Trinidad, Sarawak and Canada, responsible in all for 20,000,000 barrels in 1928, an amount equivalent to less than 1½ per cent. of the world's production. Speaking in continents, Europe, exclusive of Russia, also comes off very poorly with 35,000,000 barrels, or less than 3 per cent. of the world's total; Africa's share is negligible, about 1 per cent. of all, and Australasia does not produce any petroleum at all on a commercial scale. Asia, including Russia in Europe, produced in 1928 some 12 per cent. of the total, so that the lion's share of 84 per cent. was the contribution of the New World. As most of the new oilfields which are being developed are in South America, this is a disparity which seems likely to be intensified rather than diminished as time goes on.

The place of second largest producer of petroleum, which was held by Russia in the first decade of the century, was lost to Mexico owing to the dislocation of production in Russia caused by the War and subsequent Revolution. The Mexican oilfield is situated in the hinterland of Tampico and Tuxpan, in the provinces of Vera Cruz and Tamaulipas. Its peak production was reached in 1921, since when it has shown a steady, even rapid, decline to fourth place on the list of producing countries in 1928, a fall from prosperity in the main attributable to the disturbed political conditions of the country and the foolish attempts to impose unreasonable labour laws and oil laws on foreign corporations operating there. A more sensible attitude should, however, gradually make itself felt, as Mexico is no longer so necessary to the oil companies as the oil companies are to Mexico.

Russia, which had been displaced by Mexico from her original position of second largest producer, regained that position for one brief year in 1927, but in 1928 fell to the

third place owing to the extraordinarily rapid progress of Venezuela. The two chief fields in Russia are Baku on the Caspian Sea, at the eastern end of the Caucasus, in the Republic of Azerbaidjan, and Grosny in the North Caucasus area. These fields are connected by pipe-line with the Black Sea ports of Batoum and Novorossisk respectively, and there is stated to be a project under consideration for the construction of a further pipe-line from the Caspian Sea to Moscow. In addition to the two main producing fields, there are smaller fields at Emba, at the north-east corner of the Caspian, and also on the Russian island of Sakhalin, in the Sea of Okhotsk (North Pacific).

Although Venezuela rose to the position of the second largest producer of petroleum in 1928, the industry in that country is a very new one. Production did not begin until 1918, and was scarcely of importance until 1924, but since then it has gone ahead by leaps and bounds, reaching 37,226,000 barrels in 1926, 64,400,000 in 1927 and 105,000,000 in 1928, against a corresponding Russian production of only 80,000,000 barrels. The greater part of the production is in the neighbourhood of Lake Maracaibo, in the province of Zulia, which is remarkably convenient for supplying the American, European and Far Eastern markets, as it is near to the Panama Canal, and Maracaibo itself is considerably closer both to London and New York than Tampico, a fact which is seldom realised. There has been a very marked tendency for the Venezuelan output to fill the gaps caused by the falling off in Mexican production. The countries are very clearly rivals and competitors in the petroleum business.

Even more rapid than the rise in Venezuelan production has been the increase in the neighbouring State of Colombia, although there were signs in 1929 of a slight check. Production did not begin until 1922, but, as the difficulties of transporting oil to the coast are overcome, there is likely to be a rapid expansion, since the proximity of the country to the Panama Canal will prove an enormous advantage.

Of the three other large producers, Persia, which had previously been progressing rapidly, has shown a much slower rate of expansion during the past three or four years; Roumania, following a setback at the end of the war and immediately after, has shown a regular expansion since, and the Dutch East Indies, relatively of less importance than formerly, has marked time, with a tendency, if any-

thing, to fall back. The various smaller producers have just held their ground, Ecuador alone showing a tendency appreciably to increase her output. Iraq is not yet producing to any extent, but the potential production there is very great. Apart from that, the greater part of any increase in the world's petroleum production called for in the next few years is likely to come from South America.

The disparity between the production of the United States and of the rest of the world is to a certain extent counterbalanced by the fact that the U.S.A. is by far the largest consumer of petroleum, so that the part played by American-produced oil on the markets of the rest of the world, although enormously important, is not quite so predominating as would be thought from the fact that the U.S.A. produce more than 70 per cent. of the world's petroleum.

The object of the following chapters is to describe the oil industry as it affects the British Isles, and to trace more particularly the part played by it in the industrial and domestic life of the nation. It will also be necessary to consider, against the background of world-embracing corporations and financial interests, the general organisation and operations of the concerns responsible for the distribution in Great Britain of the products of a mighty industry drawn across the seven seas to that tiny corner of the map occupied by the British Isles.

CHAPTER II

DEVELOPMENT OF OIL INDUSTRY IN GREAT BRITAIN

History of Oil Industry up to the War

THE use of petroleum oil on a large scale in Great Britain began soon after its commercial production in America, and during the 'sixties it became a widely employed product. The principal petroleum derivatives sold at that time were kerosene or paraffin, which was burnt in lamps, and lubricating oil. Benzine and fuel oil had a very limited market, and in the main were looked upon as waste products.

Previous to the production of oil in Pennsylvania the field of the paraffin lamp had been very restricted. Towards the end of the 'forties, James Young, the founder of Young's Paraffin Light and Mineral Oil Company in 1866, began experiments in distilling oil from Scottish shale, and in the middle of the 'fifties, with the invention of a suitable modern lamp, a mineral oil industry sprang up wherever there were available deposits in Europe, especially in Galicia and Roumania. The regular commercial working of American oil, which previously had been used extensively for medicinal purposes, and had even found its way across the Atlantic as a medicine well known at the time as " Kier's Petroleum or Rock Oil," helped enormously to increase the popularity of the paraffin lamp. Before cheap kerosene brought the paraffin lamp within the reach of the masses, lamps which had to burn animal or vegetable oil were limited by reason of their expense to the well-to-do, and most people used tallow-dips.

Both kerosene and mineral lubricating oil, which soon largely displaced vegetable oils by reason of their cheapness, were imported in the early days in barrels, mainly from America. There was considerable loss from leakage, especially in rough weather. The importers were private brokers distributing locally on a comparatively small scale. They stored the barrels in their wharfs, yards or warehouses, and sent them to their customers, usually by rail, or by horse-wagon or barge if those methods were more suitable. The

business at this period, which lasted from the 'sixties until the end of the 'eighties, was a prosperous one, and sales were expanding with the increasing use of paraffin lamps.

This, the earliest epoch of the British oil industry, came to an end with the formation of a distributing subsidiary in the British Isles by the Standard Oil Company, which established the Anglo-American Oil Company in 1888. This company immediately set to work to buy out those of the existing companies which it considered worth buying out, and to undersell the rest, and it rapidly acquired a hold on the market almost amounting to a monopoly. Its methods were, in addition to disposing of competitors, to prevent so far as possible the entry into the field of new rivals by establishing a brand demand for kerosene which had previously been distributed by the canvassing of the retailers by wholesalers. The former passed it on to the public as their own, and sold it to the personal clientèle of their shops. The retailers of kerosene were the same individuals who retailed the lamps and stoves which burnt it—that is, ironmongers and hawkers—but the Anglo-American Oil Company was able to circumvent individual hostility on the part of these people by gradually persuading the private consumer to ask his retailer not just for paraffin, but for Royal Daylight or White Rose paraffin. It is rather a curious fact that since kerosene has ceased to be relatively so important commercially, and the number of uses to which it is put has extended, the strength of the brand demand has very much weakened, and kerosene is again being purchased in the retail market simply as paraffin.

The 'nineties proved an eventful decade in the oil world. The early prosperity of the trade in kerosene began to disappear with the increasing competition of gas and electricity for domestic lighting, heating and cooking, but at the same time the output of petroleum increased yearly, and a strong competitor to the United States arose in Russia, where, by the end of the century, a considerable oil industry had grown up in the neighbourhood of Baku. The problem of the oil trade was to dispose of this enormous quantity of petroleum products in the face of the competition from the rival industries of gas and electricity, which were in a position in many cases to supply more efficient service. The result was a slump in prices and an eager search for new markets for oil.

As fortune had it, the industry was not only to be saved,

but was also to witness a period of expansion on a scale which before would have appeared quite outside the bounds of possibility, and its salvation was to be the internal combustion engine. This had been invented about 1885 by Daimler, Benz and Butler, and by the early 'nineties had been proved to be a suitable engine for moving light carriages on the roads, thus dispensing with horses. It was found that the lightest fraction of petroleum, commonly known as benzine, which previously had been frequently thrown away as useless, was an admirable fuel for internal combustion engines, and, with the growth of motoring following the removal of antiquated restrictions on the use of motor cars by the Locomotives on Highways Act of 1896, the business of supplying motor spirit, or petrol, as it came to be called, became an important part of the work of the oil distributors. The Anglo-American Oil Company was the first to appreciate the possibilities opened up by the perfection of the internal combustion engine, and Pratt's Spirit has been marketed by them since 1896.

The quasi-monopoly of the trade in petroleum products which the Anglo-American had come to enjoy by the early 'nineties was broken up before the end of the century by the entry on to the British market of Russian oil. The existence of large deposits of oil in Russia had long been known, but it had been impossible before this date to develop them on a large scale, on account of the unsettled political conditions prevailing in the Caucasus and the neighbouring areas, although as a matter of historical interest Robert Nobel was engaged in the Russian industry as early as 1873. By the end of the century, however, at least 20 per cent. of the petroleum imported into Great Britain (in 1899 157,000 tons of kerosene and 16,000 tons of lubricating oil) came from Russia, the principal companies importing into the United Kingdom being the Anglo-Caucasian Oil Company, which was largely controlled by Rothschild interests and dealt mainly in Russian kerosene; Meade-King Robinson were also dealing in kerosene, and lubricating oil and benzine as well, being at that time distributors of the once-famous " Giant " Motor Spirit, and the Nobel interests were represented through their control of Bessler, Waechter & Co. These companies amalgamated to form the Consolidated Petroleum Company at the beginning of the twentieth century.

The trade on the whole continued to be carried on along

the same lines as before, but, with the growing demand for benzine, on an appreciably larger scale. All products were as a rule still delivered in barrels, but small cans were filled from the barrels for petrol, which could not easily be poured into the tank of a car from a barrel.

The Shell Transport and Trading Company had been formed in 1897, but its interests lay mainly in the transport and to a certain extent the distribution of kerosene in Eastern markets. After a price-war with the Royal Dutch, a rather older company, interested in production and distribution in the East, and in close connection with the Rothschilds, an agreement was arrived at in 1902, and the Asiatic Petroleum Company was formed to distribute the production of the Royal Dutch with the aid of the transport of the Shell group. This, however, mainly concerned trade in Asia. In Great Britain the General Petroleum Company was formed in the opening years of the century to represent Shell interests, and did a certain amount of business, mainly in kerosene. It was also the first distributor in Great Britain of Shell Motor Spirit. The year 1906 saw the amalgamation of the Royal Dutch and the Shell interests, and in Great Britain the amalgamation of the Consolidated Petroleum Company and the General Petroleum Company into the British Petroleum Company, which from that date undertook the distribution of the increasingly popular Shell products. This was a period when sales of kerosene were roughly stationary, while sales of benzine were increasing rapidly. The Anglo-American Oil Company was losing ground to its new rivals, and imports of petroleum from Russia reached their pre-war zenith of 117,000,000 gallons in 1903. In 1901 Russia was producing 55 per cent. of the world's oil. The distribution of Russian oil products brought other firms into existence, of which the most noteworthy was perhaps the Homelight Oil Company. Bowrings, which later became the Anglo-Mexican Oil Company, finally amalgamating with the Shell group, also dates back to this period.

Another of the older companies was the Gas Lighting Improvement Company, now known as the Glico Petroleum Company, which was formed as early as 1888, and which introduced Carburine Motor Spirit on to the market.

The years before the war witnessed a rapid expansion in the demand for benzine, but relatively little change in the demand for kerosene. The demand for lubricating oil,

however, continued to expand with the general growth of industry, and more particularly with the growth of motoring, and various firms entered the business as distributors of lubricating oils, the first in the field being the Vacuum Oil Company, a subsidiary of the Standard Oil interests, which commenced operations in 1901.

Immediately before the war another company appeared on the scene as distributors, mainly of motor spirit, and this was the Redline Motor Spirit Company, at that time known as the Union Petroleum Products Company. The growth of the benzine business led the larger companies in the field to increase their storage and distributing equipment, and the two or three largest became widely represented in all parts of the country. Bulk storage of oil products, and especially of motor spirit, at depots was becoming general. The Shell group had been the pioneers of the bulk ocean transport of oil in tankers. The oil from these was pumped into waterside depots or installations, where it was stored in bulk, and from them transported in bulk as required in rail tank cars to inland depots, where, in the case of motor spirit, it was filled into the familiar two-gallon cans.

The Oil Industry during the War

During the War the petroleum industry was placed under Government control, but important changes occurred in the spring of 1915. The British Petroleum Company, in which German capital has been interested, was broken up, and ceased to act as the distributors in Great Britain of Shell products, the marketing of which in the United Kingdom was undertaken by the Shell Marketing Company, a direct subsidiary of the Shell group, while the remaining interests of the British Petroleum Company and the distribution of B.P. Motor Spirit passed under the control of the Anglo-Persian Oil Company, which had been formed in 1909 for the development of oil properties in Persia, and in which the British Government had acquired a controlling holding of £2,200,000 out of a total capital of £4,000,000 in 1914. The Shell Marketing Company, the Anglo-American Oil Company and the British Petroleum Company were now by far the most important distributors of motor spirit in Great Britain, and all were possessed of extensive distributing equipment.

The Government control of petroleum during the War

took the form of the Government becoming the sole importer of petroleum products, which were bought by the agents of the British Government, mainly in America. The distribution of the products was left to the existing companies, to whom the trade was allocated by percentages, the Government, of course, controlling the price at which they sold the petroleum they had imported, and the price which the distributing companies might charge, thus allowing a fixed amount for distribution services and profit. In order to prevent needless waste through duplication of equipment, the country was divided into areas, which were allotted to the various distributors, each distributor being given a monopoly in his own particular area. Small towns were usually allotted entirely to one company, and large towns were divided between the companies, one taking one district in the town, and another a different district. This arrangement lasted until the end of the War. When the industry was decontrolled after the War, normal conditions returned with remarkable rapidity, but nevertheless the effects of the War control were apparent for a considerable time in the relatively strong hold which the companies retained in the areas which had been allotted to them during the period of control.

The ordinary trade in petroleum products was naturally not increasing during the War, owing to the restrictions on the use of motor vehicles and the consequent decrease in their numbers, and also on account of the use of gas and other substitutes, more particularly by commercial vehicles. There were also no changes of importance in the technique of the distribution of oil products.

The war on land and in the air caused an increasing demand for petrol for military purposes. Transport lorries, tanks and armoured cars all consumed petrol in large quantities, and there was, in addition, a growing demand for petrol for aeroplanes. The command of the world's oil resources, with the exception of the relatively unimportant oilfields in Roumania and Galicia, has been thought to have been one of the principal causes of the Allied victory, as the Allied armies were able to oppose motor vehicles, which are faster than horses and less vulnerable than railways, to the more old-fashioned means of transport at the service of the German armies. In the air also the command of unlimited supplies of the best grade of benzine was also of very great use to the Allies, who were opposed to German

airmen handicapped by relying solely on benzol, often of low grade, which made their machines relatively difficult to handle and subject to breakdowns, and so placed them at a great disadvantage.

The War, however, proved conclusively one thing—the fact that oil was indispensable to the Navy. This led the way to the great change which has been taking place since the War through the use of fuel oil instead of coal for burning in ocean-going vessels. It is also, apart from this, a fact of the first importance to the oil industry, as it has caused the Governments of all the Great Powers to take a much keener interest in oil than they did before the War, and, where possible, as in the case of the British Government and the Anglo-Persian, to take steps to safeguard themselves against a possible shortage of fuel in time of war. It is this fact, if anything, which has caused the oil diplomacy of post-war years, in which it is not, as is so often supposed, so much a case of unscrupulous oil companies using Governments for their own wicked ends, as of unscrupulous Governments using oil companies for their own ends, a proceeding which is by some people thought to be patriotic.

Oil fuel was found to have many advantages compared with coal. Most of these had been pointed out before the War, but there was much opposition to the conversion of the Navy to oil in 1912, mainly on the ground that coal was produced in the British Isles, whereas oil was imported from abroad, and that it was therefore unsafe to depend on it. Lord Fisher and Mr. Winston Churchill were responsible for having oil introduced into the Navy, their argument being that it was unsafe not to use it. Oil is more economical than coal, so that vessels using oil can go greater distances without refilling. The process of refilling can be undertaken at sea by pumping oil from a tanker to the ship requiring it, whereas a vessel using coal must go back to a coaling station to refill. Oil is more economical in man-power—an important consideration under conditions such as those of the last war, when there was a great shortage of man-power—and, perhaps most important of all, with oil it is possible to obtain higher speeds and quicker accelerations, two factors of paramount importance in naval warfare.

The naval engagements during the War were few, but they proved conclusively that the naval experts had been right in recommending the sole use of oil, and since the

War the more important liners, and also a number of the smaller, have been converted to oil, or have had their boilers constructed so that either coal or oil can be burnt, whichever proves cheaper at a particular period. In 1914 only 2·65 per cent. of the world's shipping used oil for boilers, compared with 28·53 per cent. in 1929, and only 0·45 per cent. used oil in internal combustion engines, against 9·73 per cent. in 1929. The use of oil in Diesel engines by ships is growing even faster than the use of oil fuel, but British shipbuilders, with a long experience of steam-engines behind them, have been slow to change, and relatively have not held their place against foreign countries in building or encouraging the development of ships using oil.

Post-War Developments

After the War one or two new concerns appeared on the market, of which perhaps the most important was the National Benzole Company, which began the sale of their well-known mixture in 1919. Immediately after the War there was very little competition from the small outside companies known in the trade as "Pirates," which had scarcely had time to re-establish themselves, and the pre-war companies, having become accustomed to a certain amount of co-operation with each other during the War, continued to act together in such matters as wholesale and retail selling prices, the general conditions of the trade, and its relations with dealers and with the public.

An immense boom occurred in motoring as soon as the War was over, and has continued ever since, so that the increases obtained in the spirit business were large and steady for all companies. Pleasure motoring and motor-cycling extended yearly, and the great possibilities of commercial motoring were perhaps first realised during the railway strike of September 1919. Since then various factors have contributed to make most large firms wish to own their own means of transport, and this has contributed to a further expansion. The great development of omnibuses did not occur until several years after the War, but all these factors made the petroleum industry prosperous, and, as usually happens with prosperous industries, attracted outsiders who were eager to share the spoils.

There was an important fusion in 1920. The Shell Marketing Company, who had been distributors since 1915 of Shell

Motor Spirit, the most popular brand in the country, amalgamated with the British interests of the Anglo-Mexican Petroleum Company, which had been distributing Mex Motor Spirit since 1912, a commercial spirit in much demand for lorries and omnibuses, to form Shell-Mex, Ltd., the new firm thus having two strings to its bow, in Shell Motor Spirit for clients who wanted a No. 1 spirit, and Mex for those who found a commercial spirit suitable for their requirements.

The best market for motor spirit in the British Isles is, of course, London, where nearly one-fifth of the population and much more than one-fifth of the wealth of the country is concentrated. This market is within easy reach of the Thames estuary, where most of the oil imported into the country is discharged and where any private individual can bring in a cargo, as the London & Thames Haven Oil Wharves, Ltd., who have a large installation at Thames Haven in Essex, are open to all. These factors, and the prosperity of the industry, led to the growth of the " Pirates," at first in the London area. Private brokers bought up cargoes of American, Roumanian, Mexican or Russian oil cheaply, as and when they could, and brought them into Thames Haven, where they stored them and ultimately sold them to small firms, who transported the oil by lorry to London and sold it at a cut price to any dealer who would take it. Like the similarly dubbed " Pirate " buses, they did not offer a general service, but only skimmed the cream of the trade, in many cases without so much as guaranteeing a proper service even to their own customers.

The National Companies held themselves responsible for organising distribution, not only in densely populated districts where customers were plentiful and distribution costs low, but also in empty rural districts, and even in out-of-the-way islands in the Hebrides, where the cost of distribution was so high as to make the trade unprofitable. They moreover took upon themselves the responsibility of providing their customers with a regular and reliable service. A garage proprietor wanting a delivery of Shell or B.P. could ring up and give his order with the absolute certainty that it would be executed at once. The National Companies therefore bitterly resented the tactics of the " Pirates," but nevertheless the lure of cheap spirit was such that, in the London area especially, they made some headway with the less careful type of motorist. The National Companies

sold their products under brands, and the purchaser knew that one sample of a particular brand would be almost exactly the same as another. The "Pirates" sold what they could buy, usually just as "petrol," and in many cases owed their luck in not being prosecuted for obtaining money by false pretences to the fact that there is no legal definition of "petrol." It must in fairness be stated that these methods applied mainly to the smaller "Pirates." The larger outside companies soon established themselves in particular districts and gave locally a reasonably good service, and in one or two cases distributed a fairly high-grade spirit. Most of the "Pirates," however, just sold whatever could be obtained at Thames Haven from the brokers. Some cargoes were certainly of good quality; others were very poor. Two companies—the Power Petroleum Company, established in 1923 as a subsidiary of the Medway Oil & Storage Company, and the Russian Oil Products, which began operations in 1925—rapidly rose to a predominant position among the "outside" companies.

For the first year or two the activities of these companies were on too small a scale, except in London, to trouble the older-established companies very much. The natural annual increase in trade was sufficiently great to cover up completely any progress they might have been making. By the end of 1926, however, the National companies became rather anxious about the progress of the "Pirates," and in the spring and summer of 1927 there was a fierce but unsuccessful newspaper campaign with the object of killing the trade of the Power and R.O.P., both of which distributed Russian oil. The campaign was directed against importing Russian oil products, but it died down because there was little genuine feeling in the country against Russian oil *per se*.

During 1928 these two companies, and particularly the R.O.P., made considerable headway, especially after the petrol tax of fourpence a gallon, imposed in April 1928, had increased public interest in cheap petrols. Both Power and R.O.P. were retailed at a rather lower price than the older brands, and benefited accordingly. Competition became acute, and meanwhile the price of petrol rose in the world market, and it became unprofitable to sell it in Great Britain. Nobody, however, was willing to advance the price, in case the other companies failed to follow suit. At the end of the year, however, an agreement was entered into, to take force from January 1929, between the National

companies, the Power Company and most of the more important " Pirates " except the R.O.P. Shortly after an agreement was entered into with the R.O.P. by the Anglo-American Oil Company as representing the parties to the other agreements, and prices were put up at once to an economic level, as all companies had been selling their spirit at a loss for some months.

Changes in System of Distribution

The most important change in the technique of oil distribution since the War has been the growth of bulk selling of motor spirit and motor oil. Except in congested districts in the centre of large towns, the two-gallon petrol tin has practically disappeared from the garage trade. The all-but-universal method for bringing motor spirit from the storage tank in the depot to the motorist's car is now, first to pump it into a bulk tank lorry; thence to empty it into a tank at the garage, and lastly to pump it from that tank by means of a petrol pump into the tank of the motorist's car. This has effected a revolution in methods of distribution, and has reduced the cost of delivery to a mere fraction of its former amount, since, instead of the lorry having to call at numerous garages, making deliveries of eight or ten or more two-gallon cans, deliveries are made in bulk at much greater speed in minimum lots of 200 gallons. In addition to delivery charges, distribution costs have been further reduced by the elimination of much manual work in inspecting, cleaning, painting and filling cans, and there has also been a big reduction in clerical work, as it obviously requires far fewer entries and records to keep track of 200-gallon deliveries of bulk spirit than of small deliveries in cans.

The bulk system of delivery has also been applied to other petroleum products, but the results, although satisfactory, have seldom been so strikingly successful as with spirit. In motor oils, particularly, there has been a change in the old-fashioned buying methods, and the adoption of the motor-oil cabinet, which in essence is a tank with a pump attached, to replace the older bulk method of a barrel with a hole in it, has increased bulk sales of motor oils, although a strong minority of motorists still prefer to buy in cans or drums.

In sales methods there have not been any changes of importance since the War except for one very interesting

experiment entered into by the so-called " Combine " companies when they were faced with acute competition from outsiders, which was undertaken as part of an attempt to freeze out the " Pirates." This was the establishment of a deferred rebate (1926) on much the same principle as that used by " Shipping Conferences " in their efforts to keep shippers " loyal." The deferred rebate was subsequently modified to a spot rebate, but the object of it remained the same. There is still a good deal of difference of opinion as to how far, if at all, it succeeded in its object, but the bulk of the evidence appears to point to the fact that, although the " Pirates " were not frozen out, their advance was to some extent stemmed by it, and proceeded less rapidly than would otherwise have been the case. The terms of the rebate were briefly that one penny a gallon would be allowed to all dealers selling " Combine " petrol so long as they did not handle any " non-Combine " spirit. A dealer therefore was faced with the following problem. He might perhaps be selling 1500 gallons per week of " Combine " spirit, on which he was making threepence a gallon profit—say, £18 15*s*. If he installed a " Pirate " pump, on which he could make threepence a gallon profit, he immediately lost one penny a gallon on his " Combine " sales—say, £6 5*s*.—and, to make up for this, he had to obtain 500 gallons a week of additional business for his " Pirate " pump. The problem, however, was not quite so simple as this. If the dealer could transfer 500 gallons of his 1500 gallons " Combine " business to his " Pirate " pump, he would be making threepence a gallon profit on this—say, £6 5*s*.—and would be losing one penny a gallon rebate only on the 1000 gallons which remained to the " Combine "—say, £4 3*s*. 4*d*. In this case he would only have to attract 333 gallons a week of new business to be " all square " on the deal. Against this, of course, he had to set the cost of his new pump, so that he probably required rather more new business than is shown by this calculation. His ability to obtain this business depended on the number of other dealers with " Pirate " pumps. If there were a large number he would be unlikely to gain much additional business, and would therefore have little incentive to install the " Pirate " pump, except as an act of self-defence if the " Pirate " threatened to put down the pumps next door in order to take away his existing business. As there appears to be a saturation point for cheap spirit, what

usually happened was that the " Pirates " made rapid headway so long as each " Pirate " Dealer could hope to win business from his " Combine " rivals, but tended to slow down as soon as there were sufficient " Pirate " pumps to make it improbable that new " Pirate " dealers would gain much business. The rebate to " loyal " dealers certainly acted as a deterrent to many people who would otherwise have installed " Pirate " pumps, but, on the other hand, once a dealer had installed a " Pirate " pump, he was in such a position, through the working of the rebate, that he made a larger profit per gallon on his " Pirate " than on his " Combine " sales. He therefore not unnaturally pushed his " Pirate " spirit as much as possible, and tried to persuade those of his customers who bought " Combine " brands to change to " Pirate." In some cases he succeeded, and accustomed people to using " Pirate " spirit who would not previously have considered buying it.

The outstanding feature since the War in the oil business has, of course, been the increase in sales of benzine which has gone hand in hand with the growth of motoring. Sales of benzine for other uses than in internal combustion engines have increased with the growth of the rubber industry, but have not made any spectacular advances, and have been rather dull in other fields. Sales of motor oils have increased concurrently with the sale of benzine, but the rate of progress in the demand for general lubricating oils, the sale of which depends, of course, on the condition of industry as a whole, has been slower. The demand for kerosene has shown little improvement since the War, the falling off in its use as an illuminant having been barely offset by the increase in its use for other purposes.

Fuel oil has also made some progress. Sales of this commodity during the coal stoppage of 1926 jumped to several times their normal amount, but only a part of the business gained was retained after the strike. However, in certain directions progress has been made, and the oil central-heating campaign for private houses which was begun in 1928 is undoubtedly opening up a large new market.

The increase of motoring has had a further consequence for the petroleum industry in addition to stimulating the demand for benzine and lubricating oils. It has caused a demand for better road surfaces, and this has in many cases led to the use of bituminous road surfaces, which now form quite a large part of the whole.

CHAPTER III

THE PRESENT POSITION

The Great Oil Groups

THERE is a widespread popular belief, assiduously fostered by the writers of detective stories and thrillers, that in some way the oil industry is more sinister than others. It is reputed to be mysterious, and to have an alluring thrill of conspiracy and backstairs intrigue. Unfortunately it is in fact as prosaic as other businesses. The groups operating in it are certainly large, and international in their interests, but there is nothing particularly remarkable in the organisation or structure of the industry. The supposed black alliance between oil and politics is a little too lurid for this everyday world, and is in the main the fabrication of hysterical journalists. It is, of course, true that there is no smoke without a fire, and the grain of truth underlying the " oil complex " of so many writers is that, under present conditions of military, naval and industrial organisation, it is of paramount importance for every Government to endeavour to secure the control of adequate supplies of oil in exactly the same way as it has to watch the supplies of other commodities, such as timber, coal, copper and rubber, necessary for the waging of successful warfare, military, naval or industrial. The Governments of most important countries have therefore been obliged to interest themselves in oil, in the case of the British Government even to the extent of acquiring shares in one of the large oil-groups distributing in the country, and in all cases have kept a close watch on developments in the industry. Oil is of special importance for Great Britain, as the defence of the country is primarily in the hands of the Navy and of the Air Force, both dependent on oil for their effective existence.

There are three main groups operating in the oil industry outside the United States, to which perhaps a fourth should be added so far as Europe and the near East are concerned. There are other groups working on a large scale in America which are excluded. The three main groups are: the Shell group, represented in Great Britain by Shell-Mex,

Limited; the Standard Oil group, represented by the Anglo-American Oil Company; and the Anglo-Persian group, represented by the British Petroleum Company. The fourth and smallest group is the Russian oil interests (Naphta-syndicat), represented in this country by Russian Oil Products, Ltd. The Shell group are under mixed British and Dutch control, the Standard group under American control, the Anglo-Persian under British and British Government control, and the Russian under Soviet control.

The greater part of the business done by the Shell group in the United Kingdom is done through Shell-Mex, Ltd., a subsidiary of the group, 50 per cent. of whose shares are held by the Shell Marketing Company, and 50 per cent. by the Anglo-Mexican Petroleum Company. Shell-Mex was formed in December 1920 to amalgamate the United Kingdom interests of the Shell Marketing Company with those of the Anglo-Mexican Petroleum Company. Its business is the distribution throughout the British Isles of motor spirit, lamp oil, motor and general lubricating oils, fuel, gas and Diesel oils and bitumen, in addition to one or two other products or by-products of crude petroleum. There are several smaller distributors which are more or less closely associated with this group, but none of them has an appreciable share of the trade. In addition to Shell-Mex, Ltd., the firm of Lubricant Producers is also a subsidiary of the Shell group, and carries on business in the United Kingdom as wholesale distributors of lubricating oils on behalf of the Shell Marketing Company and the Anglo-Mexican Petroleum Company.

The general structure of the Shell group is that the Shell Transport and Trading Company and the Royal Dutch Petroleum Company act as holding companies of the shares in subsidiaries engaged in the production, transport and distribution of petroleum products in all parts of the world. Production is carried on in most of the principal oil-producing regions, the largest contributors being Venezuela (Venezuelan Oil Concessions, Colon Oil Corporation and Caribbean Petroleum Company), the United States (Shell Union Oil Corporation, consolidating the Shell Oil Company in California, Shell Petroleum Corporation in the South-Eastern States, New Orleans Refining Company, Shell Eastern Petroleum Products in New England, Matador Petroleum Company and Shell Pipe Line Corporation), the East Indies (De Bataafsche Petroleum Maatschappij),

Mexico (Mexican Eagle Oil Company and "La Corona" Companies), and Roumania (Astra Romana Société Anonyme). A large fleet of over 1,750,000 tons is owned by the group, and operated by the Anglo-Saxon Petroleum Company, the Eagle Oil Transport Company, the Nederlandsche Indische Tank Stoomboot Maatschappij, and the Curacaosche Scheepvaart Maatschappij. Distribution is carried out by associated companies in most parts of the world, including, among many others, the Asiatic Petroleum Company, the Anglo-Mexican Oil and Shipping Company in South America, the Shell Union Oil Corporation in the United States, and the various distributing companies in all important European countries. Other associated companies operate in Africa and Australia. This group, like the other large groups, is a vertical combine, controlling, through its various branches, prospecting, drilling and producing, transport by pipe-line and tanker, refining, wholesale, and to a certain extent retail, distribution and marketing. The vertical control in this way of a large section of the industry makes it possible to obtain an efficient and economical organisation, and to dispense with the services of brokers and middlemen.

The second great group is the Standard Oil group, whose chief subsidiaries in Great Britain are the Anglo-American Oil Company, marketing motor spirit (Pratt's), lamp oil, fuel, gas and Diesel oil, motor lubricating oil and bitumen, and controlling the Glico Petroleum Company and the British Mexican Petroleum Company, which latter in turn owns the entire share capital of the Redline Motor Spirit Company. The Vacuum Oil Company, a concern which blends and markets lubricating oils, is also under Standard control. The refinery of the group at Fawley is operated by the Agwi Petroleum Company.

The Standard group is the largest oil group operating, if the American business be included, although in Great Britain its business is on a somewhat smaller scale than that of the Shell group. It is rather a loose organisation, including a number of semi-independent associated companies, such as the Vacuum Oil Company of New York and the Standard Oil Companies of New Jersey, New York, Indiana and California. The control of the group is entirely American, and the greater part of its production is in the United States, although the Standard Oil Company of Indiana has extensive interests in Mexico and Venezuela, as well as a large share in the Sinclair group. The Standard Oil of New Jersey also

has interests as a producer in Colombia and Peru, and in Mexico and Roumania (Romano Americana) as well. The Standard Oil of California has interests in Venezuela through the Richmond Petroleum Company, and in Colombia through the Latin American Petroleum Corporation. The Standard Oil Company of New York controls producing companies in the U.S.A., such as the Magnolia Petroleum Company and the General Petroleum Corporation of California, and an extensive fleet through the Standard Transportation Company. These loosely joined Standard interests are in reality practically separate groups, each group undertaking through subsidiary companies the whole business of producing, transporting, refining and marketing in the same way as the Shell group, and, within limits, often pursuing divergent policies from its allies. The Anglo-American Oil Company was a subsidiary of Standard Oil of New Jersey, but is now controlled by the Standard Oil Export Corporation. Distribution in Asia, Africa and Australasia, however, is mostly through subsidiaries of the Standard Oil Company of New York, selling the well-known " Socony " products.

The third group is the Anglo-Persian group. This is not nearly such a large group as either the Shell or the Standard, but it does an important trade in Great Britain through its main distributing subsidiary, the British Petroleum Company, which markets motor spirit, lamp oil, and fuel, gas and Diesel oils. It does not market either lubricating oils or asphalt on an appreciable scale. The marketing of " B.P." spirit in Scotland is effected through the Scottish Oil Agency, Ltd., the selling agency of a group of firms engaged in the production of shale oil in Scotland, including the Broxburn Oil Company, Oakbank Oil Company, Pumpherston Oil Company, James Ross & Company, Philipstown Oil Works, and Young's Paraffin Light and Mineral Oil Company, all under Anglo-Persian control. The National Benzole Company, the largest distributor of benzol mixture in the British Isles, obtains the spirit content of its mixture from the Anglo-Persian, and to that extent may be regarded as belonging to the same group.

Like the other groups, the Anglo-Persian control companies engaged in all stages of the oil business, including exploration and development, production, transport, refining, and distribution and marketing. The production, which is less than a third of that of the Shell group (22,000,000 tons in 1928), is nevertheless considerable, amounting to

some 6,000,000 tons a year. Production is almost entirely in Persia, mainly in the Masjid-i-Sulaiman area, but the group also has interests in the Argentine (Compania Industrial y Comercial de Petroleo) and elsewhere. For instance, the group holds 47½ per cent. of the shares of the Turkish Petroleum Company, and has an interest in the Steaua Romana in Roumania. Exploration and development work are carried on by two subsidiaries, the D'Arcy Exploration Company and the First Exploitation Company. A fleet of 800,000 tons is controlled by the group, mainly through its subsidiaries, the British Tanker Company and the Petroleum Steamship Company. There are also large refineries, one on the island of Abadan, in the Persian Gulf, and the other at Llandarcy, in South Wales, the latter being operated through National Oil Refineries, Ltd. The Anglo-Persian, in addition, holds shares, along with the Australian Commonwealth Government, in Commonwealth Oil Refineries, Ltd., and has marketing subsidiaries in Asia, Africa and Australia, as well as in Europe. The British Petroleum Company, as stated above, is the marketing subsidiary in the British Isles. In France and the French colonies there is the Société Générale des Huiles de Petrole, and in Belgium L'Alliance Société Anonyme. There are similar marketing companies in most European countries of importance.

A large interest is held in the Anglo-Persian by the Burmah Oil Company, which does not distribute its products in Great Britain, but which operates oilfields, pipelines, refineries and tanks in Burmah, and has industrial interests in India. There is a certain amount of interlocking in the directorates of the two companies. As stated above, a further large proportion of Anglo-Persian shares are held by the British Government, and the group is entirely under British control.

There is a tendency for a closer co-operation abroad between the British oil groups, the Shell, the Anglo-Persian and the Burmah Oil Company, which has become especially marked in the Eastern markets. The British groups appear inclined to present a united front to the Russians, and also find a certain amount of common ground in opposition to the American Standard group. Already a good deal of transfer of shares between the British groups has taken place.

At the end of 1927 the general agreement which had been in existence for twenty years with regard to the Indian

market between the Asiatic Petroleum Company, a marketing subsidiary of the Shell group, and the Burmah Oil Company was consolidated and converted into a permanent unification of the Indian marketing interests of the two parties. This was followed by the announcement, in October 1928, of the issue of £4,000,000 5½ per cent. Debenture Stock by the Burmah Oil Company, which was already at that time a holder of 3,561,990 £1 shares in the Anglo-Persian, in order to finance the purchase of 833,333 ordinary shares in the Shell Transport and Trading Company. At the same time an agreement was made for a new Voting Trust to be formed with a capital of £700,000 to acquire from the Burmah Oil Company 700,000 of the latter's holding of Ordinary Shares in the Anglo-Persian Oil Company. The Burmah Oil Company thus broadened the basis of its interests in the petroleum industry by becoming a larger shareholder in the Shell group, while retaining its voting rights in the Anglo-Persian Oil Company.

The first-fruits of the closer co-operation foreshadowed by this were the formation of the Consolidated Petroleum Company by the Anglo-Persian Oil Company and the Asiatic Petroleum Company, each being equally represented, to acquire all the installations and other distributing equipment belonging to the parent companies in South and East Africa, Egypt, the Sudan, Palestine and Syria, the Red Sea and Ceylon, and to carry on the distribution of petroleum products in these countries. It is hoped, along these lines, materially to reduce distribution costs by cutting out duplication of facilities and unnecessary overhead charges. There will, no doubt, be further moves towards co-operation in distribution between the various British groups. The economies which can be obtained by eliminating duplication of equipment are, of course, most marked in countries where the consumption of petroleum is small in relation to the area. These economies are less obvious where there is a heavy consumption in a small area, since here it is possible for all distributors so to organise their distribution as to make full and economical use of all their equipment all the time, and no amount of rationalisation and pooling of facilities will ever make it possible to do more than this. In a sparsely populated district, on the other hand, it may be possible in this way to dispense with a good deal of equipment which under the new arrangement will no longer be found necessary.

The fourth and smallest group already referred to, which distributes in Great Britain, is the Russian Soviet (Naphtasyndicat) marketing organisation. The subsidiary in Great Britain is Russian Oil Products, Ltd., which distributes Motor Spirit (R.O.P.), kerosene, and lubricating oils also to a certain extent. Similar subsidiaries exist in other countries in Europe, the Near East and Asia. Some of these subsidiaries—as, for example, Russian Oil Products—not only distribute Russian petroleum, but also American petroleum bought on the open market. The organisation is that the shares in the various marketing companies are held by the "Naphtasyndicat," a sales syndicate operating from Moscow, and which is responsible for the whole of the distribution of Russian petroleum both in the U.S.S.R. and abroad. The business of the sales syndicate is to dispose, on the most favourable terms possible, either wholesale to lesser distributors, or where practicable through its own subsidiaries, of the products of the three great producing trusts, the Azerbaidjan State Naphtha Trust (Azneft) of Sadovaya, Baku, the State Trust of Grozny Oilfields (Grozneft), and the State Emba Oil Trust (Embaneft).

The Soviet oil industry, which has been nationalised since 1920, is the only example of an oil group which has been completely nationalised in all branches. The State interests itself directly or indirectly in one or more phases of the oil industry in a number of countries, including Great Britain (through its holding in the Anglo-Persian), Spain and Poland. However, the structure of the groups is the same whether the industry is nationalised or not. The organisation is primarily vertical, and, as will be shown later, only to a much smaller extent horizontal. The vertical groups consist of companies engaged in every department of the industry, more or less closely bound together through their shares being in the hands of a single holding company, and through interlocking directorates ensuring a reasonable similarity of policy throughout the group.

The greater part of the whole industry throughout the world is thus in relatively few hands, but, in addition to these large groups, there is a large number of smaller producers selling their output on the open market, partly to the groups and partly to brokers, who sell again to numerous very small distributors. The proportion of the United States output which is in the hands of small producers is considerable, but the proportion of the distribution

in their hands anywhere is not very great, and on the whole the service they render as distributors is on a comparatively modest scale. In the British Isles these people are mostly dependent on American and Roumanian sources of supply, and they will continue to exist so long as the brokers are able to obtain cheap lots of oil, which means more or less until a much greater degree of control has been achieved over production than has yet been found possible. Overproduction by many small producers causes a high percentage of bankruptcies among the firms operating, and a high percentage of bankruptcies means that there is plenty of petroleum obtainable very cheaply, often below the current cost of production. It is here that the broker has his chance. He can buy on the American market, discharge his cargo at Thameshaven, where the London and Thameshaven Oil Wharves provide storage for all who are willing to pay for it, and sell it to small distributors, who can distribute it cheaply by road in the London area. They may not be able to ensure regular supplies or constant quality, but they can afford to sell at a very low price, which appeals to a certain, perhaps rather short-sighted, section of the consuming public.

There are several other companies operating in Great Britain on a sufficiently large scale to merit some attention. In motor lubricating oils, in addition to the Shell group (Double Shell, Triple Shell, etc.), and the Standard as represented by the Vacuum Oil Company (Mobiloil), there is C. C. Wakefield & Company (Castrol) and Price's (Motorine). In general lubricating oils, in addition to the Shell and Standard groups, there is Lubricating and Fuel Oils, Ltd., and in motor spirit there are several distributors, who, although not so large as the groups mentioned above, are nevertheless factors to be taken into consideration. Perhaps the most important of these is the Medway Oil & Storage Company, which imports Russian kerosene for cracking at its refinery on the Isle of Grain, and distributes through the Power Petroleum Company the only brand of spirit manufactured from cracked kerosene which is marketed in Great Britain. Other fairly important companies are the Cities Service Company, a member of an American group with interests on the Continent also, which distributes Citex and Major's spirit, the Sealand Petroleum Company, marketing Dominion and Acme Motor Spirit, and the United Oil Importers. The latter firm distributes a number

of different brands such as U.C., Manx and Albion Spirit in London, the North of England and Scotland; it was the United Caucasian Oil Company of Copenhagen, connected with the German Naphtha Industries and Tankanlogen Aktiengesellschaft. Other distributors of petroleum products include the Texas Oil Company, a subsidiary of the American Texas Corporation, which distributes Texaco Motor Oils, Texaco and Galtex Motor Spirit. Cory's, the coal merchants, own an installation at Coryton, on the Thames estuary, and distribute through their own service stations as well as selling direct to very small distributors. There are also a number of other small firms, which, however, only operate on a very small scale, and rarely import direct, relying in most cases on purchases of spirit from brokers who have brought in cargoes to Thames Haven.

The "Oil Combine" and the "Pirates"

Of the firms outside the large groups, some distribute the various petroleum products in the same way as the groups, but others deal only in spirit or in lubricating oils, or in some other single product. In the spirit trade the number of these smaller distributors is relatively not large, although in itself considerable, but in the lubricating-oil business, especially general industrial lubricating oils, they do much better, as an easy opening is offered for small local men to blend lubricating oils bought on the open market, and sell them to local mills, factories and collieries through their personal influence in the district. In Manchester alone there are said to be more than a hundred such local blenders. However, in general the position in the oil business is that products for the private consumer, except kerosene, have a branded demand, *e.g.* motor spirit at garages and motor lubricating oils, but products which are not bought in large quantities by the general public—*e.g.* spirit and motor oil sold to commercial consumers and general lubricating oils—have a far weaker branded demand, and the products of the large groups may suffer from the competition of small local men in this type of trade. Where a demand comes from the general public—*i.e.* is a consumer demand—a firm which is either unable or unwilling to advertise on a national scale finds it very difficult to obtain a footing in the market. This applies equally to most other industries, *e.g.* tobacco. The retailer of petroleum products tends increasingly to

deal in branded goods, but the large commercial consumer uses them only to a considerably less extent. He pays much more attention to price and specification, and is sceptical about the value of paying for a brand name.

Costs in the oil industry include, first the cost of producing the crude, secondly the cost of refining, and thirdly the cost of transporting the oil to Great Britain. These costs are much the same for all companies, except perhaps the Russians, whose position will be explained later. The fourth cost is the cost of distribution and marketing in the United Kingdom, so that the profits of a particular distributor will depend partly on his selling price and partly on his cost of distribution. A company with a low cost of distribution may be able to sell at a lower price than a company with a high cost of distribution. The selling price to the public, of course, includes the further variable factor of the retailer's profit. However, from the point of view of the distributing company, the cost of distribution is of the very highest importance.

It is in this connection that a position of some injustice has arisen. The larger groups offer a national service. Their products are available in all parts of the country. They undertake to give a regular service everywhere, to sell their brands anywhere at any time during working hours, and to call regularly on all customers. They are in competition, however, with more or less irresponsible distributors who are prepared to market spirit only in the easy areas at the easy garages, and often, even in these areas, give an irregular service. Through undertaking only the most profitable business, they are able to undersell the distributors who operate on a national scale. If they were compelled to provide a proper service, work the same hours and pay the same wages as the national distributors, they would be compelled to sell at as high a price as the other companies, and would find it very difficult to continue in business, as the demand for their products is due to their cheapness, not their quality, which is appreciably below that of the products distributed by the larger and more reputable companies.

The position of the national distributors is a difficult one. A large section of the public loses sympathy with a firm as soon as it undertakes a public service on a national scale, performs it efficiently, and offers good wages and working conditions. The ignorant and envious at once

become eloquent on the subject of wicked combines and monopolies which fleece the public, and attempt to make heroes of small and inefficient firms which flourish under the shadow of the national distributors, perform little or no public service, and offer relatively poor wages and working conditions, giving them the rôle of disinterested protectors of the public, although there is no record of such firms ever having led a price reduction or held back when the national distributors raised prices.

The position of the distributors of Russian oil is rather different. They do not offer a service everywhere, but they do cover very wide areas, and in most cases their products are slightly cheaper than those of the national distributors, in order to enable them to regain a foothold in markets from which Russian oil was cut off during and immediately after the War. They can continue to sell at a low price, for the reason that their competition is manifestly unfair. The confiscation of oil properties when the Russian oil industry was nationalised in 1920 is, of course, important, although too often exaggerated, but infinitely more important is the fact that the oil trade in Russia is a monopoly, and the home price is fixed at a higher level than would be possible were competition permissible. The high level of profits on the home market makes uneconomic dumping abroad easy, in exactly the same way as the pre-war dumping of German iron and steel in England by the iron and steel cartel. In 1928–1929 the total production of Russian oil was 13,788,000 tons, and the total exported 3,495,000 tons, or little over one-quarter of the output. Given a monopoly of the home market, which absorbed three-quarters of the production (Russia is, of course, mainly dependent on kerosene for lighting), it is not difficult to understand how the surplus profits obtainable through the monopoly of the home market can without difficulty be used to finance and subsidise the one-quarter exported in such a way as to obtain a footing in foreign markets. It is, in fact, a classical case of dumping, except that the foreign producer is not a cartel protected from interference in the home market by a high tariff barrier, but a Government monopoly, competition with which would be illegal, and which, outside the home market, is permitted to compete, free from all restrictions, with rivals without any similar protection.

The three largest groups operating in the country, the

Shell, the " Anglo " (Anglo-American Oil Company) and the B.P., with their respective subsidiaries, affiliated companies and connections, form what is popularly known as the " Combine " so far as motor spirit, kerosene, and fuel, gas and Diesel oils are concerned. In the lubricating-oil trade there is no such " Combine." The " Combine " represents the only tendency towards rationalisation and horizontal agreements between the distributing and marketing subsidiaries of the large vertical groups, and is the only safeguard of the retailer against unorganised cut-throat competition. The " Combine " works in agreement with the Motor Trade Association, which interests itself in the protection of garage proprietors and dealers by the maintenance of fixed prices for proprietary motor goods, and with the Motor Agents' Association, which deals with all other aspects of the protection and development of the retail branch of the motor trade.

The first and most important point of agreement of the " Combine " in the motor spirit business is on the subject of which parties are and which parties are not legitimate customers. By agreement none of the " Combine " distributing in Great Britain sells direct to the private motorist. Their customers must either be recognised " Dealers "—that is, retailers of motor spirit, usually garage proprietors, —or " Commercial Consumers "—that is, owners of vehicles registered as commercial vehicles—a classification which does not include commercial travellers' cars or private cars used only for business or professional purposes. It is not to the interest of the distributing companies, however, to encourage very small commercial consumers without bulk equipment to require direct deliveries of spirit, since the trouble taken to give the service is much greater than can be justified by the value of the business, and the cost of distribution of spirit delivered in cans in small lots is very high. It is, therefore, the policy of the " Combine " distributing companies to encourage the very small commercial consumer wherever possible to go to the dealer. This serves two good purposes : it eliminates an undesirable customer from the point of view of the distributing company, and it increases the dealer's goodwill by giving him a desirable client.

A dealer must be a bona-fide dealer genuinely engaged in the motor trade on a site approved by the Motor Agents' Association if he is to obtain supplies from the " Combine."

This gives some protection to the people in the retail branch of the industry, who would otherwise have to meet much more competition than they now do from grocers, confectioners, tea-rooms and public-houses which had nothing whatever to do with the motor trade, but which could make a profitable side-line of a petrol pump on the street corner or in the front garden. No control is exercised over the number of dealers in a particular area. The M.A.A., in fact, approves any site where a man may wish to start in business as a garage proprietor or owner of a filling-station, and merely excludes people who, while carrying on some different business, wish to sell petrol as well.

The second great point of agreement between the "Combine" or "National" companies is on the price of those petroleum products covered by their agreement in the British Isles. This includes both wholesale and retail prices of spirit for dealers, which are fixed by agreement for the different zones throughout the British Isles, being cheapest in London and dearest in the outlying parts of Scotland and Ireland. There is also a fixed schedule of prices for ordinary commercial consumers in the various zones, and, in the case of large commercial consumers taking annually 25,000 gallons and upwards, special rebates are allowed.

The standard profit for the retailer of the "National" companies' brands is now (1930) fixed at three halfpence a gallon, but in addition to this there is a spot "loyalty" rebate of one penny a gallon, making a total profit of twopence halfpenny a gallon on all bulk spirit delivered, provided that the dealer sells in bulk only the products of the "National" companies, or of a group known as the "Independent" companies, which includes all the other fairly large distributors in the country with the exception of the Russian Oil Products, Ltd., viz. the Power Petroleum Company, United Oil Importers, Sealand Petroleum Company and Cities Service Company. All dealers obtain over most of the country twopence halfpenny a gallon on spirit in cans, the same profit as that allowed the "loyal" man on bulk spirit. Slightly different conditions prevail in the Inner London zone, where it is difficult to obtain permission to erect petrol pumps, and where on that account the "loyalty" rebate is extended to "packed" spirit sold in cans or barrels.

The "National" companies combine with the Motor Trade Association in endeavouring to maintain the retailer's

profit. In certain areas where competition among dealers is very acute there is a tendency, which would be much more widespread were it not for the efforts of the "National" companies and the Motor Trade Association, for short-sighted dealers to cut their standard profits. If left unchecked this would lead to a complete demoralisation of the retail branch of the trade.

Up to the end of 1928 the group referred to above as "Independent" companies were not co-operating in any way with the "National" companies. They supplied spirit to anybody who required it, whether he was in the motor trade or not, and only made somewhat feeble efforts to maintain dealers' profits. By the agreement of January 1st, 1929, however, the "National" companies ceased to discriminate in the matter of loyalty rebate against the brands sold by the "Independent" companies, who in turn agreed not to supply any fresh premises which were not approved by the Motor Agents' Association, and to make retailers whom they supplied maintain the same rate of profit as that allowed by the "National" companies. They further agreed with the "National" companies gradually to eliminate all non-branded petrol globes, *i.e.* globes on dealers' pumps which did not describe clearly the brand and grade being sold from the pump. The Power Petroleum Company, which draws supplies from Russia, further agreed to set aside 5 per cent. of their f.o.b. purchase towards the compensation of expropriated Russian oil interests.

The R.O.P. have since March 1929 been covered by a partial agreement under which they agreed to sell certain of their products to the "National" companies at 5 per cent. below the market price in lieu of paying 5 per cent. of the value of their f.o.b. purchases to expropriated owners of Russian oil properties, and restrictions were placed on their trade in the British market. Outside the agreement altogether are a number of small distributors. They are for the most part genuinely "Pirates," content to skim the cream of the easy business, and to leave the less profitable to concerns whose object it is to render some public service in addition to taking profits. Such companies are fortunately losing ground, as it is gradually being borne in on the public that their products are usually unreliable. They are drawn from different sources, and therefore vary a great deal in quality from one cargo to another, and do not approach any standard specification. The dealers are also

finding that such " Pirate " firms do not offer a good service, and are no help to the genuine dealer, as they sell to anybody, do not insist on price maintenance, and in some cases run service stations more or less openly, which cater for the private motorist, and to that extent rob the bona-fide dealer of his business.

CHAPTER IV

ECONOMICS OF OIL

Determination of Price of Petroleum Products

THE oil industry probably touches the economic life of the world at more points than any other industry. Its products include fuel for internal combustion engines, illuminating oil, lubricating oil, fuel oil and bitumen for road surfaces and other uses. These are only the more important of the products; there are, in addition, others used by cleaners and bleachers, paint manufacturers, patent-medicine manufacturers, and makers of rubber and rubber-compounds. This diversity of products and of their uses is the salvation of the industry. As the demand for one product declines there are sure to be compensating or more than compensating increases in the demand for others, and the perfecting of cracking processes has made it possible within limits to regulate the relative proportions of the different products with the object of adjusting supply to demand. The ease of transporting oil ensures that in any part of the world an effective demand will always bring an adequate supply on to the market, and that the ruling price will not vary from the world price by more than the cost of transport plus distribution, except for some temporary or accidental cause. The industry is extremely flexible, both as to its gross production, which can be rapidly increased at short notice whenever the total demand for oil increases, and to its distribution, for oil can be transported quickly and cheaply anywhere. A very young industry, it has already had to adapt itself to several sudden and revolutionary changes in technique and demand, and it has always done so quickly, efficiently and without difficulty.

On the side of production the oil industry is highly speculative. The cost of operating on a small scale has never been prohibitive, and the prizes held out to the fortunate individual who " strikes oil " in large quantities are tempting. For this reason there have at all times been too many people entering the producing side of the industry, and a

perpetual tendency to total over-production in relation to the demand of the period. The reason is just the same as in gold-mining, and fundamentally psychological. The average man is an incurable optimist, and therefore a gambler. He always over-estimates his chances of success in a speculative venture; hence industries in which the prizes, though few, are worth striving for tend to attract more labour, brains and capital than can be justified on ordinary economic grounds. Most of the people engaged in these occupations receive part of their wages in hope. Perhaps their philosophy is right. A pleasure is usually better in anticipation than in enjoyment, and the man engaged in a speculative occupation is certain of a lifetime of such anticipation. The unfortunate economic effect is that over-production is the common lot of speculative industries. In the case of gold, world-prices rise automatically to adjust the equilibrium between the supply and demand for gold. In the case of oil, nothing happens except that oil prices slump, or at best remain at a depressed level. This peculiarity of the oil industry has made its great problem one of distribution rather than production, how to find a market for the surplus products, or how to create a market for them, rather than how to meet the expansion in demand. The latter has only occasionally been a problem, but the former has been a difficulty almost constantly, and still remains the major problem of the industry.

The extent to which the production side of the industry is in the hands of small producers may be gauged from the fact that there were in 1928 4,140 producing companies operating in the U.S.A. However, some of the producers are vast concerns, and in the rest of the world the big producer is equally or even more in evidence. Although shares in many of the producing companies are distinctly risky, and in most speculative, nevertheless a return on the capital invested must be given to some companies, even if the whole of it goes to a small number of the more fortunate undertakings, in order to ensure continued and ample production of oil. The price must somehow be high enough, and the number of the fortunate large enough, to continue to attract capital to new enterprises.

The product of the oil wells is crude petroleum, which, when refined, yields a number of different products. The world-price for crude is regulated by the American price,

as the United States both produces and consumes the greater part of the world's supplies of petroleum. The price usually quoted is for " Pennsylvania crude," but this is really only of historical interest. Pennsylvania was the first oilfield to be opened up in the early days of the industry. Since then both the mid-Continental and Californian fields have far outstripped it in respect of output. Petroleum is not used much commercially in its crude state, and practically the whole of the output must be sold by the producer to refining companies. Refineries are usually at or near a seaport, and the crude petroleum must be transported from the producing field to the refinery. The method of transportation chosen was a novel one, introduced by J. D. Rockefeller in the early days of the Standard Oil Company. It is by pumping the oil through a pipe known as a " pipeline," which may be hundreds of miles in length, thus reducing handling charges to a minimum and dispensing with the need and cost of construction of a railway, or even of a road.

At the refinery the crude petroleum is refined into the marketable products, and these may further be cracked so as to increase the proportion available for motor spirit. They must be sold to distributing companies at a price which, on an average over the whole of the products, must be sufficient to make it worth while to produce and refine the crude. This is not unlike the method of assessing charges on a railway. A railway must earn enough to pay the wages of its staff, the interest on the capital borrowed, and to make good the wear and tear on its equipment, buildings and permanent way. It is impossible to allocate costs exactly between different commodities carried by the railways, so the system adopted is to charge what the traffic will bear on each commodity in such a way that the total yield from all commodities covers the cost of service, *i.e.* the cost of running the railway. Similarly with petroleum, the total yield of all petroleum products must be sufficient in general to cover the cost of carrying on the industry, but the allocation of that cost between commodities has to be on a basis of what the traffic will bear, according to the state of the market and the nature of the demand for each commodity, and the yield must be sufficient on total to cover costs. The general tendency of the industry towards over-production prevents the total yield from ever averaging much more than the cost of carrying on the industry, but

the cost per ton of the different petroleum products varies enormously, and the variation is due solely to demand, and is not attributable at all to different costs of producing the different products.

The relative cost charged for petroleum products does not remain constant over periods. If the demand for one product falls off, then attempts are made, not always wisely, to resuscitate it by dropping the price, and at the same time, much more wisely, to find new uses for the product, and so develop a new demand. If neither of these methods is successful, then the unwanted product is cracked, and more marketable commodities are thus obtained.

The central problem in petroleum production is not how to meet an expansion or a shrinkage in the total demand for petroleum, which is easy, but how to meet an expansion or a shrinkage in the demand for only one product, with a constant market for other products. Cracking helps, but is not a complete solution. Any further help must come from the marketing side rather than from the producing, and have the object, by means of advertising campaigns and all the other developments of high-pressure salesmanship, of stimulating the demand for the other products, in the event of a sudden increase in the demand for one, or, in the event of a sudden contraction, of endeavouring to find other uses for the product, and thus to maintain a well-balanced demand for all products. The importance of the distributing side of the business in this direction can scarcely be exaggerated. The maintenance of an equilibrium in demand makes it possible for all products to be sold at a reasonable price. Once the balance is upset the price of the product in demand will soar, and that of the other products will slump, a state of affairs undesirable alike from the point of view of the producer and of the consumer, as a stable oil industry is not possible without fairly stable prices.

There is a danger in this direction in the development of Government oil monopolies, as in Spain, in so many countries. Such monopolies are usually only distributors (although the Spanish monopoly is attempting to secure control of production also), and therefore are less likely to take a broad view of the whole situation than the international oil groups which are both producers and distributors. They will not be concerned with maintaining a well-balanced demand, the advantage of which to the consumer is only demonstrable in the long run, but will interest themselves solely in immedi-

ate requirements, without trying to develop the demand steadily for all products. If State monopolies of oil distribution were to become general, a complete upsetting of the ratios of the prices of the various products might easily result through marketing being unscientific with reference to the production position. Such an objection is, of course, not valid in the case of a monopoly which both produces and distributes, such as the combination of the Azneft, Grozneft and Embaneft in Russia with the Naphtasyndicat.

State distributing monopolies which tend to use the oil industry as a means of obtaining revenue make it possible for the internal price of petroleum products in the country where they are operating to vary considerably from the world-price; otherwise such variations are only temporary. The tendency to oil over-production ensures that in the absence of restrictions oil will be brought to any market where the price is higher than the world-price, which means in practice the American price plus the cost of transport and distribution, in order to take advantage of the higher rate of profit obtainable in the over-priced market. The surplus of oil thus brought will rapidly depress prices, as supply will outrun demand. This will quickly restore the normal situation, as the process will continue until there ceases to be any special incentive to sell in the market in question rather than in any other market.

Similarly, the price of oil in any market will not for long remain below the world price—*i.e.* the American price plus the cost of transport and distribution—because the profit on the market in question will be less than in other markets, and this will lead to a shortage, and a rise in prices to the world-level through demand overtaking supply. There are, however, one or two exceptions to this rule. In times of special over-production, particularly, it may not be possible to dispose of all the oil produced remuneratively. In such circumstances the price in one country, which is a desirable market, may be depressed for some time if two rival groups decide to fight for the trade. Contests of this kind usually take the form of a trial of strength by cut-throat competition and low prices, and, if one side is more sure of victory than the facts warrant, or if the diplomatic services of the two groups are not able enough to frame an agreement acceptable to both sides, then the struggle may last for some time, and the price of petroleum products remain not only below the world-level, but also below the cost of replacement.

Sooner or later, however, a peace must be patched up, as it is demonstrably against the interests of both groups to indulge in a war in which both lose money and only the consumer benefits. This being the case, as the groups are fundamentally run on business lines with the object of making a profit, the price must ultimately rise until it ceases to be below the world level. The market for oil is emphatically a world market, and the prices, apart from short-period fluctuations and taxes, are ruled by world-production in relation to world-demand. The ease of transporting oil makes this statement universally valid. The power which local distributors appear to possess of fixing prices in their own particular markets is strictly limited.

The price at any particular point of time is therefore much the same all over the world, after making due allowance for transport and distribution, but, nevertheless, there are probably few industries in which prices vary more from one period to another and vary more rapidly than in the petroleum industry, with its various products. These changes are, of course, due to the difficulty of maintaining an equilibrium between supply and demand, both in total and as between the different products produced. On the side of supply there are constant attempts to regulate production, especially in the United States, by agreements between the companies operating. From the longer point of view it is also easy to increase output over a period, as new fields such as those in Venezuela and Colombia can, with modern equipment, be opened up with extraordinary rapidity. The elasticity of supply is, however, all in one direction. The elastic can be stretched without any difficulty at all, but it is a long and tedious business to coax it back again to its previous length, and at best this can only be partially accomplished. The only way to restrict production is by agreement. The various small producers all hope that, by some stroke of luck, they may, through a particularly fortunate well, find themselves in a position to put oil on the market, even in a slump period, at such a low cost to themselves as to make their fortunes, whatever happens to the other producers. So long as this gambling element is present—and it cannot easily be eliminated—restriction will be a matter of extraordinary difficulty.

On the side of demand there is over a short-period relatively little elasticity in response to a general price change, except perhaps in the case of one product which

will be dealt with later on. The reason is that in most cases oil is not a large item of expense compared with the total expenditure. The cost of petrol is only a small part of the cost of running a car, and the cost of lubricating oil is a still smaller item in running a factory. There is admittedly a certain amount of elasticity in the demand for petrol, for instance. If petrol is very expensive, then pleasure motorists will not be likely to go for such long runs, and commercial vehicles may even, although this is less likely, put up their charges to such an extent as to make traffic go back to the railways. A high price may discourage people who are thinking of becoming motorists from buying cars. Lubricating oil must be used, and there is little or no elasticity in demand shown when the price changes. In general it may be said that the short-period effect of changes in the price of petroleum products is only noticeable when there is a readily available substitute at a price which is competitive, or which has become competitive on account of a price-change. If no substitute is practicable, then any change in price will have a quite negligible short-period effect on demand, for the reason given above. This is the principle on which taxation experts work when they point to petroleum oils as a suitable subject for taxation on account of the short-period inelasticity of demand, and it cannot be denied that an import duty, although having some effect on consumption, is not immediately ruinous for these products. It is only when the long-period effect of such taxes is investigated that the short-sightedness of the policy of taxing them becomes apparent. Taxation experts, however, are seldom interested in long-period effects.

The long-period elasticity of the demand for petroleum products is considerable, except perhaps in the case of lubricating oil, which must be used whether it is expensive or not—a fact which all buyers recognise. It is not so important, perhaps, that the prices of petroleum products should be very low as that they should be stable, changing, when they do change, in the right direction for the customer. Potential consumers, especially of fuel oil, are held off by the fear that, once they have burned their boats, the price will be raised against them. However, even over the long-period, although, as a general rule, a decreasing price will stimulate demand and increase sales, a rising price will not actually reduce sales, but will rather prevent their expansion, especially in the case of petrol.

In view of the tendency of the industry to over-production, and of its continued expansion, the policy of the enlightened oil groups is likely to be to maintain prices stable and fairly low. With the ever-present threat of over-production, any attempt to put prices up to an appreciably higher level, as was possible in the conditions during and immediately after the War, will be courting disaster, since the general position of the market will not allow it. With such a multitude of producing agents, it is unthinkable that sufficiently drastic restriction could ever be agreed upon to make a large all-round rise in prices at all possible. The problem of the distributing companies will rather be how to dispose of steadily increasing quantities of petroleum products, and that problem can only be solved by reasonable and stable prices, and the absence of punitive taxation. Merely to maintain the *status quo* will be equivalent to failure. Success can only be achieved through a vastly increased rate of production and consumption of oil.

Variations in Demand for Petroleum Products

In the early days of the petroleum industry the most important product commercially was kerosene, or illuminating oil, which rapidly displaced the existing lamp oils and candles. Other petroleum products had at that time practically no market. The growth of motor transport completely changed this position, and, relatively to the enormous demand for benzine which grew up, the kerosene trade languished. At the present time, in Great Britain, which is a fair example, 40 per cent. of the total demand for petroleum products is for benzine or motor spirit. The amount of " straight run " benzine—*i.e.* benzine distilled straight from the crude—obtainable from the world's oil production was insufficient to meet this demand, so that producers were faced with the problem either of increasing the total production, and thereby obtaining large quantities of petroleum products other than benzine for which there was no market, or of converting part of the less saleable products, such as kerosene, into motor spirit. A process was introduced, technically known as " cracking," by which kerosene, for instance, could be " cracked " into lighter and heavier fractions, and the lighter fractions used as motor pirit. The solution of the problem was mainly found in this way. It is stated by Davenport, in " The Price of

Petrol," that the proportion of motor spirit recovered from crude in the United States increased from 18·2 per cent. in 1914 to 25·9 per cent. in 1919, and to 36·7 per cent. in 1927, increasing each year. Such a process cannot, however, be continued indefinitely, in the present state of technical knowledge, and the time is already approaching when the cheapest way to produce more benzine will be to increase the output of crude rather than to intensify cracking operations.

Benzine is undoubtedly the most important of all the petroleum products in the present world economy. It is also relatively expensive compared with kerosene or fuel oil, largely on account of the nature of the demand, which is neither particularly elastic nor sensitive to price changes. At the present price-level, motor spirit accounts for only about one-sixth of the cost of motoring, the total amount of which is hardly likely to be affected by ordinary commercial changes in the price of such a small item. An increase of even 20 per cent. in the price of benzine will make a year's motoring only 3 per cent. more expensive, and a similar reduction in price will, of course, not have a greater effect.

Benzine is necessary for motor transport, as there is at present no really effective substitute available at anything like the same price. If the price is made too high, it may discourage motoring a little, but that is not the public's safeguard against an excessive price. The motor spirit market is a comparatively easy one to enter, and any increase in price over world prices would quickly attract competitors. The world price must, however, be determined on the lines of "what the traffic will bear," so that with the return on other products, the total yield may be sufficient to make it worth while to continue production. With petrol the traffic will bear a relatively high price. Producing companies must try to get back their costs, and it is probable that they will rely mainly, perhaps increasingly, on petrol to do this for them. Motoring is expanding rapidly in all parts of the world, and offers a strong market for petrol. The most important of the other products obtained from the crude, kerosene and fuel oils, seem destined for the present to be in the nature of "passengers" carried on the back of the petrol trade. This is especially true in the case of fuel oil.

The market for kerosene is weak because of the spread

of gas and electricity, and the prices obtainable for fuel oils are very low, since they have to be competitive with coal, and coal prices are, and are likely to continue to be, extremely weak, owing to world over-production in relation to the present-day demand. As motoring increases throughout the world it will be necessary to open up new oilfields to provide petrol, and as the markets are so weak for kerosene and fuel oils, the cost of opening up the new oilfields must be borne mainly by petrol, and the price of petrol will of necessity have to be fixed high enough to make it worth while to increase production.

Any appreciable increase in the price of petrol would undoubtedly lead to a transfer in the demand for cars from the larger makes to those with a low petrol consumption, especially if the rise came suddenly, but in spite of considerations such as this, it is a reasonable deduction from experience during and immediately after the War that the elasticity in the demand for petrol is not great. Where there is no obvious substitute, the relative elasticity of demand for different commodities depends on how far they are luxuries and how far necessaries. Thus the elasticity in the demand for bread is very small. Bread is a necessary, and expenditure on bread is given priority of place in most family budgets to expenditure on anything else. The demand for Havana cigars, on the other hand, is very sensitive to changes in price, and has been almost killed by heavy taxation, because Havana cigars are a luxury, with many substitutes. The elasticity of the demand for petrol is not very great, because it is necessary for every motorist, but the expenditure on it, nevertheless, is not a large part of his total expenditure.

Kerosene has to be marketed under very different conditions from motor spirit, and its distribution presents quite different problems. The original use of kerosene was as an illuminant for lamps, with the natural development of kerosene stoves for heating and cooking. Even at the present time half the kerosene sold in Great Britain is for domestic purposes. This, however, is not an expanding market, and the users are almost all people in country districts, especially remote country districts where there is no gas and only privately-generated electric light, and, to a certain extent, the poor in towns, although gas has largely ousted lamps from favour with them. The great kerosene markets of the world are among the peasants of the East,

but there is a ready sale of kerosene wherever there are large populations removed from the amenities of modern civilisation. However, the spread of such amenities into comparatively poor and remote districts, which forms such a large part of the development programme of almost every country, will inevitably slowly kill the trade in kerosene for domestic purposes, and the outlook would not be promising were that the only use for the product.

The " cracking " of kerosene for the production of motor spirit has already been referred to, but, in addition, entirely new markets have been found in several directions. Garages are using kerosene in large quantities for car-cleaning, as it is a cheap and useful solvent of grease and dirt. More important still, perhaps, is the field opened up by the gradual industrialisation of agriculture. Agricultural machinery is largely run on kerosene, and the possibility of extending sales in this direction is promising, as machinery appears to offer the only salvation for arable, and even for dairy farming. Agriculture suffers from the low price of its products relatively to manufactures. Hitherto attempts to organise farmers with the object of making the terms of the exchange more favourable to themselves have not been markedly successful, even from behind the protection of a tariff wall. Without that protection, which is not likely to be provided in this country, they have little chance of success. The only solution is therefore to reduce costs. Rates and taxes on farmers are now so low as to leave little room for further reductions, and rents are also low. The only other costs are materials, and implements and labour. The cost of the first might be reduced by co-operative buying. The cost of the second obviously cannot be reduced by cutting wages which are already as low as the social conscience of the country is likely to tolerate. The only alternative is to increase the productivity of labour by the use of more machinery, and it is to this alternative that farmers are turning. The tendency of agriculture will be to use more machinery and more kerosene.

Fishing-boats and other coastal sailing craft are now for the most part fitted with auxiliary motors using kerosene, and offer a steady market, and there is also a considerable industrial use for kerosene as a fuel for internal combustion engines. The growth of these various uses for kerosene is, however, barely sufficient to make up for the decline in domestic consumption, and there is no likelihood of checking

that decline, because kerosene lamps and stoves are dirty and troublesome, and require a great deal more labour in cleaning and adjusting than do systems using gas or electricity.

Kerosene consumption, however, is not very sensitive over short periods to price changes, and even over long periods the demand is rather inelastic. The rural consumer of kerosene for domestic lighting only uses it because there is nothing else available. Gas and electricity would be preferred, and a person would hardly be deterred from installing them by the fact that kerosene was cheap. The up-to-date farmer finds the economy of machinery so great that he is not inclined to cease to use it merely because kerosene is expensive, and the same applies to the fishing-boat, except in so far as other petroleum products can be used instead. The industrial user who wants kerosene to provide the power for his machinery is perhaps the most likely to be in a position to turn readily to a substitute, but on the whole he will find his kerosene only a small part of his working costs, even if the price be high, and if he is finding it more suitable for his purposes, will not wish to change. A large reduction in the price of kerosene relatively to other petroleum products would probably do little to help sales. The fall in the domestic consumption could scarcely be checked, and other users would certainly benefit by the price change, but would hardly expand their demand proportionately, as kerosene forms such a small percentage of their total outgoings.

The demand for lubricating oil is definitely non-elastic, but, in spite of that, profits on lubricating oil sold for industrial purposes are exceptionally low, on account of the large number of " blenders," and the intensity of competition. Lubricating oil is necessary; there is no substitute, and the proportion of operating expenditure in a factory, or even in running a car, spent on lubricating oil is negligible. It has therefore all the qualifications required for a product with an inelastic demand. The market for lubricating oil is partly dependent on the spread of motoring, lubricating oil for motors accounting now for perhaps 25 per cent. of the total. The demand for lubricating oil for general industrial purposes is dependent on industrial activity, and cannot be affected much by variations in the price.

With modern cracking processes the two chief petroleum products are motor spirit and the fractions known as fuel

oils, including fuel oil proper, gas oil and Diesel oil. Each of the two accounts for nearly 40 per cent. of the British consumption of petroleum products, and for not far short of that proportion of the world's production. The increased demand for motor spirit has led, since the War, to an enormous expansion in the demand for crude petroleum, in spite of cracking processes. The world production of crude increased from 68,000,000 tons in 1918 to 186,000,000 tons in 1928; production in the United States alone increased from 47,000,000 tons to 130,000,000 tons. There has not been the same increase in the demand for other petroleum products, and as by far the greater proportion of these consist of fuel oil, the problem of creating markets for fuel oil has become one of urgency to the industry, since, if motor spirit prices are to be at all reasonable, it will be necessary to find a way of disposing profitably of fuel oil.

In this group the market for gas oil is expanding steadily with the increasing consumption of gas, and also with its growing industrial use, but there is not much prospect of any spectacular increase in the power of the market to absorb this product. The demand for Diesel oil is expanding with the increase in the percentage of shipping using Diesel engines and the growing popularity of Diesel engines for industrial purposes. A further and desirable development might be an increase in the use of Diesel engines for heavy lorries, as this would relieve some of the pressure on petrol, and make the market for Diesel oil rather firmer. The difficulty in this will be whether the saving in cost will make the change sufficiently attractive. The price of Diesel oil is extremely low, and, if the demand increased, might be expected to rise. Furthermore, a large part—in fact the greater part—of the cost of motor spirit consists of retailer's profit, cost of distribution and the petrol tax, and, if Diesel oil for use on lorries were also taxed—and it is difficult to see how this could equitably be avoided—and a distribution system were required for Diesel oil for lorries similar to that given for petrol, the price would rise to a figure much closer to that of petrol than now rules in a market where consumers are mainly large buyers taking several tons at a time. Diesel oil is also used for some central heating plants.

The general problem, however, is how and where to find a profitable market for fuel oil, which is produced in very much larger quantities than either gas oil or Diesel oil, and is all the time in direct competition with coal.

Fuel oil is used extensively and increasingly for raising steam, both in the shipping and industrial worlds, and for many purposes offers advantages over coal. The growing popularity of oil for shipping is shown by the following table, taken from Lloyd's Register of Shipping :—

	1914. Percentage of total gross tonnage.	1929. Percentage of total gross tonnage.
Sailing vessels	8·06	2·45
Oil, etc., in internal combustion engines	0·45	9·73
Oil fuel for boilers	2·65	28·53
Coal	88·84	59·29
	100·00	100·00

The proportion of motor shipping to total is average in Great Britain, below average in the United States and Japan, and above average in the Scandinavian countries, where it is over 30 per cent., and in Germany.

There is scope for a considerable increase in the use of oil in this direction, but whether such an increase can be profitably obtained is another matter. Oil is cleaner than coal and requires less labour, but it is rather more expensive, and, with costing carried to a fine art, it is this factor alone which counts over a large proportion of business. This being the case, it is obvious that the reason the return on fuel oil is so low, and therefore indirectly that the price of petrol is higher than it would otherwise be, as the total return from all products must in the long run cover costs, but can only be divided among the products according to "what the traffic will bear," is the low price of coal, for which a number of factors are responsible.

Belligerents attempted to maintain their coal output during the War, and drafted men into the mines. Immediately after the War there was plenty of employment for these men, as prices were high, the demand for coal being relatively inelastic over short periods, and the French and Belgian coalfields were out of action, while the Silesian coalfield was disturbed politically. The return of the French and Belgium pits to their full productive capacity coincided with the dislocation of the Ruhr, so that the general overproduction and slump did not become apparent until 1925. The factors to be taken into account in causing the slump were the more economic methods of utilising coal, the introduction of which had been encouraged by the high prices of

the post-war boom years, and the use of substitutes, more particularly electricity generated by water-power, lignite or brown coal, and oil. The large number of men employed, their strong trade-union organisation, and the lack of proper national organisation, at least among British coal-owners, and of international, or perhaps more strictly continental organisation of all European coal-owners, prevented a contraction of the industry to an economic size in all producing areas, the solution which is obviously the only way of remedying the situation. The relative inelasticity of the demand for coal would make a reasonable price rise all round harmless, and would not prejudice one country in competition with the others. Instead, everybody fought to obtain a larger share of a smaller total market, and prices universally slumped. Except during the artificial shortage created by the long stoppage in the British mining industry in 1926, fuel oil prices have inevitably slumped in sympathy with coal, and, with coal at a price at which it is almost impossible for a European miner to obtain a standard of life comparable to that of workmen of a similar degree of skill in other occupations, it is extremely difficult to expand the market for fuel oil at the rate at which it should be expanded in order to keep pace with the growth of the demand for motor spirit.

Rationalisation

The problems facing the coal and oil industries are to a certain extent comparable. Both industries tend to suffer from over-production. Coal is still mainly used in the raw state, but, if the industry is ever to regain its former prosperity, it will be through the sale of so-called " by-products," and gas and electricity. Crude petroleum is very little used commercially, and to a greater extent than coal the prosperity of the oil industry depends on " by-products." None the less, both are industries in urgent need of rationalisation. By this is meant that both are industries which are in a position to take advantage of the possibilities of large-scale production and large-scale marketing. Rationalisation involves the concentration of production on the most efficient producing agents; the supplying of markets from the nearest and therefore cheapest sources of supply, and the adjusting of supply to demand by rationing output among producers.

Modern industry is a highly complex structure, and to

operate at maximum efficiency, it must be sure first of all, in its capacity of a consumer of certain products of common consumption, that supplies will always be available in sufficient quantities at a stable price, and secondly, in its capacity of a producer, that there will be a steady demand at that price, so that there may be some basis on which to calculate when considering technical or other improvements involving increased expenditure, and giving some security of employment for the workers. It has been found in practice that these conditions are not met when the basic industries are left to free competition and the unrestricted working of the law of supply and demand, and, in fact, that their natural tendency is towards more or less violent fluctuations in output and prices working in a kind of vicious circle.

The oil industry, which supplies one of the first necessaries of modern life, has suffered more than most industries from irrational production and distribution. The gambling instinct has loaded the industry with a permanent tendency to over-production, and on the marketing side fierce fights between rival groups, accompanied by cut prices, are followed by agreements, when the groups have to recoup themselves for their losses in the previous price war. The result is fluctuating prices in a basic industry.

Apart from production without reference to demand and unnecessary price-wars, an enormous amount of waste has resulted from the organisation of the industry into vertical groups, including producing, refining, transport and marketing companies. The marketing subsidiaries of these groups operating in most parts of the world have to draw their supplies from their group's oilfields, which are often much further from the market than those of other competing groups; hence the amount of transport involved in the oil industry is far greater than need be the case. On the marketing side also there is a great deal of wasteful duplication of equipment and overlapping.

The first part of the process of rationalising the petroleum industry must consist of getting some sort of control of production, as the evils of the industry arise from over-production and the consequent fight for markets and fluctuating prices for consumers whose desire and need is stability of prices. This can only come by agreement among all producers in all the oilfields of the world, and is therefore a task of enormous difficulty. In view of the fact that the

United States alone, with 70 per cent. of the world's production of petroleum, has 4,140 producers, the difficulty of fixing quotas in such a way as to satisfy everybody is colossal. There must inevitably be a tendency for the more fortunate producers with the lowest cost of production per barrel to rebel at the restrictions imposed upon them, and, relying on their low production cost, produce to full capacity, and trust to their ability to under-quote other companies to enable them to find a market.

Local demands will be met from local sources, so that the real difficulty is with the export trade. As the United States are by far the largest producers, consumers and exporters of petroleum products, the lead here must come from America, and the method by which attempts are being made to control the export trade is by a Sales Agency of the type usually associated with Continental Cartels, such as the Westphalian Coal Cartel, which must be representative of all producers. If such agencies could be established in all producing countries, it would not be difficult to cut out unnecessary transport by supplying each market from the nearest source of supply, and ration the amount sent on to the various markets of the world according to demand. Rationalisation of oil must be international in its scope to be effective, because oil can so easily be transported, and the formation of an Exporters' Association buying definite quotas from producers, and so regulating sales to marketing prices through controlling the whole export trade, seems to be the best way of carrying through rationalisation.

There is among a majority of ordinary consumers a not unnatural fear of monopolies and international combines, as it is assumed that such organisations would act without conscience and with the sole object of bleeding the public by extortionate charges for the products they were selling; the fear of this appears to be very exaggerated, and within limits the interests of hypothetical monopolists and consumers would be, in the case of oil, much the same. In the first place, the alternative to combination among producers for the good of the industry as a whole is cut-throat competition, which is thought to be advantageous in some quarters. This view is quite erroneous, as has been shown by the respective fortunes of the coal industry in Great Britain and in the Ruhr in the past few years. Cut-throat prices in the coal trade brought the pit-head price of coal down

from 18*s.* 10*d.* a ton in 1924 to 12*s.* 10*d.* a ton in 1928, against 10*s.* 1½*d.* in 1913, with corresponding reductions in miners' wages. There is no question about industry being able to stand a higher price; it can very well afford it so long as competitors are given no differential advantage. The average wage per shift in the Ruhr industry in the same period rose from 5*s.* 5½*d.* to 8*s.* 2½*d.*, and the output per man-shift correspondingly increased. The explanation is that the German industry was rationalised in this period. Price were maintained in the home market, production was concentrated on the best seams of the most economical mines, plant renewed and new machinery installed. The result has been a prosperous industry and stable prices. In England competition has been so intense that profits have been cut to a minimum or have become losses, and there has been no surplus available for renewing plant or installing machinery. The standard of living of the miners has been continually and unnecessarily depressed, and certain consumers, such as the railways, have come to rely partly on depressed and falling prices of coal as a means of showing low running costs and apparent annual economies in working. Other consumers have, of course, also been subsidised, for that is what it amounts to, and consumers of coal in general are growing accustomed to paying too little for it, and, when the price returns to its economic level, as it will after a painful process of gradually forcing out of production the less economical pits, there will be a grave disorganisation among industries which have been unnecessarily and unnaturally subsidised by cheap coal. A fair and stable price for coal would in the long run have been better both for producers and consumers. Consumers may benefit for short periods from obtaining commodities at uneconomic prices, but in the long run, producers, when the opportunity comes, must not only raise their prices to an economic level, but also recoup themselves for their losses. The consumer's interest is to have stable prices over the whole period, rather than sharply fluctuating prices.

However, it may be claimed that with combination extending over a whole industry, prices may be stable, but will nevertheless be too high, as there will be no guarantee against the combine bleeding the public. It has already been seen that the demand for most petroleum products is comparatively inelastic over a short period, a fact which

at first sight might seem to lend colour to this fear. There are three reasons, however, why an all-powerful combine, assuming it had no regard whatever for the public, would not do this. The first is that although demand is inelastic over short periods it is much more elastic over long periods. Taking the long period point of view, the interest of the combine is to increase the demand for petroleum products, and so increase its profits as the potential expansion of demand is almost unlimited. A policy of excessive prices is very short-sighted, because it ultimately checks demand, and therefore prevents a steady increase in profits. It might be argued, of course, that there is nothing to prevent a combine being short-sighted, and preferring to sell a small quantity at a large profit per unit rather than a large quantity at a small profit, but the safeguard here is that the choice between the two courses is only possible for a monopoly marketing a commodity for which there are no substitutes, and the existence of substitutes is the public's second guarantee against excessive prices. If petrol prices were excessive, an enormous impetus would be given to the production of oil from coal and shale, and to the use of alcohol and producer-gas for internal combustion engines. The heavier road vehicles would again be steam wagons. Kerosene is directly in competition with gas and electricity, petroleum lubricating oil with vegetable oils, fuel oil with coal, and asphalt with tar. It would not only be short-sighted on the part of the petroleum industry to charge excessive and unreasonable prices in view of such a position : it would be suicidal.

The third protection of the public is that the petroleum industry, for various reasons already considered, suffers from a permanent tendency to over-production. This may be slightly curbed from time to time, but it is always present, and the impossibility of checking production for long would, apart from all other considerations, always bias the petroleum industry in favour of low prices and a big output, rather than high prices and a small output. The latter would be too big a temptation to producers to break any agreement for restriction into which they had entered.

In one important respect the oil and coal industries are dissimilar. The largest producers of coal—the United States, Great Britain, Germany and Belgium—are also the largest consumers. Except for the United States, the largest producers of oil—Venezuela, Mexico, Persia, Colombia

and Russia—are not the largest consumers. Oil is, broadly speaking, produced in backward and undeveloped countries, and sold to the industrial communities of Europe, Australasia and North and South America. This means that, excepting the United States, most of the oil of the world is an export of one country and an import of another. As oil is now necessary to existence, and especially to the existence of modern navies and armies, there is always a temptation for the Governments of the developed importing countries to attempt to exercise undue political influence over the Governments of the backward exporting countries from which they draw their supplies. It is this tendency which has led to the association of oil in the minds of the public with doubtful political ventures of various Governments. In so far as this association is intended to imply unscrupulous wire-pulling on the part of the oil companies, it is probably unjustified, except perhaps for a few of the concession-hunters.

In spite of the world-wide ramifications of each oil group, the control of the group is usually national, either American, British or Anglo-Dutch. It is sometimes supposed from this fact that national rivalries between the groups are inevitable, and that in due course, owing to the interest of Governments in oil, this must lead to war. Such prophecies have been made hopefully for many years by the enemies of an Anglo-American entente, and in general the wish is so obviously the father to the thought that they scarcely deserve notice. They are based upon the quite wrong assumption that there is a shortage of oil in the world and that the Great Powers will have to fight for oilfields in order to ensure themselves a regular supply. This is ridiculous, in view of over-production; efforts are more likely to be directed towards slowing down the development of new areas than towards fighting for them, and, quite apart from that, the assumption is made that the American consumer has a monopoly of all oil produced in the United States, and presumably the British consumer of all oil produced in the British Empire. The market for oil, like the market for wheat or cotton, is a world-market, and therefore there is a ruling world price. At that price oil will always be available for any buyer who can pay, and, in time of war, can protect his transport. In ordinary times oil can, of course, be bought by anybody. The bulk of the oil used in Great Britain is imported from the United States. British

capital is interested in some of the companies which produce it in the U.S.A., and American capital in a number of the companies which distribute it in Great Britain. If, in the future, there should even appear to be a danger of a world petroleum shortage, the effect would scarcely be to impel nations to go to war for what little remained. What might be expected to happen would be that a stimulus would be given to the development of the numerous substitutes for the various petroleum products.

CHAPTER V

ORGANISATION OF THE OIL DISTRIBUTING COMPANY

Sales Organisation

THE companies distributing petroleum products have two main objects: Firstly they wish to sell as much as possible, and secondly they want their cost of distribution per gallon to be as low as possible. The organisation of the distributing branch of the oil industry is entirely directed towards these ends, and therefore involves two main functions: selling and transportation.

Most of the petroleum used in Great Britain is imported in the refined state, although a certain amount of crude petroleum, representing something under 20 per cent. of the total consumption, is imported and refined in the country at Shell Haven, the refinery of Shell-Mex, Ltd., and at Llandarcy, where National Oil Refineries have their plant. The oil is discharged from ocean tanks into storage tanks at various installations round the coast, usually in more or less remote spots, in order to avoid the risk of possible fires spreading and doing damage to property. Probably the two largest installations are those at Shell Haven and Thames Haven, in the Essex marshes on the Thames estuary, but there are others of a considerable size on the Bristol Channel at Avonmouth and also in the neighbourhood of the great ports of Liverpool, Southampton, Hull and Newcastle. The various products are stored at the installations and blended to the correct specifications.

The oil companies are considerable employers of labour at their installations. The labour problem is a difficult one, because, as explained above, installations are usually some distance from towns of any size, and special arrangements, in the case of Shell Haven and Thames Haven necessitating a special railway line and trains, have to be made to take the employees to and from their work. A large proportion of the work at installations is not very highly skilled, and much of the labour is low-grade, approximating often to that of dock labourers. It is, however, fairly regular and

exacting, and the standard of wages is high compared with the usual rates for unskilled workers.

After bringing the oil into the country, the next problem is to distribute it, and to understand the work involved in this it is necessary to turn to the sales side of the business. So far as motor spirit, kerosene and lubricating oils are concerned, the sales unit is the depot. The larger companies each have hundreds of depots in the country supplying spirit, kerosene and oil to dealers and commercial consumers throughout the area served by each depot. Some of the depots are situated in large towns, some in small towns, others in market towns in the purely agricultural areas, but almost invariably they are adjacent to the railway sidings, and usually on railway property. Naturally the amount of business done from each depot varies very considerably, according to the type of district and the area served, and hence the staff employed varies also, but on an average the following is the most usual organisation.

There is first of all the depot Superintendent, who is responsible for the general supervision of the work at the depot, for the organisation of the work of the lorries attached to the depot, for calling on customers and canvassing new buyers, and also for a certain amount of clerical work. If he performs all his duties adequately, he is probably the most useful, and certainly the most hard-worked man in the business, especially in the summer, when his work often lasts as long as the daylight holds. In a very large depot the Superintendent may have one or more assistants to help him with his work, and in the case of small depots a single Superintendent may be responsible for two or occasionally even three depots, but normally there is one Superintendent to each depot. The Superintendent, who is provided with a car, is in charge of all the work done in the depot. He is responsible for the correctness of any clerical returns rendered, for the routing of the lorries, for calling on all customers of the company and keeping in touch with them, clearing up any misunderstandings which may have arisen, seeing that their sales do not fall off, and for selling new bulk storage equipment; he must also canvass potential customers and know what trade exists in his area and which of the companies are obtaining it. There are, in addition, queries from his superiors and complaints from the men under him, besides a hundred and one other things, so that a Superintendent usually finds his time pretty well occupied,

and, like the policeman's, his lot is not always a very happy one.

The depot premises consist of several underground storage tanks, an office and a number of sheds. It houses the equipment necessary for pumping from rail tank-cars into the storage tanks, and from the storage tanks into the bulk tank lorries which actually perform the work of delivery, and also that concerned with repainting, cleaning and filling cans. On account of the risk of fire, artificial light is not permitted, except for one small bulb, which is inserted into petrol cans to test for rust, and smoking, or even the possession of matches, is forbidden under very heavy penalties. The sheds, office and outer wall are usually constructed out of corrugated-iron sheets, which, although sometimes an eyesore, are nevertheless comparatively fireproof, and serve to minimise the risk of an outbreak.

Under the Superintendent the depot staff may be divided into two sections: inside and outside. The inside staff consists of a storekeeper, who is the senior man on the spot, and responsible to the Superintendent for all the work done inside the depot, an assistant storekeeper, responsible to the storekeeper for the clerical work and records, and one or two or even more odd-job youths, whose work consists of painting, repairing, washing and filling petrol cans, helping to load and unload the lorries, and making themselves generally useful.

To each depot are attached a number of lorries for delivering to customers the motor spirit and the other commodities dealt with at depots, such as kerosene, and motor lubricating oils. A very small depot may perhaps have only one lorry, whereas a large depot may have half a dozen or more, according to the amount of work to be done. The outside staff consists of the lorry-drivers and lorry-boys, one driver and one boy normally being attached to each lorry, although in the case of the smaller lorries the boy may be dispensed with. The driver must be a salesman as well as a driver, in much the same way as the driver of a milk-float, and, in addition to his wages, a commission or bonus is commonly paid to each driver on the motor spirit, kerosene and motor oils he delivers. The driver must also collect payments, among his other duties. The sales effected from a depot depend to a considerable extent on the ability of the drivers, as well as the superintendents, and the qualifications required of a driver are therefore high.

Customers who take regular deliveries are called on by the lorries, which have to be routed in such a way as to effect their calls at about the time that a further order from the customer is due. The distribution system given in this way is excellent, but, in addition to this, a customer can telephone to the depot if he requires an immediate delivery, and it is the business of the Superintendent to make his arrangements such that the requirements of the customer can be met with the minimum of delay.

The depots are, for purposes of organisation and control, grouped together in Divisions, some thirty or so depots going to form a Division. Each Division consists of a clearly defined territory, comprising the areas included in the depots which go to constitute it. There is a Divisional Office with a clerical staff, and in charge of the whole is a Divisional Manager. The last-named is, in fact, a sales manager, primarily in charge of the Superintendents, drivers and others engaged in the business of selling. He is assisted usually by two Assistant Divisional Managers, one of whom will look after one half of the Division, and the other of the other half. At the head of the clerical work of the Division is the Divisional Accountant; he is responsible for all the accounts, records and statistics which are compiled from the information sent in from the depots.

A large distributor may perhaps have the country divided into as many as twenty Divisions, and, if each Division includes an average of thirty depots, there would then be approximately 600 depots. Selling enthusiasm is stimulated between the different Superintendents by a system of comparing results from the different depots, and gingering up those where sales are sagging. The same process is carried out to a certain extent between the Divisions, which are controlled by Sales Managers at the Head Office in exactly the same way as the depots are controlled by the Divisional Manager at the Divisional Office. As the need becomes evident new depots are opened and territories re-distributed, and Divisional Areas may even be altered and new Divisions carved out of the old. Changes are so frequent in the oil industry that it is imperative to keep the whole organisation as flexible as possible. A company which neglected to do this, would soon begin to lose ground and fall behind.

The products distributed through depots are broadly those for which customers are very numerous and the average delivery is rather small. The other petroleum

products, such as fuel, gas and Diesel oil and bitumen, are usually bought in considerable quantities, although by a rather small number of customers, and for that reason the unit made by the depot is normally, except perhaps for oil for central heating and the canvassing of business of that kind, rather too small to give economical distribution. The above products are partly dealt with from the Head Office and partly from the Divisional Offices, where there are one or two experts attached to each product as salesmen and supervisors. They actually arrange for deliveries from the nearest installation or sub-installation, as the depots are not ordinarily equipped with storage for products of this kind.

Small companies distribute all their products in this way from one or two installations, and manage without depots and their expensive equipment, but such a method would not be practicable for a large concern, which is able to cover the ground more thoroughly by a network of depots than in any other way. The depot system also makes it possible for the local Superintendent to keep personally in touch with the business. It is too expensive a system for a company which is only marketing one subsidiary product. Such companies cannot cover scattered territories very effectively, and are at a decided disadvantage compared with the composite companies, on account of the extremely limited frequency of the calls which their salesmen are able to make on their customers. The singleness of purpose attainable by a man selling only one product is probably outweighed considerably by this disadvantage.

On the sales side the organisation therefore, starting from the bottom, consists of lorry-drivers working from a single depot and responsible to the Depot Superintendent; Depot Superintendents responsible to Divisional Managers; Divisional Managers responsible to Head Office Sales Managers; Head Office Sales Managers responsible to the General Manager. Similarly the clerical records prepared at the depots have to be forwarded to the Divisional Office, where they are summarised depot by depot, and again forwarded to the Head Office, where they are summarised Division by Division as well and carefully studied by the management, this being the only possible way of keeping track of events in such a huge organisation. As the activities of a large distributing organisation of this kind are so widely spread that there is no possibility of keeping a

rigid personal control over all units, a very detailed system of records has grown up.

Distribution and Distribution Equipment

It was shown that the function of a distributing company was not merely to sell as many of its products as possible, but also to distribute them as cheaply as possible, thereby increasing the profit per gallon. There are two stages in the process of distribution or transport which affect the distributing company. There is first of all the distribution or transport from the installation to the depot, from the depot to the consumer, and secondly the cost of distribution, and both processes must be costed very exactly. The factors to be considered in the cost of distribution from the depot to the consumer are the vehicles in which the product is carried, the type of package in which the product is packed, and the facilities for delivering it expeditiously to the consumer. Each of these is the object of constant careful attention on the part of the distributors.

The oil distributors are among the largest operators of motor vehicles in the country, and each company has an organisation for dealing with the fleets. Arrangements must be made for garaging and cleaning the vehicles and making minor adjustments. Central depots are required to which vehicles can be sent for more extensive repairs and overhauls, and there must be a system for the minute costing of all vehicles. Over all, a supervisory department is required to study the problems which arise, be responsible to the management for the conditions of the motor fleet, compare the suitability of different types of vehicle for different tasks, and keep abreast of technical improvements in motor vehicles which may be of interest or importance to the company. Programmes of buying, overhauling, painting and repairing vehicles have to be drawn up, and arrangements have to be made for growth in the organisations. Licences and insurances have to be attended to, the most favourable possible terms obtained when buying new vehicles, and accidents to vehicles on the road carefully watched.

A department is, of course, required to watch the fleet from the mechanical point of view, but, in addition, it is necessary to compare the cost of distribution by the lorries at different depots, to obtain satisfactory explanations in the case of expensive depots, and to try to standardise the

routing or other methods which may be found to account for the greater economy of operation at some of the cheaper depots. Some distributors employ transport experts attached to each Division to organise the routing and make sure that the available lorries are being used to the best possible advantage. It is also necessary to ascertain at the Head Office that the number of lorries is sufficient for the needs of each Division, and also that in no case is it in excess of the needs. Ultimately it is the business of the Superintendent to organise the routing of his own lorries. He must see that all customers are given an adequate service, but that nowhere is there any unnecessary duplication or overlapping. Lorry costs form such a large proportion of the total cost of distribution that it is of the greatest possible importance to organise a system which will obviate any waste under this head.

In addition to the actual cost of operating the lorries, there is the factor of the suitability or otherwise of the containers in which the oil is carried. It was formerly the rule to distribute most petroleum products in barrels or cans of some kind, and this involved the laborious business of filling the packages from the storage tanks at the depot or in some cases at the installation, of carrying round the packages on the lorries and unloading them at the customers' premises, and subsequently of collecting, cleaning, repainting and repairing the empties. This is an expensive method of distribution, and the present tendency is, wherever possible, to distribute in bulk; in the case of motor spirit, for instance, to pump the spirit from the tanks at the depot into tanks carried by lorries, and then to pump it out again into tanks situated below ground at the customer's premises. This has been found by experience to be very much cheaper for all petroleum products where there is enough business in a district to give full-time employment to a bulk vehicle. In some products, such as lubricating oils, there are many districts which do not justify whole-time bulk vehicles, and in these deliveries in containers known as "churns" are found to be the most suitable method. It is part of the business of the management to reduce distribution costs by encouraging as large a portion of the deliveries as possible to be made by the most satisfactory method from the point of view of the distributing company, by using such means as price differentials in favour of the most convenient system of delivery.

If deliveries are to be made in bulk it is necessary that the customer should be provided with bulk equipment into which the deliveries can be pumped, and the provision of such equipment to consumers, together with its subsequent maintenance in good condition, has come to constitute an important part of the work performed by the distributing companies. For motor spirit, the equipment normally consists of an underground tank of one or more compartments, the minimum capacity of a compartment being usually 300 gallons, and a pump with which to pump the spirit through a hose in regulated quantities of $\frac{1}{2}$, 1, 2 or 5 gallons. For lubricating oils, there is a variety of types of equipment, the most popular being cabinets consisting of a small tank of some 40 or 50 gallons and a little pump, the whole enclosed in a kind of box; other types approximate more nearly to the spirit pump, while some are, in fact, only barrels with a hole and plug. Equipment is provided by the distributing companies and also by manufacturers, and may either be bought outright or on the hire-purchase system. In either case the supplying company undertakes to instal the equipment, maintain it in working order, inspect it from time to time, and give new coats of paint as required. Even in the case, say, of a spirit pump bought outright from the manufacturers, the company supplying the spirit will undertake to look after the pump.

The business of supplying the necessary bulk equipments is of such magnitude that a special department is necessary at Head Office for dealing with bulk storage questions. In addition to the selling of the bulk equipment, there is need for constant attention to the locking or sealing of tanks, the fitting of proper globes to describe accurately the spirit sold from the pump, the conversion of pumps from one grade to another, or even to another company's products, and sometimes the removal of a pump from one site to another.

A development made necessary by the extension of the bulk delivery system has been the growth of a maintenance service to ensure that all pumps and bulk equipments are kept in proper working order, and that their appearance is at all times smart and a good advertisement for the spirit they stock. It is necessary to have facilities immediately available for repairing or making any adjustments required to pumps, on the demand of the customer. Further, a regular inspection service must be carried out at intervals

as a precautionary measure, irrespective of whether a pump requires attention or not.

The organisation of the maintenance and inspection services is based on Divisional Areas. Attached to each Division is a staff of engineers, service officers, fitters and painters, whose activities are so planned that every corner of the area is covered with the least possible waste of time, travel and expense.

The regular inspection work is carried out by the service officers, whose duties consist in travelling round and systematically inspecting every pump. Most companies provide their service officers with light vans, which enable them to cover the ground quickly and avoid the wasteful delays that would be inevitable with other methods of travelling. The vans moreover are roomy enough for them to carry a complete range of such spare parts as are normally required for ordinary adjustments and repairs. A fair average of the number of visits a year to each pump, is four. The service officer makes a careful examination of every pump equipment, makes any tests that are called for, and finds out if the customer has any complaints as to its condition and working. He personally undertakes any adjustments or small repairs that can be done in a reasonably short time. Should he find that something more serious is necessary, a fitter is sent along specially, at the earliest possible moment.

Each Division has a large staff of fitters; their work is, in the first place, the original installation of the pumps, and secondly, all the varied work of repair and attention which arises in connection with a larger number of pumps. As with any mechanical apparatus, breakdowns do occur occasionally, and, in addition, accidents occur, or customers require alterations. It is necessary to have fitters available to go, sometimes at a moment's notice, wherever the need arises. Something happens to a pump on a Saturday morning, and a garage proprietor sees the prospect of losing the week-end trade through it; whatever the difficulties, he must receive attention, since no modern undertaking can afford to turn away dissatisfied customers. The fitters are therefore located in zones so as to reduce to a minimum the time spent in travelling and getting to the job. The work is controlled centrally from the Divisional Office, where there is a divisional engineer, who is responsible for all the technical work of his Division, and his control of the service

officers and fitters is based on the requirements of the Divisional Manager and his sales staff.

In addition to the care of the mechanical condition of the pump, there is also the important question of keeping all pumps smart in appearance. A shabby pump is not only no advertisement, it is a bad advertisement. To keep a large number of pumps well painted involves a considerable amount of work, and requires careful organisation if it is to be properly and economically carried out. A pump is exposed at all times and to all weathers, and will not retain a good appearance for longer than a certain period. This period varies according to the different conditions affecting the durability of the paint. On an average, pumps are painted at least once in every year. In order to achieve a uniform standard and to make sure that the painting is properly done, it is found advisable by most companies to have the work carried out by their own painting staff, rather than to place it with outside contractors. Each Division has a staff of painters, whose whole time is occupied in travelling round and keeping pumps in trim. There is a system of reporting pumps and other bulk-storage equipment, such as motor oil cabinets, which require repainting, and on these reports is based the itinerary followed by each of the painters.

Almost as important as the work of distribution from the depots and looking after the equipment is the task of moving supplies from installations to depots and of deciding on the location of both installations and depots. This is development work in the sense in which it is usually understood in commercial concerns, and is largely a matter of costing. Installations and depots must be situated at the most convenient points for giving economical distribution service, and it is necessary to ascertain for each depot the cheapest installation from which to draw supplies and the cheapest way in which to transport them. The most usual way is by rail tank-car, and most depots are adjacent to railway sidings, but road tank-wagons, especially Scammells, are being used to an increasing extent for feeding depots near by the installations, and careful comparisons of costs both by rail tank-car and road wagon have to be made and kept constantly up to date, as in the present fluid state of transport economics a delivery system which is the cheaper to-day may be the dearer in a few months, owing to changes in railway rates, or Scammell costs, or taxation. Where

the transport is by road, it is usual, although not quite universal, for each company to operate its own lorries, but hired vehicles are also sometimes used.

In addition to installations and depots, there is an intermediate type of place usually called a sub-installation. It is, in fact, a large waterside depot fed by coastal craft from the main ocean installations, and it acts as a subsidiary point of supply for depots inland, and also as a distributing centre to customers in its own depot area. Such depots are necessarily situated either on the coast, or on canals or navigable rivers. A continual study has to be made of the possibility of opening up new water-side or inland depots, or in other ways of reducing costs of distribution or of improving the service offered to the consumer. All activities must, of course, aim directly or indirectly at one of two things: either at increasing sales, or at reducing costs of distribution.

Closely related to the problem of deciding on the number and location of the depots is that of deciding on the distribution of depot equipment in the way of motor vehicles. If a depot has too many motor vehicles, its delivery costs will be too high; if it has too few, it will not be able to give its customers a good enough delivery service, and the drivers will have little or no time for going out after new business. It is necessary to strike the happy medium.

The wide extent of the operations of a petroleum distributing company, the nature of the product dealt in, and the inevitable lack of supervision over many of the employees, render necessary a very careful system of stocktaking and depot inspection. Records are kept by the storekeeper at the depot, and must be right up to date when called for by travelling depot inspectors. In particular, the quantities of petrol received and sold are closely watched. Petrol expands in hot weather and contracts in cold weather, and is also subject to loss by evaporation. Leakage statements must be prepared, and any undue leakage immediately investigated. A similar watch has to be kept on leakages at installations, and an organisation maintained at the Head Office for supervising and checking all records sent in from the depots, for watching leakages and statements of stocks of barrels and cans, and in general for making sure that employees are not only honest in the collection of accounts and other pecuniary matters, but also that there is no petty thieving of articles which are the property of the company,

or large-scale swindling in the products sold by the company. Small thefts of these products might pass unnoticed if they only occurred occasionally, but the system is such that any large or regularly maintained pilfering would soon come to light.

The sales organisation by Divisions and depots is the usual method of marketing spirit, kerosene and motor lubricating oils. In addition to these products, however, the more important distributors also market fuel, gas and Diesel oil and bitumen. These are not as a rule sold through the depots, on account of the comparatively small number of customers. Deliveries are usually made either by Scammell lorry or by rail tank-car direct from installations, while the canvassing of business is organised on divisional lines only, one or more supervisors being attached to each Division, and the whole business being kept in very close personal touch with the appropriate Sales Manager at the Head Office. A good proportion of the contracts are also obtained direct by Head Office, where the Sales Managers are often in a better position to negotiate with the very big buyers than the local representatives. Customers for fuel, gas and Diesel oil, and for bitumen are mainly purchasers of considerable quantities.

A liaison service between the customer and the sales department is an essential in a large marketing organisation. If a customer makes a complaint about the quality of a product he has bought—a habit which customers have, the world over—two processes are necessary. Firstly, some competent person must investigate and find out if the complaint is justified or if it is merely frivolous: secondly, if it is justified, steps must be taken by any distributing company desirous of retaining its share of the market to remove the cause of the complaint. In oil distribution, complaints, other than those of bad service, which are dealt with by the sales staff, or of faulty bulk equipment, usually concern the quality of the product sold. These are investigated by trained chemists, and should they be justified, steps are taken by these experts to put the matter right.

The petroleum industry makes much use of advertising, and all the large distributors have a department at their Head Offices to deal with it and with publicity matters in general. The advertising is by no means entirely competitive. To a certain extent each company, naturally, extols its products against those of its rivals, but advertising

would still be desirable even if there were only one marketing company in the country, in order to encourage people to indulge in pursuits involving the consumption of petroleum products. In the same way, a tobacco monopolist would still be well advised to continue advertising in order to encourage people to smoke, or a concern with a quasi-monopoly of the mustard trade may find it worth while to run a Mustard Club to persuade people to take more mustard. It is becoming more and more clearly recognised to-day that the serious things for an individual firm are not only competition from other firms within the industry, but from other industries. The important question from the railways' point of view is not whether traffic between London and Birmingham should go by the Great Western or by the London, Midland & Scottish, but whether it should go by rail or by road. The competition of motor transport is a much more serious matter for both the G.W.R. and the L.M.S. than their own competition with each other. The work of gaining the public's ear, and incidentally its purse, is tending to become much more of the nature of judicious publicity than of competitive advertising. It is far more important in the long run for the sale of motor spirit to remove hindrances to the growth of motoring, whether in the nature of heavy taxation, insurance or garaging, than to encourage people to buy cars and, having done so, to use them.

Other petroleum products, such, for instance, as fuel oil for central heating, are obviously in direct competition with quite different products, *e.g.* coal; bitumen, again, competes with tar. Publicity with regard to these must be directed against the rival industry, not against the rival firm. In fact an advertisement of a product of this kind by one of the oil companies is a help to all, as the potential market is so large that it is merely a waste of time for the distributors to quarrel over the division of the existing market.

The organisation of a distributing company on modern lines will be seen by the reader to cover a good many branches of activity, all of which must be supervised and controlled by a central management. As these activities extend over practically every square mile of the country in the case of the larger companies, and the number of the employees of the largest exceeds 10,000, it is obvious that a close personal supervision is out of the question. The only possible way in which the management can keep in touch is by a highly

organised system of reports, records and statistics collected from all branches and summarised. They can thus put their fingers on the weak spots and give instructions to the local representatives accordingly. In some respects the organisation must be almost military, but it must be much more elastic, and there must be the utmost possible delegation of responsibility and authority combined with strict supervision and control. The local man must, so far as possible, be in a position to make decisions on the spot, but the system must make it possible for his mistakes to be discovered in time to be remedied.

The organisations of all the larger distributors in Great Britain are much alike, not that there has been any conscious attempt to achieve uniformity, but rather because each company has allowed its organisation to grow little by little to meet practical situations and considerations, and, as these have been similar for all firms engaged in the industry, similar types of structure have resulted. These organisations are, of course, different from those in other countries, as would be expected, but on the whole the system of distribution they offer is second to none from the point of view of the convenience of the final consumer, although perhaps it is less economical than that of other countries where there are relatively fewer points at which the ultimate consumer can make purchases, and therefore fewer points to which deliveries have to be made. Owing to this fact, it is possible in many other countries to fix a lower rate of profit for the retailer, which is made up for by his larger turnover. This, however, is a feature common to the greater part of British industry, and by no means confined to the oil industry. The country suffers from too many retailers, who bring in their train the evils of big profits per unit and low turnovers. This is a part of our economic organisation which must be tackled seriously if Great Britain is to be brought on to a competitive level with other countries. The cost of living, and therefore the wage level, is too high in Great Britain because the index number for retail prices is many points ahead of the index number for wholesale prices compared even with the pre-war position, thereby constituting a hindrance to prosperity which is not found to the same extent in most other highly industrialised communities.

CHAPTER VI

THE REFINING OF OIL

The Refining Process

PETROLEUM may be imported either in the crude state or as a refined product ready for consumption. In point of fact well over 75 per cent. of the petroleum products used in Great Britain have been refined abroad. The vessels used to transport the oil here from the port nearest the oil-field are invariably oil-tankers, although formerly wooden barrels were the standard containers. An oil-tanker is really a floating tank, the shell of the vessel constituting the walls of the tanks. Two steel bulkheads are built right across the ship, fore and aft, the space between the bulkheads being filled with water. These transverse water-tanks are called cofferdams, and serve to keep the oil, which is between the two cofferdams, from the crew's quarters, which are forward, and from the engine-room and stores, which are built aft. The oil in a tank steamer is thus surrounded on two sides and the bottom by the sea, and fore and aft by the two walls of water or cofferdams. The oil tank is subdivided by cross bulkheads into smaller tanks and by a longitudinal bulkhead running fore and aft.

When a tank steamer enters a dock all the fires on board are put out and the crew sent ashore while the oil is pumped out through hoses into the shore tanks, using steam supplied from the shore. The shore tanks, with the necessary equipment for distributing their contents to the depots drawing supplies from them, constitute an installation. If crude oil is imported it is, of course, necessary to refine it before it can be marketed.

Refining practice is, in theory at any rate, simple and easy to understand. Crude oils from various sources differ very widely in their composition and properties, some yielding relatively large amounts of petrol and kerosene and only small quantities of lubricating oil, whilst others may yield practically no petrol or kerosene and may be useful only as a source of fuel oil or bitumen.

Crude oils are not pure substances like alcohol or water, but consist of a complicated mixture of a large number of hydrocarbons. The public does not want the crude oil mixture, nor does it particularly want the individual hydrocarbons, but it does want some of the hydrocarbons, and prefers to have those of the same kind or qualities grouped together. The operation called "refining of crude oil" really consists of splitting up the original crude oil, separating the hydrocarbons into little groups or lots, re-arranging these groups, and finally removing from the rearranged groups certain undesirable impurities, which, if present, would render the product unfit for a particular use.

The method of splitting up used in the refining process is that of distillation, the system being based on the different boiling points of the various hydrocarbons present in the crude oil. The mixture of hydrocarbons known as motor spirit boils between certain temperatures, kerosene between temperatures at a rather higher average, while gas oils have higher boiling points than kerosene, and fuel oil even higher than gas oil.

A distillation plant consists of three different parts: the boiler or "still" as it is called, (the still may hold as much as 100 tons of oil), the condenser and the receiving tanks. The still is heated by a furnace, and the vapours which are given off pass through the vapour line into the condenser, where they condense again and form a liquid which is collected in the receiving tanks. Steam is often led into the still in order to cause the oil to distil at a lower temperature than would be the case in the absence of steam. By this means it is possible to minimise what is known as "cracking," or the decomposition of the oil which might otherwise take place, and which would often spoil the products obtained.

The old-fashioned method of distillation is the batch method, the still being a cylindrical steel vessel fitted with a manhole for cleaning purposes, a thermometer and a pressure gauge. A perforated pipe runs along the bottom of the still and is connected by a valve outside to the steam supply. A draw-off valve at the bottom of the still allows the residue after distillation to be run off, and gauge glasses indicate the amount of oil in the still. The still is set in a brickwork furnace and is filled about two-thirds full of crude oil. By means of a fire underneath the still vapours are given off and pass through the vapour pipe. The first vapours which condense are naturally the most volatile

fraction of the crude oil, *i.e.* the components with the lowest boiling points, and, as the temperature gradually rises, components of higher boiling point distil over. By this means a rough separation into several cuts or fractions can be effected, but these fractions must usually be redistilled in order to get better separation.

In the first distillation a little motor spirit may be obtained at the beginning of the distillation, then a mixture of motor spirit and kerosene, later on a kerosene fraction; and then a mixture of kerosene and gas oil.

In order to separate these fractions further into products fit for marketing they are redistilled in a different type of still, which is heated with steam pipes. By this redistillation the mixture—say of motor spirit and kerosene—can be split up into these two products, which, after refining with chemicals, are fit for the market.

The simplest type of condenser used, consists of a coil or pipe immersed in a tank of water. The condensed liquids, before going to the receiving house, pass through what is known as the "tail-house." Here is a large iron box divided into compartments. According to his instructions, the stillman runs the condensed distillate into the proper boxes, and from these it flows to the receiving tanks, and, after being tested, is pumped to the storage tanks.

The periodic or batch system of distillation is inefficient and uneconomical, and has been largely replaced by the continuous method. The oil runs from one still to another, making the whole process continuous, and, as the temperatures of the oil in the series of stills are kept at continuously higher levels, the motor spirit, kerosene and other fractions in turn are gradually distilled off, leaving a residue in the last still.

During recent years distillation in a series of cylindrical stills has been largely replaced by distillation in tubular stills, the best known process of this type being the Trumble process. In the Trumble process the crude oil passes through a heat exchanger, where it receives heat from the hot liquid fuel or residue coming from the Trumble plant. It then passes to a bench of retorts, consisting of 4-inch piping several hundred feet long, arranged so as to be heated by a furnace. The oil is converted during its passage through the tube, where it gradually gets hotter and hotter, into a mixture of residual oil and vapour. This mixture passes

up through a pipe into a large vessel known as an evaporator, where the heavy residue falls to the bottom and the vapours pass on.

It will be seen that the tube-still method of distillation differs essentially from the batch-still method in that all the vapours come off together. If they are allowed to condense together the product obtained is a mixture of motor spirit, kerosene and gas oil, and arrangements must therefore be made to separate the various fractions before condensation. This is done by passing the mineral vapours through a row of vessels or dephlegmators in which they are fractionally condensed. The fraction containing constituents with the highest boiling points—*i.e.* the gas oil fraction—naturally condenses first. The remaining vapours, consisting of motor spirit and kerosene, pass on, and the next product to condense is kerosene, or perhaps a mixture of kerosene and gas oil. Farther on are condensed kerosene, then kerosene containing some motor spirit, and finally practically only the vapours of motor spirit remain, and these are condensed in the ordinary way in the condenser. Some of the cuts produced may again have to be redistilled in order to obtain a cleaner separation of the various products.

Motor spirit, which is also called petrol or benzine, is the first main fraction obtained by the distillation of crude oil, and is now far and away the most important, being chiefly used as a fuel for internal combustion engines. Straight-run motor spirit may be produced either by the batch-stills or the tube-stills described above. The demand for motor spirit is, however, too great to be met entirely in this way, and is supplemented by motor spirit produced by other means, mainly by the cracking of the heavier constituents of petroleum, by extraction from natural gas and by carbonisation of coal. Motor spirit other than " straight-run " is, however, not in such demand in Great Britain, although there is one company supplying only " cracked " spirit. There are several different " cracking " processes, the best known being the Burton, Cross, Holmes-Manley and Dubbs. One method is by producing a so-called " synthetic " crude oil with temperatures of 800° to 1,000° F. and pressures of from 500 to 2,000 pounds per square inch, and then allowing the synthetic crude subsequently to distil by its self-contained heat. Another method is the tube-still method, which consists in heating the oil under pressure in tubes and allowing it to discharge to a vaporiser. The motor spirit and

other components are then fractionated out in the same manner as in the case of tube-stills used for normal distillation. The chief difference lies in the fact that a considerable amount of non-condensable or fixed gas passes out with the motor spirit.

After motor spirit has been fractionated, it has to undergo various treatments with the object of purifying it, involving removal of sulphur, stoppage of gumming tendencies, decolorising and deodorising. The two latter processes are entirely in deference to the prejudices of the buyer, as it has never been proved that they have any effect on the efficiency of operation of a motor-car. The treatment is usually that of washing with chemicals of various kinds; there are many patents, but there is no need here to enter into a detailed description of the pros and cons of the different processes.

Many qualities are required of a motor spirit, and if it is to come up to scratch in respect of all of them, great care must be taken with the blending, in order to turn out an " all-round " well-balanced petrol. The spirit must be economical in use—that is, it must give a good mileage per gallon. Other things being equal, a spirit of high specific gravity is desirable from this point of view, and these spirits command a ready sale, although the insistence on the high specific gravity is less pronounced than formerly, as such spirits are only economical in use provided that they are in all respects suitable for the engine. The spirit must also be of a quality to make starting easy in cold weather. It must therefore be volatile and vaporise readily at low temperatures. A good motor spirit must, in addition, be clean and leave little carbon deposit, as the modern motorist objects to frequent decarbonisations. Perhaps most important of all, the spirit must have a high anti-knock value, as, especially in Great Britain, motorists refuse to use a motor spirit which knocks or on which the engine fails to run smoothly. There is also a demand for spirits giving greater power—*i.e.* spirits which enable the engine to operate at a high compression ratio such as would be found in conditions where there was a considerable carbon deposit in the cylinders. This quality is to some extent an alternative to a small carbon residue. A spirit may either give less power and less carbon residue, or more power and more carbon residue. From the point of view of running efficiency and the frequency of decarbonisation it does not very much matter

which, although a clean spirit with a high anti-knock value is, of course, preferable to either.

A spirit which possesses all these points is very unlikely to be obtained from crudes derived from only one source. The more efficient companies therefore draw crudes from many, and by mixing motor spirit with a high specific gravity obtained from one crude, with motor spirit of high anti-knock value derived from another crude, and the two with motor spirit of high volatility from some other source, and so on, it is possible to obtain a petrol suitable for all purposes, and one which does not have any particular quality developed in a lop-sided way at the expense of all the others.

One of the weaknesses with regard to motor spirit is that in Great Britain it has no definition, and anybody is perfectly free, so far as the legal position is concerned, to put anything he likes in a tank and sell it as motor spirit, without being prosecuted for obtaining money from his customers by false pretences. This is a great disadvantage to the more reputable distributors, who, for instance, have recently had to face the competition of spirit containing a large percentage of kerosene, which, of course, is not liable for petrol tax, and can therefore be bought and sold cheaply. The motorist needs protection against unscrupulous distributors who thus defraud him by persuading him to buy a so-called motor spirit which dilutes the oil in his sump and rapidly ruins his car, but at present nothing can be done, as the distributor would still be within his legal rights if he sold pure kerosene as his own private brand of motor spirit. Unfortunately dishonesty of this kind is tacitly encouraged by a certain section of the Press which sees something sinister in every move of the " Combine," and delights in anything which might be thought to reduce its trade. The same section of the Press raises an outcry of " avaricious monopolists " whenever petrol prices are increased, and whenever they are reduced professes to trace the cause of the reduction to a desire on the part of the " monopolists " to stifle competition by forcing rivals into the bankruptcy court. There ought to be an official specification for motor spirit, and severe penalties should be imposed on all distributors who sell products which do not come up to this standard.

The public further needs protection in the description of motor spirit. Motor spirit which is described and sold to the public as " anti-knock," for example, ought to come up to an official specification for a special anti-knock spirit.

The present position is that any distributor may claim any special qualities he pleases for his spirit and none may say him nay. Motor spirit is an article of such popular consumption and such tremendous importance in the industrial and social life of the nation that such a state of affairs should be impossible. Motor spirit sold as "No. 1" must be a No. 1 spirit, and pass an agreed standard, and petrol described as "anti-knock," or "Aviation," must also come up to some more stringent specification of requirements.

In addition to ordinary motor spirit, there are various special boiling-point spirits refined, which are really petrols of very closely controlled distillation ranges, in many cases of less than 40° F. Such special products are not used as motor spirit, but as solvents in the rubber industry, in the preparation of cements, for boots and shoes, for seed extraction, as a solvent for grease and dirt in dry cleaning, and for many other specialised processes. For most of these processes a spirit of high solvent power is required, and for all these purposes spirits derived in particular from Borneo crude oils are specially in demand.

A specification is laid down for motor spirit by the B.E.S.A. (British Engineering Standards Association). According to this the liquid shall consist of hydrocarbons and be free from visible impurities and mineral acid. The range of distillation must be determined according to the standard methods of testing, as laid down by the Institute of Petroleum Technology, and the liquid must, when distilled according to such methods, conform within the following limits of temperature:

"When the liquid is distilled according to the standard method, the first drop temperature indicated by the thermometer shall not exceed 55° C.

"When 20 per cent. by volume of the distillate has been collected, the temperature indicated by the thermometer shall not exceed 55° C.

"The whole of the liquid shall have distilled when the temperature indicated by the thermometer is 225° C."

In addition to the specification laid down for motor spirit there are two for Aviation spirit, for Grade 720 and Grade 760, the number of the grade being the minimum specific gravity permissible in each grade at 15° C. In addition to a low distillation range, Aviation spirit may not contain any olefine hydrocarbons (cracked spirit). The percentage of aromatic hydrocarbons is laid down: the residue after evaporation in a bath of boiling water must not exceed

0·01 per cent. by weight, and must be oily, and the sulphur content must not exceed 0·05 per cent. by weight. These specifications are not, however, official, as has already been explained. From the legal point of view there is nothing to prevent a man selling ordinary motor spirit or even No. 3 spirit as Aviation, since there is no penalty attached to his doing so.

White spirit is the fraction next to benzine, and is, in fact, intermediate between benzine and kerosene, usually having a distillation range of about 140° to 200° C. According to the B.E.S.A. specification, white spirit must be wholly a petroleum product, " water white," clear, odourless and free from water and other visible impurities. It must also be free from objectionable sulphur compounds, leave no grease spot or mark on filter paper, and be of a volatility similar to turpentine. After evaporation the residue must be wholly organic. The B.E.S.A. distillation range is not more than 10 per cent. below 150° C, not less than 80 per cent. below 190° C., and not less than 90 per cent. below 200° C.

The next fraction to white spirit is kerosene, which distils at 150° to 300° C. The colour may be anything from standard white and prime white up to water white. There should be no acid, and less than 0·05 per cent. of sulphur, while the specific gravity should lie between 0·760 and 0·860. As kerosene is still largely, and was once mainly, used as an illuminating oil, it must burn without incrustation or smoking in an ordinary wick lamp. Kerosene distillate, which is obtained when crude oil is distilled, has usually a yellowish colour and disagreeable smell; it is refined in order to make it fit to market, by treatment with sulphuric acid and caustic soda, with the object of improving the colour and smell and removing harmful constituents in the distillate, which cause charring of lamp wicks and smoking on the glass.

The behaviour of kerosene in a lamp depends to a great extent on the chemical constitution of the hydrocarbons of which it is composed, and certain kerosenes which contain large proportions of aromatic hydrocarbons—*e.g.* Borneo kerosene—do not burn satisfactorily in an ordinary lamp, although they burn quite well in a lamp which has a sufficiently high chimney to give a good draught. The average household lamp, however, seldom has a tall enough chimney, and is therefore unsuitable for kerosenes having a large percentage of aromatic hydrocarbons; these are, however,

often extracted with liquid sulphur dioxide, the residual liquid being a kerosene of excellent burning quality in any lamp.

After motor spirit and kerosene have been removed, the next fractions are gas oil and fuel oil. Gas oil is the lighter, and is primarily used for making gas and for carburetting coal gas or water gas. Fuel oil is valuable on account of the practical absence of mineral matter, water and the lighter fractions of petroleum, combined with a very large percentage of hydrogen in its composition. Residual fuel oil is the block residue of petroleum from which water, benzine and light illuminating oil have been removed; it comes mainly from refineries manufacturing only benzine and kerosene, so that the product is more or less tapped crude, or the residue from cracking plants. The properties on which the value of the oil depends are: its constant heat of combustion, the ease with which it flows, and the sediment with sulphur and other impurities contained in it. The sediment is mainly asphaltic or carbon.

The specific gravity of fuel oil varies enormously from the neighbourhood of 0·850 to 1·000, according to the source of the oil and the amount of light constituents which have been distilled out of it. Viscosity also varies a good deal, but not in proportion to gravity. The B.T.U. per gallon is usually between 140,000 and 160,000. The British Admiralty specification for fuel oil requires that the oil shall consist of liquid hydrocarbons, shall have a flash point of not less than 175° F. closed test, shall not contain sulphur in excess of 0·75 per cent., shall be free from acid and from earthy, carbonaceous or other impurities which might choke the burners, shall not contain more than 0·5 per cent. of water, and shall not exceed a standard viscosity of 1000 seconds for an outflow of 50 c.c. at 32° F. Fuel oil for burning is usually a residual oil, but gas oil is always a distillate. A distillate is, of course, a fraction distilled from a crude oil, whereas a residual oil is the residue after the lighter fractions have been taken off. Diesel oil must contain a smaller amount of water and sediment than is permissible in fuel oil, and the carbon residue must also be very small. Ordinary Diesel oils are a somewhat heavier type of gas oils which are invariably distillates, but residual oils are sometimes used for heavy high-compression Diesel engines, though as a rule, the heavier and more viscous types of fuel oil are only used for furnaces.

The residue of some crudes is of most use as a fuel oil, but others give a lubricating oil residue which can be worked up into commercial lubricating oil. There are several different methods according to which this can be done. The older method involved distillation at atmospheric pressure, which leads to decomposition and cracking of the products obtained. If wax is present in the residue the whole may be reduced by straight fire, producing a wax distillate. This distillate is cooled and filtered to separate the wax, and then redistilled and treated to give the various fractions. There are other methods in use, such as a centrifuge for removing the wax from the lubricating oils. Sulphur and impurities are usually removed by treating with sulphuric acid.

In one of the large British refineries the oil is fed through the Trumble preheater, where a gas oil distillate is taken off, the residue passing into the first of a batch of six vacuum stills. The oil in the stills is kept at a range of temperatures gradually increasing from the first to the last still, the undistilled residue from each still being fed by gravity into the next still. By this process each successive still gives a higher distillate, with higher distillation range and higher viscosity, than that given by the preceding. The various distillates from the six stills are collected and bulked together, the residue from the last still being a hard asphalt. The bulked lubricating oil distillate is treated with caustic soda in order to remove "petroleum acids" and is then put through the whole distillation process again. During the second distillation the various fractions are collected separately, spindle oil, light, medium and heavy distillates, the final residue being an asphalt containing the caustic soda and the petroleum acids extracted from the oil.

The lubricating oil distillates are treated with strong sulphuric acid to remove impurities, the mixture of acid and oil being thoroughly agitated by means of compressed air. The acid tar, which is drawn off after settling, is mixed with heavy fuel oil, thoroughly washed to remove acid, and is finally burned under the boilers, whilst the lubricating oil distillate is transferred to settling tanks so as to ensure separation of the last traces of acid tar. After this treatment the oil is agitated with absorbent earth and a little lime (a so-called "dry refining" process), to improve the colour, remove the last traces of acid, and also some undesirable

constituents which might tend to produce instability in the oil. After this treatment the oil is passed through filter presses, and is then ready either for marketing direct or for blending according to circumstances.

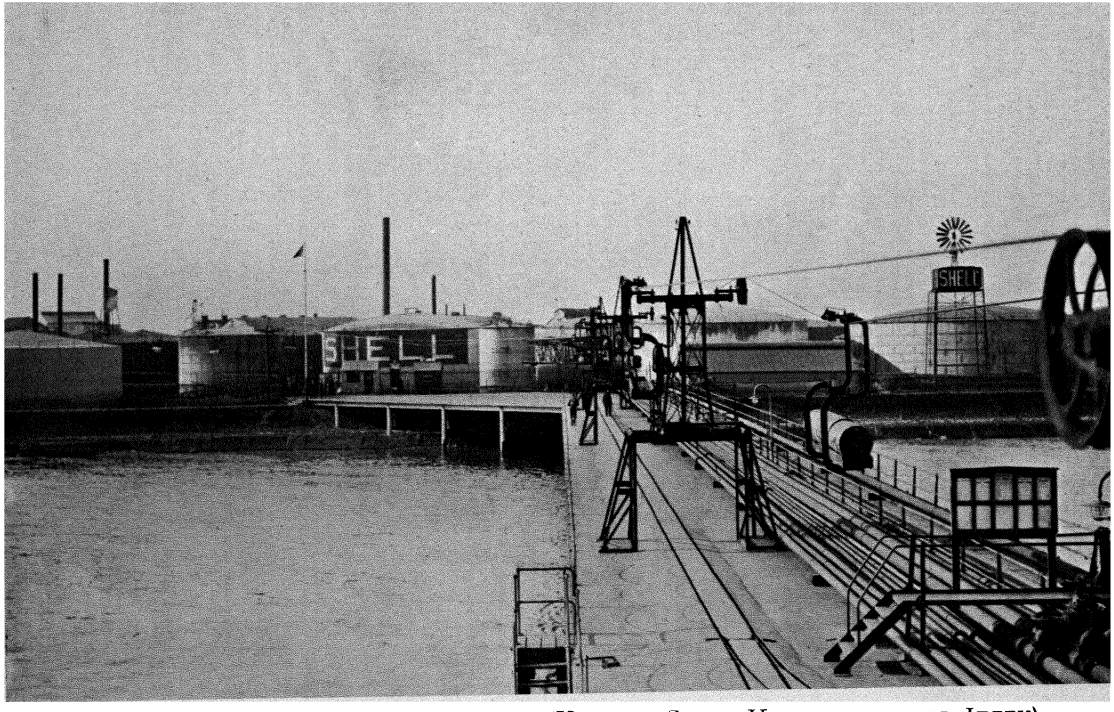
In addition to fuel oil and lubricating oil, the residue after distillation may consist of bitumen or asphalt, a black non-oxidised bituminous hydrocarbon, semi-fluid to hard in consistency. Asphalt is also found naturally, especially in Trinidad. The first process in manufacturing bitumen is to remove water which will not be completely separated by sedimentation, since the specific gravity of those oils which are most suitable for road purposes is much the same as that of water. The removal of the water is most commonly accomplished by the type of plant already described as a pipe-still. The principle is to pass the oil through a much-coiled pipe heated to considerably above the boiling point of water. The purpose of the coils is to stir up the oil. When it finally escapes, the water and more volatile constituents are blown away in the form of steam, and are collected in a condenser, while the residue is collected in a batch-still, where it is distilled in the ordinary way.

It is of the greatest importance in distilling an oil for use on roads to distil at a sufficiently low temperature to minimise decomposition and cracking, which take place at about 600° F. with asphalt hydrocarbons. Distillation by fire must stop, therefore, before this point has been reached. After this point the commonest method is to blow superheated steam, which mechanically carries over the more volatile hydrocarbons, at a temperature very considerably below boiling point.

Bitumens are usually graded on penetration—*i.e.* the distance, in tenths of a millimetre, to which a standard needle will sink into the bitumen at 25° C. in five seconds under carefully controlled standard conditions.

Ocean Installations

The business of refining oil in Great Britain, as in most other oil-importing countries, is carried on in proximity to the ocean installations where the oil is imported. This is partly a matter of convenience, as it saves unnecessary transportation, and partly because the risk of fire makes it advisable for both installations and refineries to be situated



A Modern Ocean Installation (View of Shell Haven from the Jetty).

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at some distance from towns. Rather lonely stretches of coast are usually selected.

The business of the installation is to unload, store and blend the oils brought in by tankers, and prepare them for sale on the home market, or sometimes prepare them for export. There is a considerable export trade in the products of British refineries and in oils blended at the installations. The processes in which the installations are concerned should be carried out as cheaply as possible, and hence much attention is paid to costing. Although centres for distributing, the installations are not engaged in selling, and their organisation is an entirely separate department of the business of distribution.

The selling organisations in the different Divisions must make arrangements for the ordering of rail cars or road wagon loads of oil from the nearest installation, but they are not in any way connected with the organisation of any installations that may be situated in their Divisions.

The installations act as depots for the depots, which latter must be in a position to draw fresh supplies at short notice whenever their stocks are running low. The installations must therefore act as warehousemen for oil. There is probably on an average about three months' supply of oil in the country at any given time. This figure tends to be a little higher in the spring, when production has been outrunning the low consumption of the winter months and prices tend to be on the low side, and a little lower in the autumn, when the high consumption of motor spirit, lubricating oil and bitumen during the summer has brought the stocks rather low. It is naturally advisable that a moderate stock of petroleum, as of other necessaries, should be carried in the country in case of national emergency. Those importers who are not subsidiaries of the large producing groups also try to make profits by bringing into the country large stocks before a rise in price, and living a hand-to-mouth existence before a fall.

However, storage space is valuable, and must be charged up by the distributing companies to the products using it, thus entering into the cost of distribution, and moreover there are appreciable losses, especially to the lighter fractions, from evaporation during the summer months. In the early summer this is counteracted for products sold in gallons, such as motor spirit, by the expansion caused in the warmer weather, but during the autumn there is always a heavy loss

in gallonage to all stocks on hand, owing to the contraction induced by the cold weather. If too great stocks are kept on hand, the payment which must be made for storage space and evaporation will cause an increase in the cost of distribution, and the bill must ultimately be footed by the consumer.

CHAPTER VII

BENZINE OR MOTOR SPIRIT

Distribution

THE backbone of the oil trade of Great Britain is the sale of motor spirit. The amount sold in 1929 was nearly 3,000,000 tons, or some 6 per cent. of the total world consumption of 50,000,000 tons. The former figure has increased from 371,000 tons in 1914 to 831,000 in 1921, and 1,537,000 in 1924, and is still rising.

The greater part of the 3,000,000 tons of benzine or motor spirit sold in 1929 was sold for use in motors, but a small percentage, probably about 0·8 per cent. of the whole, is used for other purposes than as fuel for motor vehicles, motor-boats or aeroplanes. Industrial benzine—*i.e.* benzine not used as motor spirit—is largely employed in the manufacture of rubber, rubber compounds, rubber substitutes and floorings, and is used by dry cleaners, bleachers and dyers in the clothing and textile industry. It can even be bought in small tins for domestic use. The industrial consumption of benzine is increasing, but at not so fast a rate as the market for motor spirit.

The demand for benzine for use as motor spirit in Great Britain comes mainly from motor vehicles. There are still relatively few motor-boats compared, say, with Norway, and the development of air transport has not been sufficient to give rise to any considerable demand from that source.

The system of distribution in Great Britain has always been for private vehicles—*i.e.* motor-cars registered on a horse-power basis and motor-cycles—to obtain their petrol supplies from a dealer or retailer. The owners of commercial vehicles, however, both goods and passenger, are entitled to purchase their requirements direct from the big distributing companies, and in early days generally used to avail themselves of that privilege. This proved to be a very expensive system for the distributors, so far as the owners of only one or two vehicles were concerned, as the amount

purchased each time was scarcely enough to make it worth while to give the distribution service, especially in the case of farmers and outlying customers. The tendency has therefore been to encourage the owner of one or two commercial vehicles to purchase supplies direct from the dealer exactly like an ordinary private motorist. This has been accomplished by making it cheaper to buy from the dealer's pump than in cans direct from the distributor.

Several of the larger companies, and especially the Anglo-American Oil Company, tried to overcome the difficulty of the small commercial vehicle owner by themselves establishing service stations in the central part of the large towns to supply spirit direct to commercial vehicles. These have not been an unqualified success for various reasons. In the first place, they are severely handicapped by being unable to supply private vehicles, the agreement between the distributing companies and the motor traders being to the effect that the former shall not compete with the latter for the retail trade with private vehicles. Company-owned service stations are thus at the outset deprived of a large number of potential customers. In the second place, their business is simply to sell petrol and oil, whereas with the ordinary garage this is a side-line. It is only in very favourable circumstances that it is possible to make a living solely from these products. There is a tendency among some garage proprietors to look at their petrol and oil business not only with a view to the profit it brings in directly, but also as a means of holding to the garage the custom of those motorists who bring in their repairs, buy acccessories and spare parts, or who perhaps place orders for new cars or buy second-hand cars. With the company-owned service station, petrol is not a combination of a bait for bigger fish and a useful side-line, but is the sole source of income. A third consideration of importance is that the owner of a private garage can, if he wishes, remain open all through the night, or for as many hours as he is willing to work. The company-owned service station is, of course, at liberty to remain open all night, but this involves the employment of three shifts of attendants, who each require an eight-hour day, while the hours of the private garage proprietor are entirely his own affair. However, perhaps the most important consideration of all is the cost of a suitable site in the central part of a large city. This may easily be £8000 or £10,000. The interest on this would therefore be

£500 or £600 a year. If the retail profit be twopence-halfpenny a gallon, this alone would eat up the profits on a throughput of 5000 gallons a month.

In the United States the system of the company-owned service station supplying all classes of customer is very much commoner, but there are factors in the situation there which make the system more practicable. Speculation in real estate is much more widespread, and, on account of the rapid rate of development, much more profitable there than in England. It is therefore possible to obtain the use of a vacant lot for a service station for a nominal rent from a speculator who has bought it, on condition that the owner may be given possession at very short notice in the expectation of a rise in its value. The question of high rents, or of being permitted to serve only certain classes of petrol users, does not arise.

There is one small company distributing in England which does the greater part of its business through its own service stations, but it is not normally desirable for a distributing company to do much of its business, even with commercial vehicle owners, through its own stations, since, as the small commercial vehicle owner often—to-day perhaps even usually—buys direct from the garage, the motor trade does not look favourably upon companies which are, in their opinion, poaching on the dealer's preserve. This is a consideration of the greatest importance, since the distributing companies' policy is always the maintenance of amicable relations with the dealer. As a general principle, unless a company is prepared to do its whole business through its own service stations, it is preferable that it should do as little as possible in that way.

In many countries the tied garage or service station is the rule. The garage sells either X's or Y's or Z's petrol, but not all three spirits. In Great Britain there is no such restriction, and the larger garages therefore stock all the leading brands. Most motorists have a preference among the different brands on the market. They perhaps prefer "Y" petrol to "X" petrol, and if both are available will always choose the former. If, however, the garage only stock "X" petrol, very few motorists will refuse to have it and drive on to another garage to buy the "Y" brand. This being the case, assuming the sites are equally good from the point of view of attracting the motorist's attention, where tied garages are the rule, the proportion of the total

sales going to the "X," "Y" and "Z" companies will be according to the number of garages they have tied to them. If they are all in a position to obtain the same number of garages, each company will get a third of the business. If, however, all garages sell all three brands, then the proportion of the total sales each gets will depend on the popularity of the brand. Supposing "Y" petrol is so popular, well advertised and well spoken of that 50 per cent. of motorists ask for it, and "X" and "Z" petrols are each as popular as the other, then 50 per cent. of the business will go to the "Y" company and 25 per cent. each to the "X" and "Z" companies. It is obvious then that the free-garage system favours the most popular brands and the habit of buying by brand in general, which in turn leads to expenditure on advertising. The tied-garage principle, on the other hand, favours the less popular brands, as few motorists are such enthusiastic loyalists to a particular brand as to go on to another garage rather than accept an alternative spirit which is not their favourite.

The free dealer is now the established system in Great Britain, and will certainly remain so. The British public demands an exceptionally good distribution system for petrol, as for other commodities, and the private motorist expects to be able to buy his favourite brand at least every mile or two along the road. This has resulted in an enormous multiplication of the number of retailers, of whom there were over 28,000 in 1929, controlling more than double that number of pumps. There is simply not enough profit in the trade to keep all these establishments going solely as retailers of petrol and oil, which part of their business must in the circumstances be a side-line, albeit quite a profitable side-line, to their other activities.

The fact that the dealer is more or less free, and usually stocks several brands, limits considerably his power of influencing demand. He may push a cheap brand by suggesting to customers who ask for more expensive brands that they should try it, and he may be able to influence the indifferent customer more or less effectively, but on the whole the demand, as in the case of tobacco and cigarettes, must come from the consumer, who will choose according to his own tastes and prejudices, and is likely to resent being over-much guided by the retailer. It is therefore very important to reach the final consumer by means of good advertising and publicity. The free-dealer system is cer-

tainly to the consumer's advantage, as he has both power and opportunity to choose between rival brands, and this inevitably leads to competition and the maintenance of a high standard of quality and efficiency of service.

Consumption

It is impossible to ascertain exactly the amount of motor spirit consumed by different classes of vehicle, but a fairly accurate estimate can nevertheless be made. There were in 1929 some 950,000 private motor-cars registered in Great Britain. The average annual mileage of a private car, including private owners, many of whom do a good deal less, and commercial travellers, business and professional people, most of whom do much more, is usually put at between 7000 and 8000 miles. An average of 7500 may perhaps be assumed with safety. The miles obtained to the gallon by the typical car may be reasonably put at about 25, which would give an annual consumption of 300 gallons or 1 ton per car. The amount of petrol consumed by private cars would therefore be 950,000 tons. The consumption per vehicle of the 700,000 motor-cycles and motor-cycle combinations may average 75 miles per gallon, or one-third of that of the average car, but against that the average annual mileage is probably less, so that it might possibly be fair to add a further 150,000 tons for motor-cycles, bringing the total consumption by private vehicles up to somewhere about 1,100,000 tons a year of the total consumption by all vehicles of 3,000,000 tons. This leaves 1,900,000 tons for commercial vehicles. Of this total probably fully one-fifth—say 400,000 tons—went through garages, and the remaining 1,500,000 tons consisted of direct deliveries to commercial consumers. Business done through dealers may be estimated at approximately 50 per cent. of the total, amounting to 1,500,000 tons, of which 1,100,000 were for private vehicles.

It is more difficult to allocate the 1,900,000 tons consumed by commercial vehicles among the different classes concerned, but the following estimate is probably not very far from the truth. There were some 35,000 omnibuses and charabancs registered in 1929. These may have averaged 7 miles to the gallon, and perhaps 25,000 miles a year, so that their annual consumption would be about 12 tons each, or 420,000 tons in all. There were also some 60,000 passenger vehicles

licensed of less than fourteen seats, including taxis, small omnibuses and cars for hire. If the consumption of these be put at the rather high figure of 3 tons per year, then a further 180,000 tons would be accounted for, making the total consumption by commercial passenger vehicles about 600,000 tons. This leaves 1,300,000 tons for the other classes, including something over 300,000 commercial goods vehicles using petrol, averaging perhaps 12 miles per gallon and 15,000 miles a year—say 4 tons a year each, or 1,200,000 tons in all. The balance of 100,000 tons may be accounted for by miscellaneous vehicles, including agricultural vehicles and vehicles used by the Government, police and hospitals, and also by the consumption of petrol on motor-boats, aeroplanes and industrially. The motor spirit trade for 1929 may therefore be divided as below :—

Motor Spirit Trade, 1929

	Tons.	
Private Cars taxed on Horse-power	950,000	
Motor-Cycles	150,000	
Private Vehicles		1,100,000
Omnibuses and Charabancs	420,000	
Other Commercial Passenger Vehicles	180,000	
Commercial Goods Vehicles	1,200,000	
Miscellaneous Vehicles	100,000	
Commercial Vehicles		1,900,000
Grand Total		3,000,000

Of this total probably 1,500,000 tons were sold through garages, and 1,500,000 tons delivered direct to the consumers by the distributing companies.

Dealers' Profits

Of the trade done by dealers, possibly 90 per cent. consists of sales from the pump, and of the remainder all except a fraction is in cans, the rest being delivered in barrels. It is on the safe side, therefore, to say that nearly half the motor spirit consumed in Great Britain goes through the dealers' pump—*i.e.* 1,350,000 tons. There were in 1929 some 28,000 dealers with 62,000 pumps, so that the average throughput per dealer's pump was about 22 tons or 6600 gallons—about 550 gallons per pump per month. The retailer's profit per gallon is twopence halfpenny. The

average profit per pump per year would thus be a little under £70, and per dealer per year from the sale of petrol both from the pump and in cans, perhaps £170, assuming that the full price is charged to all customers. This scale of remuneration means that there are comparatively few stations where it is worth while to employ even a boy selling petrol 100 per cent. of his time. Normally it is essentially a part-time job to be dovetailed in with other work. As a matter of fact the intense competition between garages for trade has in many areas led to price-cutting below the standard profit by dealers. In these districts the average profit per gallon would be considerably under twopence halfpenny, perhaps more often three halfpence per gallon. Out of these profits the cost of the pumps has to be paid. A pump usually costs between £90 and £100, although there are also rather cheaper makes on the market, and this must be paid off out of the profits on the hire-purchase system. The usual method is for the distributing company to supply and instal the pump, and for the dealer to pay off the debt gradually. He is not strictly tied to the company while paying off the debt, as he may be able to transfer the financial responsibility for the pump to another distributing company. The latter company will settle up with the company originally installing the pump, and will have its own spirit stocked by the pump in question. The dealer is also at liberty to purchase a pump direct from the manufacturers, but this is costly, and only a small proportion of retailers are prepared to go to this expense.

It would, of course, be quite easy to distribute efficiently the present amount of motor spirit with only half the number of dealers and pumps without doing harm to any distributing company, provided the public were prepared to go a little further afield for their petrol. However, they are not, and in any case it is too late to alter the system now, as the public have been spoilt and expect a much more comprehensive distribution system than is given anywhere else in the world. The fault lies ultimately in the fact that the dealer in Great Britain is a free agent. Anybody may become a dealer, and in the years after the war the rapid development of motoring led to a mushroom-like growth of garages which provided congenial occupation for many thousands of ex-service men of mechanical aptitudes whose careers had been broken up by the war. Each company

was free to sell to the dealer, and, when pumps gradually began to displace the old-fashioned two-gallon cans, from about 1921 and 1922 onwards, each company endeavoured to get representation—*i.e.* to instal pumps at every dealer's premises in the country. Had this development been checked, distribution would be cheaper than it is, as the number of points to which deliveries would have had to be made would have been much fewer.

In addition to petrol and oil, most dealers sell tyres, accessories and spare parts, do repairs, at any rate of a fairly simple nature, deal in second-hand cars, keep one or two cars for hire, and, if the occasion arises, act as agents for new cars. Many of them also retail electrical apparatus, wireless sets, kerosene and hardware, and sometimes, when their premises are on suitable roads, run tea-rooms in conjunction with their other business, or perhaps just sell mineral waters and cigarettes. The men running these businesses and employed by them include a large proportion of competent, skilled and intelligent men, but the industry, on the entry into which there have been no restrictions, and for which little initial capital is required, has also attracted an appreciable number of short-sighted and inefficient individuals, a fact which has made the problem of organisation one of extreme difficulty.

The bodies representing the retail side of the industry are the Motor Agents' Association, whose function it is to encourage the retail trade, and, where possible—as, for instance, by agreement with the petrol companies about the sale of pumps—to prevent from entering the petrol retailing business, people who are not genuinely engaged in the motor trade; and the Motor Trade Association, who are interested primarily in the maintenance of a fixed rate of profit on the proprietary goods dealt with by the dealers. These bodies have a great deal of power, and on the whole pursue a moderate and reasonable policy, but in spite of this the Motor Trade Association in particular is not able in many areas to maintain the standard rate of dealers' profit on the sale of petrol, and, it might be added, has been even less able to maintain the full standard profit on the sale of new cars, and this in spite of every effort on the part of the Association and severe penalties on defaulting members. It will be a slow process gradually to enforce and maintain the standard retailer's profit all round, and it is unlikely to be entirely successful until the standard

retailer's profit has in all cases been brought down to a reasonable level in view of the greatly increased turnover retailers have been enjoying in consequence of the growth of motoring. Standard profits are in many cases so high that there is no effective public opinion in the trade against price-cutting to regular customers, and in certain districts price-cutting to casual customers is not unknown.

In the retailing of petrol the way in which price-cutting appears to have arisen is in the penny rebate formerly allowed to vehicles with commercial licences, in view of the fact that they usually make much larger purchases of spirit when they fill up than private vehicles. This has been claimed fairly generally to be an injustice by commercial travellers and others using their cars partly or wholly for business, but who were not strictly entitled to the rebate because they had a private licence. These people demanded, and usually succeeded, in purchasing their supplies at the same price as was charged to commercial vehicles. Their demand was not perhaps an unreasonable one, but it was obviously impossible for a garage, especially with casual customers, to know which motorists in private cars used their cars for business and which did not, and so in many areas garage proprietors proceeded from giving a penny rebate to bona-fide commercial travellers to extending it to all private motorists who asked for it. The larger lorry-owners and omnibus owners resented this, and, by pointing out their much larger purchases compared with the private motorist and threatening to take their business elsewhere, in some districts succeeded in buying petrol even cheaper than the rebate price.

The retailer's profit can only be maintained where public opinion among retailers is in favour of it. It is fixed at a much higher rate than in the United States, where—in New York, for instance—it is only 3 cents per American gallon, but against that petrol stations are, relatively to the demand, more numerous in Great Britain, and if the British consumer requires such a good service he must pay for it.

The great majority of the companies distributing petrol in Great Britain are agreed on fundamentals as to how the trade should be conducted. There are, however, several distributors who do not adhere to these conditions, and who are prepared to disorganise the trade by allowing anybody willing to sell their products to become a retailer. With the object of preventing this kind of thing and maintaining some

standard of organisation in the trade, all distributing companies which are parties to the agreement allow dealers who do not handle the brands of other companies a loyalty rebate of one penny a gallon. All dealers are entitled to buy at the ordinary wholesale price and to retail at three halfpence in excess of this, but the rebate gives the " loyal " dealer a net profit of twopence halfpenny a gallon, against three halfpence for the " disloyal " man.

The " loyal " dealer has the further advantage in trading only with firms which are parties to the agreement, in knowing he is on the same footing as all other dealers in the price he pays the distributor for his motor spirit. Firms outside the agreement are not prevented from prejudicing the position of the small dealer by giving special rebates to the large man. With commercial consumers of spirit—that is, buyers who take direct deliveries from the distributing companies and use the spirit entirely for their own commercial vehicles—the position is different. Quantity rebates fixed according to a sliding-scale are allowed for the larger buyers, the largest class of all being in a position to purchase their supplies twopence a gallon cheaper than the small users. This is justifiable on account of the very much smaller delivery costs for large consumers who commonly take very big quantities at a time. The large dealer does not show the same saving, as the difference between the large and the small dealer from the distributor's point of view is mainly that the former takes deliveries oftener. The actual amount of the delivery made, which is the important factor controlling delivery costs, does not vary very much as between large and small dealers. Furthermore, the small commercial consumer does not have his position prejudiced by the fact that the large buyer can obtain his supplies more cheaply, a peculiarity which is, of course, not confined to motor spirit, in the same way that the small dealer would be prejudiced if a large dealer 100 yards away were able to obtain a lower wholesale price. The largest class of buyers of all, such as city and municipal corporations and the biggest omnibus companies, usually ask for quotations from the various distributors, and may obtain their supplies even more cheaply than the twopence rebate class.

The excessive multiplication of dealers which has resulted from the growth of motoring, the ease of entering the business, and the small amount of capital required have been

at the root of most of the evils of the retail trade, but this should improve gradually, as, with the growing complexity of the business, the amount of capital required to start in it is steadily increasing. A garage proprietor must nowadays have several petrol pumps and motor-oil cabinets, which are no longer given away on such easy terms by the petrol companies as in the early days of the rush for pump representation. If his premises are in the country on a main road he is expected to provide a way from the road up to his pumps and out again, so that traffic filling up at his station does not cause an obstruction. A decade ago, when garages were rarer, a motorist was willing to follow petrol signs up side-streets, passages and mews in order to fill up. To-day he expects to find stations on the road, and is not willing to go a yard out of his way for petrol, so that the modern garage proprietor requires much more expensive premises if he is to get a fair share of business. There is also a tendency for business to become more concentrated on the better stations. All these factors are working in the direction of making it more difficult for the man without either capital or skill to enter the business, and, although a leaven of unskilled undesirables is likely always to remain in the trade, there can be no doubt that in general the status and conditions of the retail branch of the trade are improving. The greasy man in overalls knowing little about cars and less about business and accounts will, it may be hoped, in time disappear. A new and better type which will replace him is already coming to the front.

Grades of Motor Spirit

There are a number of different grades of motor spirit on the market. To a certain extent the different marketing companies tend to specialise on one or other grade in which they have a goodwill advantage with the consumer over their competitors, but most of the companies are prepared to market any grade on demand. From the point of view of the amount sold, by far the most important grades are the so-called No. 1 Spirit, which most private motorists use, and No. 3, or Commercial Spirit, used by most owners of commercial vehicles. The No. 1 Spirit costs twopence a gallon more than the Commercial, but offers certain definite advantages in greater ease of starting, smaller carbon deposit and reduced "knocking." In the actual mileage obtained

per gallon there is little or nothing to choose between the two grades.

The specification of No. 1 and No. 3 grades is not constant throughout the year, but is varied according to the climatic conditions. In winter, for instance, a volatile spirit is much more necessary than in summer to ensure easy starting, and the winter specification of the various grades of petrol is therefore different from the summer. Below are given typical specifications for the No. 1 and No. 3 Spirits sold by a well-known firm of distributors.

	No. 1.	No. 3.
Specific Gravity at 60° F.	0·730	0·740
Distillation (I.P.T. method) :		
Initial Boiling Point	27° C.	32° C.
Ten per cent. distilling to . . .	51° C.	60° C.
Twenty per cent. distilling to . .	65° C.	77° C.
Final Boiling Point	200° C.	200° C.
Percentage distilling at 100° C. . .	45	35

In addition to this, the H.U.C. of the No. 1 Spirit is very considerably higher than of the No. 3, which means that the No. 1 grade has a much greater anti-knock value than the No. 3.

No. 1 Spirit is in Great Britain sold entirely by brand. Pumps for retailing it all have globes bearing the name of the brand, and motorists are thus able to choose the brand they prefer. To prevent cheaper brands being substituted and sold from these pumps as No. 1 Spirit, it is usual for the underground tanks in which the spirit is stored at the garages to be padlocked, and the key to be held by the distributing company. It has been found by experience that this is the only way of preventing fraud. A tank locked in this way is described as being "sealed" by the supplying company, and has affixed on the side a round disc stating the name of the company which has sealed it, the grade stocked in the tank and the correct retail price which should be charged for it. Cans are also sealed in order to ensure that they are not being filled at garages with cheap spirit and sold to the public as good quality spirit.

The markets for No. 1 and No. 3 Spirits are by no means exactly differentiated as between private and commercial vehicles. There are a number of private motorists who prefer cheapness to quality in their motor spirit, and in some cases who take rather a short-sighted view of economy, and simply buy the cheapest spirit obtainable, perhaps a spirit

quite unsuitable for their particular type of engine. There are also a number of commercial vehicle owners who prefer to use the best quality of spirit only, and consider that the smoother running of the engine, easier starting and smaller expenditure on decarbonisation and repairs make up for the extra price. It is a matter of great difficulty to decide whether a smaller expenditure on petrol and a rather higher expenditure on other items, or a larger expenditure on petrol and less spent on other things is more economical, and the answer depends on the type of engine and vehicle to a very great extent.

No. 3, or commercial grade petrol, is very widely used on commercial vehicles, and the total sales of this grade are greater than the sales of No. 1 Spirit, as the bulk of the spirit consumption in Great Britain is by commercial vehicles. The branded demand for No. 3 Spirit is not so strong as for No. 1, but it is increasing. A few years ago it was common for a dealer with a pump for retailing No. 3 Spirit to put up a globe labelled simply "Petrol," and fill up his tank with any spirit available. Many men gave all the larger companies a turn in rotation, and the same applied to commercial vehicle owners with pumps who bought direct from the companies. The effect of advertising No. 3 Spirit, and of intensive canvassing by the representatives of the various companies, has been to establish a certain brand-demand for particular brands of commercial petrol, and many retailers' pumps stocking No. 3 Spirit are sealed and bear certificates in exactly the same way as No. 1 pumps.

In addition to No. 1 and No. 3 Spirits, there are several other grades. Aviation Spirit is priced by most distributors at fourpence a gallon more than No. 1 Petrol, and is a very superior volatile spirit suitable for aeroplanes, sports cars and racing motor-cycles, and also for cleaning purposes, but, as its market is limited and its price very high, sales of Aviation Petrol do not form a high proportion of the total. It is not much used by private motorists, but would probably be more popular were there more pumps for its sale.

Aviation Spirit is relatively much more used by commercial users buying their supplies direct, and especially by firms manufacturing or using aeroplanes and high-grade motor-cars. The ordinary motorist who does not exceed 50 miles per hour with his car, and is normally content with a steady 35 m.p.h. on the open road, does not want Aviation, as it is too expensive, and its advantages are not

sufficiently apparent at the speeds at which he wishes to travel. There will always be a certain demand from the special classes referred to, but, until flying becomes much more popular, the sales of this grade are not likely to show a rapid increase.

There is a considerable demand for the various benzol mixtures retailed now at the same price as No. 1 Spirit, although formerly one penny per gallon more expensive, and containing on an average about three parts of spirit to one part of benzol. Benzol mixtures are particularly popular in the hilly districts of the North of England, where their anti-knocking qualities are appreciated. Also, on account of the heavy benzol they contain, they have a high specific gravity and a rather high mileage per gallon, but they are dirtier than a pure spirit, and their use therefore necessitates more frequent decarbonisation of engines. In addition to the ordinary benzol mixture, as retailed at garages, there is a commercial benzol mixture marketed by most companies at one penny a gallon more than ordinary commercial petrol, consisting of No. 3 grade spirit with a small addition of benzol. Commercial benzol mixtures are sold in moderate quantities in some areas, but their popularity is largely local, and not so great as might be expected. The spirit content of the ordinary benzol mixtures is in most cases a No. 3 Spirit, the main difference between the ordinary and the commercial mixture therefore lying in the proportion of benzol content. Pure or "straight" benzol is marketed as a motor spirit on a small scale, but the sales of it are inconsiderable, and are mainly to the type of buyer who might otherwise be expected to take Aviation Spirit. On the whole, benzol mixtures, although widely used in Great Britain, are not nearly so popular as in some parts of the continent of Europe. In Germany, for instance, where the benzol production is much greater than here, and the total consumption of motor spirit less, the proportion of the total demand which has to be met from benzol is correspondingly larger.

Ethyl petrol consisting of a mixture of No. 1 and No. 3 Spirits with the addition of a chemical, tetraethyl lead, ($Pb(C_2H_5)_4$), as a "dope," is marketed in the United Kingdom at one penny a gallon above the price of No. 1 Spirit, but it has not attained any great degree of popularity, and is mainly used by motor-cyclists. The extra expense of using ethyl petrol, and the popular prejudice against the

alleged risks of its use, have prevented its obtaining as large a proportion of the trade in Great Britain as in the United States.

In addition to the above grades, the marketing of which is fairly general throughout the country, there are a number of special grades, in some cases refined specially for a particular large consumer. Cleaning spirit with a special boiling point and various rubber solvents can be obtained from the distributing companies if required. At the other end of the scale one or two of the largest omnibus companies purchase special consignments of cheap low-grade spirit which would in the ordinary way be unable to find a market as motor spirit in this country, but which such companies are able to use, when properly mixed with ordinary commercial spirit, without ill effects. Apart from the last-named, the "special" grades mentioned above are commonly known as "Industrial Spirit," and are mainly marketed in the industrial areas, and particularly in Lancashire. In the non-industrial areas there is practically no demand for special grades of spirit at all, and of course the demand nowhere comes from dealers, but is confined to large commercial users buying direct from the distributing companies.

Probable Expansion of Market for Benzine

As by far the greater part of the demand for benzine is for motoring, the future demand can be estimated from the probable expansion of motoring. In Great Britain the future expansion of private motoring can hardly continue at the same rate as in the past, and the number of private cars registered is not likely to exceed 1,250,000. In August 1929 there were 970,000 cars licensed, and at some time or another during the year there were over 1,000,000 private cars registered. The most recent Income Tax figures available indicate that there are roughly 786,000 incomes of over £400 a year in the country, and approximately 1,187,000 of over £300. After making full allowance for under-statement of incomes, for persons owning more than one car, and also for cars used mainly for business purposes by commercial travellers and others, it is still difficult to see how saturation point can be placed for motor-cars at a higher figure than 1,250,000 vehicles. The total annual consumption of these, at a ton of benzine per vehicle per year, would be approximately 1,250,000 tons.

The ownership of motor-cycles is commonest among young people, and especially among classes not affluent enough to run a car. The cost of running a motor-cycle is relatively low, but the pleasure to be obtained from it is problematical in these days of congested roads, and must depend largely on the temperament of the rider. There were in 1929 just over 700,000 motor-cycles licensed. The number is not increasing rapidly, and is not likely to do so, although a general improvement of trade would certainly be quickly reflected in the registration figures. The total consumption of benzine by motor-cycles is hardly likely to come within measurable distance of exceeding 200,000 tons per year. The total consumption by private vehicles seems likely, therefore, to settle down to perhaps 1,500,000 tons a year. For commercial vehicles it is impossible to give any figures. There is no obvious limit to the extension of the number of omnibuses except the elasticity of the amount of travelling done per person. There is every reason to think that the amount of travelling per person is still increasing, and that there is room for a good deal more growth in this direction before saturation point is reached. With regard to goods vehicles, the demand on the part of professional motor hauliers is constant, the number used by them being in the neighbourhood of 60,000, but the demand from private firms wishing to own their own transport continues to expand. There is a limit to their expansion, of course, in the amount of transport work to be done, but still room for a great deal of increase, although passenger transport probably has, in fact, a greater potential increase, since people may increase the amount of travelling they do for pleasure, whereas only the factor of necessity enters into the transport of goods.

The extent of the potential market for benzine for private cars does, however, give a basis on which to make calculations. The garage business must be organised on the assumption of an annual distribution of 1,500,000 tons to garages for the use of private motorists. In addition to this, a proportion of the commercial consumer business will go through garages. The Commercial Consumer taking supplies in bulk is not likely to change or be changed over to the garage, but the can Commercial Consumer is disappearing, partly through the installation of bulk outfits at Commercial Consumers' premises and partly through the power of attraction of cheaper spirit from the dealer's pump. In

addition to the 1,500,000 tons of private car business, the garage may in a few years also have to distribute possibly 750,000 tons a year to Commercial vehicles. The total profit for the garage industry on this trade will be, at twopence halfpenny a gallon, rather more than £7,000,000. Even when spread over the present total of 28,000 garages—which, of course, is increasing—this only gives an average profit on petrol of £250 per garage per year. This is not a large sum, and out of it the pumps must be paid for. The problem of distribution is clearly going to be largely to check the increase in the number of garages or even reduce their numbers, and thus secure a better average profit per garage.

As the ownership of private cars, and so the garage business, nears saturation point, it is going to become increasingly difficult to maintain the sales of new cars. This is purely a question of income and of the expense of running cars. It may be taken as axiomatic to-day that almost everybody in or near the car-income category either has a car or wants one. The reason why there are relatively fewer cars in Great Britain than in America is firstly that the average income is higher in America, and secondly that the cost of running a car is lower. With the present standard of living and cost of running a car there is clearly a saturation point in Great Britain determined by these two factors. The number of cars can be increased beyond this saturation point only in two ways: either by increasing incomes and so raising more people into the car-income category, or by reducing the cost of motoring and so lowering the minimum car-income and bringing in a larger proportion of the population as potential motorists. For practical purposes, taking the short-period point of view, the former alternative is impossible. Therefore it is to the interest of the garage industry and all other trades dependent on private motoring, such as car and tyre manufacturers, oil distributors and the makers of spare parts, to make the saturation point settle at as low an income-level as possible.

Elasticity of Demand and the Petrol Tax

Items entering into the cost of motoring include the original cost of the car, the tax and insurance, the repair and garage bill, and the petrol and oil used. To increase motoring it will be necessary to effect reductions under these heads

of expenditure. This will, of course, only delay saturation; it will not prevent it.

There is a widespread tendency to exaggerate the importance of petrol as one of the costs of motoring. The most important costs are, as a matter of fact, repairs and depreciation, although the tax and insurance combined are with many cars a big element in upkeep. Expenditure on petrol depends, of course, on the mileage, but actual figures based on the cost of running a fleet of 600 salesmen's cars, access to which has been given the author by the firm concerned, indicate that on a mileage of 8000 per year the cost of petrol exclusive of tax is likely to amount to somewhere between 12½ per cent. and 15 per cent. of the total expenditure on the car.

This relatively small expenditure on petrol compared with the total expenditure is perhaps the main reason why the demand for petrol is found to be so inelastic when prices rise or fall. When prices rise, loud complaints are always made that pleasure motoring is being killed. Statements that it is being encouraged are not made when the price falls, as would naturally be expected if the other argument were true. However, the fact is that changes in price make very little difference over the short period, because a 33 per cent. rise in petrol prices would barely increase the total cost of motoring for the ordinary private motorist by 5 per cent. If the weather is fine the man with a car is likely to make the most of it, and not "spoil the ship for a ha'p'orth of tar." The potential new motorist may perhaps be made timid about buying a car if he hears complaints on all sides of the expense of petrol, but if he works out his costs he is scarcely likely to hang fire on that account. A motorist, the cost of whose motoring is budgeted up to a 5 per cent. margin, would indeed be a miserable man, as a repair bill for unforeseen work for this amount is an unwelcome possibility for every motorist, and to such an unfortunate would presumably spell insolvency. Motor spirit is the most necessary thing of all in motoring, and yet its cost is small relatively to the other costs of running a car, and very small if indirect expenses such as meals and hotels, which are incidental to pleasure motoring, be added. For this reason the demand for it is steady, and, within reasonable limits, slow to react to changes in the price.

The fact that petrol is relatively cheap, and that, although it is produced in enormous quantities, the final consumer buys it in very small amounts, has made a petrol duty a favourite

method of taxing motor transport in many European countries and also in most states in the U.S.A. There was a petrol tax in the United Kingdom from 1909 to 1920 of threepence a gallon in the first years and subsequently sixpence a gallon during the War. This tax was abolished on the recommendation of the Departmental Committee on the Taxation and Regulation of Road Vehicles, on the grounds of :—

" Practical operation : because of the difficulty of collection occasioned by the system of rebates.

" Principle : on account of its failure to cover all liquid fuels used for mechanical traction.

" Scope : by reason of its application to imported fuel only."

In spite of this the petrol tax was re-introduced in 1928 in order to produce the wherewithal to finance Mr. Churchill's de-rating scheme, and, at the rate of fourpence a gallon, proved from the revenue-producing point of view a complete success. The mistake of allowing rebates for various special classes of consumer which had been made with the former petrol tax was this time avoided, and, although certain consumers, such as the users of benzine for industrial purposes, have rightly felt that they had a grievance through having to pay a tax which it was intended should fall on the motoring community, the tax has nevertheless been an easy one to collect, because no exceptions have been made. Further, the depressed state of the coal industry has changed the attitude of the public towards a tax which gives a subsidy to home-produced benzol, against which there is no widespread feeling in spite of the tariff protection it enjoys.

The petrol tax yielded over £13,000,000 in the first year of its operation. This was more than had been expected, and the cost of its collection to the Government was not very large, since, through taxing at the source, the Government were able to pass the work of collection over to the oil distributors.

In spite of the obvious advantage that a petrol tax has from the Government's point of view in being both cheap and productive, there are nevertheless grave drawbacks associated with it. There are four recognised canons of taxation. A tax must be, firstly equitable, secondly certain not arbitrary, thirdly convenient in the time and manner of its payment, and fourthly economical in collection. The first requisite about a tax is that it should yield enough to

be worth the trouble of collection. Granted that the basic principle in applying the tax should be equity of incidence, provided that an exact application along this line does not offend too obviously the principles of certainty, convenience and economy; the difficulty begins when an attempt is made to define "equity." A good deal of difference of opinion is possible between individuals as to what constitutes "equity"; a tax levied according to the benefit received from it may, from some points of view, be considered equitable, whereas from another aspect a tax may appear equitable when it is regarded rather as a contribution by individuals towards a common expenditure according to ability to pay, or, in the case of a service such as military service, according to ability to render it. The "benefit-received" attitude towards taxation, practically speaking makes taxation a form of insurance, and on the whole seems more suitable as a guiding principle in levying motor taxation than a contribution according to ability to pay.

The petrol tax in Great Britain is really a tax on motorists for the upkeep of the roads. The money for the roads is provided partly by the motor vehicle taxes from the Road Fund, and partly by the ratepayers, and the petrol tax was instituted to relieve certain classes of the ratepayers who were thought to be contributing too heavily to the local taxation account.

As a tax on motorists the petrol tax has the advantages of fulfilling the canons of certainty and of convenience in the time and manner of its payment, as the motorist pays for it in small amounts every time he purchases petrol. From the point of view of the Government it also fulfils the canon of economy in collection, but this is only made possible through shifting the onus of collecting the tax on to the petrol distributors, who charge a farthing a gallon, or a farthing on every fourpence collected, for the trouble and expense to which they are put in collecting the tax. This is equivalent to 6 per cent. of the yield of the tax, and, if the figure of a farthing a gallon represents the true cost of collection to the petrol companies—and there is no reason for supposing that this is not the case—the tax would appear to be an expensive one to collect from the point of view of the consumer who ultimately pays it.

It is, however, under the head of equity that the principle of the petrol tax fails to stand a close examination. If it be agreed that the roads should be paid for by the motoring

community according to the benefit each member of it receives from them—the claim which is usually put forward by the protagonists of a petrol tax—then the petrol tax must clearly be an undesirable way of taxing motorists, for several reasons.

If a petrol tax is to be considered a tax on road use, there can at best be supposed to exist only a very rough connection between this and petrol consumption. Petrol consumption tends to be high on bad roads, in bad weather, in hilly districts, and on vehicles which make frequent stops, whether through being held up in traffic or through making calls for the purpose of effecting deliveries, etc. It is thus obvious that a petrol tax bears unduly hardly on the commercial vehicle owner and on the man who uses his car for business, even if road use be considered a fair method of taxation. It is not necessarily so. Rather an interesting parallel exists in the payment for the water supply of whether it is more equitable to pay according to the volume of water used or according to the number of taps. There can be little doubt that the latter is the better method, since the expense consists almost entirely in having the water supply laid on. Once that is done the cost to the supplier of the water is practically constant, whether much or little is consumed. Similarly with the road system. The expense consists mainly in constructing and maintaining a road system suitable for the use of motor traffic. Given that, it makes comparatively little difference to the annual cost whether the road system be used much or little; a man who has a car doing 5000 miles a year needs just as good a road system as a man with a car doing 25,000 miles a year. There is, therefore, no reason from the point of view of equity why the taxation should in any way be made to vary with the mileage. The mileage is comparatively unimportant. It is the existence of the road system which matters. On the other hand, the owner of a heavy vehicle certainly does need on the whole a costlier type of road than the owner of a light vehicle, and if the authorities are expected to supply a type of road suitable for heavy vehicles, but more expensive than would ordinarily be required for light vehicles, it is fair that the heavy vehicle should be required to contribute at a higher rate than the light vehicle.

A petrol tax presses heavily on the motor vehicle which has to do a large part of its mileage in urban areas. Traffic congestion necessitates frequent stopping and starting, and

this involves waste of petrol. Again, broadly speaking, it is the commercial vehicle which does the greater proportion of its mileage in congested streets. The owner of the pleasure vehicle can choose the time and place of his journeys, and naturally prefers the less congested and more picturesque rural roads. The claim of the supporters of a petrol tax that it is a tax on road use, and therefore roughly on the damage each vehicle does to the roads, is particularly ill founded in view of this fact. If it were possible under a petrol tax to separate the amount of tax raised on mileage done on urban roads from the amount raised on rural roads, and compare those figures with maintenance costs, it would be found that the revenue raised from congested urban roads was far greater than the cost of keeping them in repair, and the revenue from rural roads much less. A strongly made urban road can stand up to a tremendous amount of traffic without appreciable damage, and the cost of maintenance per ton-mile of traffic passing over it is therefore very low; however, owing to the congestion and consequent blocks and stops at cross-roads, the consumption of petrol per ton-mile for vehicles running on such roads is definitely greater than under almost any other conditions. The same vehicle will consume up to 100 per cent. more petrol per mile in congested traffic than where traffic conditions are open, gradients and surfaces being the same. In effect this would mean, under a petrol tax, that the vehicle which has to do most of its mileage on congested roads pays up to double the amount of tax of more fortunately placed vehicles, in spite of the fact that in so far as any relation may exist between road use and damage to the roads the former vehicle would be doing less damage per ton-mile than the latter.

There are other factors also which make a petrol tax bear unduly on the commercial vehicle owner. One of these is the fact that the unloaded weight of a private car is roughly 75 per cent. of its loaded weight, whereas the corresponding proportion for a commercial vehicle is 45 per cent. It is therefore necessary for the commercial vehicle to have a larger reserve of horse-power in relation to its unloaded weight than the private vehicle, and the consequent difference in engine design involves lower efficiency and an extravagant petrol consumption when a commercial vehicle is running unladen.

Commercial vehicles, especially goods vehicles carrying fairly light loads, are usually more bulky in proportion to

their weight than private vehicles. This greater bulkiness, which is particularly noticeable in the case of box-vans, causes the vehicle to offer a greater resistance to the wind, and hence increases considerably the fuel consumption, but without adding in any way to the use made of the road. Heavy and compact loads are free from any such extra fuel factor. A petrol tax thus causes unfair discrimination against particular types of vehicle, and tends to hit retail shopkeepers particularly heavily, since they are the chief users of small delivery vans, which, with their relatively large surface to offer resistance to the wind, and their necessarily large mileage on congested city streets, are liable to victimisation on at least two scores.

A petrol tax also involves a higher proportionate payment from the man living in a hilly district than from the man living in a flat district. The labour of climbing, the internal transmission losses and the constant use of the brakes all conduce to a high petrol consumption in a hilly district. The average petrol consumption per mile is said to be at least 25 per cent. higher in a hilly district like Cumberland than it is in flat districts like certain parts of the Eastern Counties. This is, on the whole, a smaller variation than might reasonably be expected, and only a minority of the population of Great Britain lives in or near really hilly areas, but nevertheless it is an important point in view of the emphasis laid by the supporters of the petrol tax on its alleged equity.

This supposed equity is more apparent than real. There can be little doubt that a petrol tax imposes distinct hardships on several classes of commercial vehicle owner, perhaps most of all on owners of light delivery vans and two-decker omnibuses, which do not for the most part come into very direct competition with the railways, and injury to which benefits nobody, least of all the public. The private vehicle, on the other hand, is let off comparatively lightly.

Petrol consumption is clearly at best but a very imperfect gauge of road use, but, as has already been explained, there is no particular reason why vehicles should be taxed in proportion to the use they make of the roads, any more than why householders should pay for their taps in proportion to the amount of water they actually run off through them. It sounds very plausible to argue that vehicles ought to pay in proportion to the wear and tear they inflict on the roads. If this were an accepted axiom in assessing con-

tributions towards motor taxation, many vehicles would get off scot free, since the wear and tear they inflict on good roads in ordinary weather conditions would require the aid of a microscope to be perceived. The wear and tear is mainly a function of nature—that is, the weather; given a road system suitable for motor traffic, it seems foolish to attempt to hinder the growth of that traffic by imposing a tax on the use made of the roads, especially when that use appears to have little, if any, deleterious effect on them.

One of the greatest drawbacks to a petrol tax is that it does not cover very exactly the field over which the taxation is intended to be imposed. Petrol is not the only fuel on which motor vehicles are run, and the whole of the demand for petrol does not come from motor vehicle owners, since there are internal combustion engines which are not used for propelling road motor vehicles—for example, engines on aeroplanes and motor-boats. Benzine is widely and increasingly used by laundries, cleaners, bleach works and rubber manufacturers. It is a decidedly arbitrary procedure to impose a tax on the raw materials of these industries, and yet with industrial spirit as widely used as it now is, if rebates were granted to these classes, there would be a risk that the tax would become unworkable.

The Price of Petrol

There are fairly wide differences in the price of petrol between different parts of the British Isles. There appear to be three factors controlling these costs: the quality of the spirit, the cost of distribution, and the intensity of competition, although it is in practice difficult, in any particular instance, to decide which of the last two is the more important. In the first place, there is a difference in price between No. 1 Spirit, the grade usually used by private cars, and No. 3 Spirit, the grade used by many commercial vehicles, of twopence a gallon in the case of most companies, corresponding to the difference in quality. Benzol mixture is sold at the same price as No. 1 grade spirit. The less popular brands sell at prices rather below the level of the more popular brands in order to find a market, and there are also one or two very inexpensive brands, often of somewhat doubtful quality.

There is also a difference in price corresponding roughly to the difference in the cost of distribution between spirit sold in bulk and spirit sold in cans. The difference in 1929

was one penny in both the wholesale and retail price in the Inner London area and twopence halfpenny both wholesale and retail in the rest of the country, including the loyalty rebate. The restrictions on the erection of pumps in London account for the small differential there. Elsewhere there are not the same restrictions on pumps, and therefore the differential is larger. Handling spirit in cans is a nuisance from the retailer's point of view, and he was formerly given the additional incentive to sell in the most economical way by making more profit on bulk than on cans, in addition to the time and trouble he saves. As a result can sales by dealers are now negligible in many parts of the country.

It is extremely difficult to ascertain exactly what is the difference in the cost of distribution in bulk and in cans when both systems are in operation at the same time side by side, as there are a number of things which cannot be accurately costed. For example, a lorry may be delivering spirit in bulk from a portable tank and also spirit in cans. It is making a few deliveries of bulk spirit at a low cost because the minimum delivery is 200 gallons, and at the same time a large number of very small deliveries of cans which take up a long time. Lorry costs are allocated at a flat rate per gallon over both bulk and cans because there is no other method which can be proved more accurate, but actually the cost per gallon for the cans is possibly several times as high as the cost per gallon of the bulk. Similarly with clerical costs: the average bulk delivery is perhaps 300 gallons, and the average can delivery 30 gallons, but approximately the same amount of clerical and accountant's labour is required to keep the necessary records for one delivery of 30 gallons in cans as for one delivery of 300 gallons in bulk.

It is, however, safe to say that the difference in the cost of distribution of bulk and cans is not less than the difference in price. It is surprising that, with a bonus on bulk to all "loyal" dealers for several years, and a difference in price of twopence retail in most parts of the country for the same article, according to the method of distribution, that it should have taken five or six years to turn over the dealer business all but completely from cans to bulk, when the advantages of the latter are so obvious that, without any economic incentive, bulk should have replaced can distribution in a fraction of that time on the strength of its

greater convenience. It points to a much greater degree of conservatism in habits and preference among the actual consumers than might reasonably be expected to be the case.

The country is divided into zones for the purposes of both wholesale and retail prices, and the prices of all the more important companies vary from zone to zone in the same way, the variation being roughly controlled by the cost of distribution, although other factors are also taken into account. The most important zones are the Inner and Outer London Zones, and the Rest of England and Wales and South Scotland Zone. At present (1929) the retail price of spirit is a halfpenny cheaper in bulk in both the London Zones than in the Rest of England and Wales, and of cans three halfpence cheaper in the Inner London Zone, and a halfpenny cheaper in the Outer London Zone. The Inner London Zone comprises roughly the urban area of London, and coincides more or less with the Metropolitan Police Area. The Outer London Zone covers the area within a radius of over 50 miles from London. So far as the Inner London Zone is concerned, the bulk price does correspond to a saving in the cost of distribution which is very low in this area for bulk, as, in comparison with the amount of trade, the number of pumps is small, on account of restrictions on their erection, and consequently the average throughput per pump is very high, and the average amount of spirit delivered per delivery is correspondingly high. The cost of delivery per gallon is therefore low. Although there are few pumps in London in relation to the enormous demand for petrol, there are nevertheless a very large number per square mile, and the high density means that there is comparatively little waste mileage run by the bulk wagons between one garage and the next. In London the distributors of petroleum products can obtain all the benefits of large-scale work.

The much lower price of spirit in cans in London, compared with the provinces, does not altogether represent a difference in the cost of delivery, which, although lower in London than in the country, is not so much lower as the difference in price would suggest. It is to be regarded, partly, at any rate, as a concession on the part of the distributors, in view of the difficulty garage proprietors find in obtaining permission to instal pumps in the Inner London Zone.

The difference between the price of spirit in the Outer

London Zone and in the Rest of England and Wales Zone does not in all cases correspond to a difference in the cost of distribution. The cost of distribution is low in the residential areas in the neighbourhood of London and in the seaside resorts on the South Coast, but there are sparsely populated districts to the north and north-east of London within the limits of the Outer London Zone where distribution costs are high. The reason for the extent of the Outer London Zone is to be found in its proximity to the Thames estuary, to which most of the petroleum consumed in Great Britain is imported, and to the existence in the estuary of public oil wharves, a fact which has encouraged speculative importing by brokers, who naturally attempt to get rid of their stocks more or less locally, and so cause intense competition in the south-eastern counties, and, as a result of the competition, low and sometimes unremunerative prices.

In addition to the zones already mentioned, there are a number of other zones. In the North Scotland, Orkney and Shetland Zones, and the Belfast Zone, prices are one penny more than in the Rest of England and Wales and South Scotland, a difference fully justified by the cost of distribution. The same price also prevails in the Isle of Man. In the Hebrides prices are fourpence more than in the Rest of England and Wales Zone, and in the Rest of Northern Ireland twopence more. There are other zones for Dublin, the Rest of the Irish Free State, Jersey and Guernsey. In all these cases the difference in price corresponds roughly to the difference in distribution costs. The correspondence is, of course, only rough. There are, for instance, rural areas in the south of Scotland with higher costs of distribution than urban areas in the north, but it is not practicable to make a zone for every town and village corresponding to the cost of distribution to the point in question. Compared with many Continental countries, there are comparatively few zones in Great Britain, and this certainly tends to promote better feeling in the trade between wholesale distributors and retailers, as retailers with businesses in one zone, but within a short distance of competitors in a cheaper zone, not unnaturally feel that they have a grievance, and a large number of anomalies inevitably occur, as when a lorry going out from a depot to deliver spirit may deliver at the more expensive price at a garage near the depot, but, on going further out and making a delivery at a considerably greater cost to the company in an outlying

corner of the territory, may charge the latter customer less per gallon than the man with a garage only a few yards from the depot.

The Zone system is, nevertheless, necessary as a protection to the large national distributor who gives a service in all parts of the country and has a system of distribution extending into every village. Such a distributor takes the rough with the smooth, and if he delivered at the same price in all parts of the country, he would have to average up his losses on the sparsely inhabited areas by charging more than necessary in the centres of population. His competitors who did not offer a national system of distribution would confine their activities to the centres of population, and skim the cream of the business in that way. The zone system is a partial safeguard against this, but, as it only corresponds roughly with the cost of distribution, it is not a complete safeguard, and the national distributors are still faced with the task of giving a regular service to every village and back street, while some of their competitors restrict their activities to the large towns and the big traffic routes.

The zone system will remain so long as such varying service is given by the different companies, and would probably be continued even apart from that, as it is the best guarantee for the outlying areas that they will receive proper treatment and attention. If, for the sake of uniformity, zones were abolished, the distributors would certainly concentrate on the profitable areas, and neglect and discourage trade in areas where they were working at a loss. However, it might be suggested that a good deal of discontent is caused through the delineation of the zones being somewhat arbitrary. If the zones were made to correspond with counties, for instance, or rather groups of counties, there would be less discontent, as county feeling is strong, and the residents of different counties are accustomed to the idea of payments varying according to the county in which they reside—as, for example, in the matter of rates.

Cost of Distribution

Apart from differences in the grade of spirit being sold, it will be seen from the foregoing that the whole system of price-fixing in the motor spirit distributing industry is dependent on a scientific system of ascertaining and analys-

ing the cost of distribution. This is a subject which in the organisation of a distributing company ranks next in importance to the selling of the products. The products must be sold in the first place, and there must be a selling organisation strong enough to do this, but, next to sales, the attention of the management must be directed to finding how much it costs the company to sell, or rather to distribute, and to the directions from which this expenditure can usefully be attacked with the object of reducing it. This involves an elaborate system of costing and the subdivision of the whole cost of distribution into the appropriate headings. The principles by which the various items of expenditure are allocated must be sound. Once the system has been laid down, the collection and summarising of the information become a matter of routine, but a good deal of the policy of the distributing company will be determined by a proper interpretation and analysis of the results of the costing. Under normal conditions the retail price of the spirit will be very close to the cost of replacement, plus the cost of distribution, plus the retailer's standard profit, and the pushing or not of new systems of distribution, new schemes or new types of equipment will depend on an analysis of the costing figures. The importance of accurate costing may be appreciated when it is realised that differences of a fraction of a penny per gallon represent many thousands of pounds per year for the larger companies.

The principle of costing is to analyse a process—in this case the distribution of motor spirit—into its essential parts, and subdivide the items of expenditure into as many headings as required. The most important of the main headings of costs in a distribution service is transport, which may be subdivided into :—

(*a*) Transportation to installations. When the spirit is not imported direct to the installation at which it is required, it is discharged where it is brought in, and subsequently transported by barge or coastwise vessel to the installation which is to receive it.

(*b*) Transportation from installations to depots. This is usually either by rail tank car or by Scammell lorry, but sometimes by barge.

(*c*) Delivery from depots to buyer's premises. This is entirely by road tank wagon.

The second main heading consists of the industrial charges incidental to the process of distribution. These are :—

(*a*) Installation charges. Spirit stored at an installation must, of course, pay for the use it makes of the space it occupies, the labour employed in handling it, and the general upkeep of the installation.
(*b*) Filling charges. The cost of filling the spirit into packages.
(*c*) Repairs to the packages used.
(*d*) The replacement of scrapped packages.
(*e*) The provision and maintenance of bulk storage equipment, which is almost always undertaken at a loss.

The third heading is the cost of supervision which may be subdivided into :—

(*a*) Salaries and expenses of Superintendents.
(*b*) Salaries and expenses of depot and Divisional Office staff.
(*c*) Salaries and expenses of Head Office staff.

The fourth heading is the cost of the premises used :—

(*a*) Rent.
(*b*) Rates.
(*c*) Insurance.
(*d*) Maintenance.
(*e*) Depreciation.

The fifth and last heading is the cost of advertising.

These figures have to be compared, period with period and area with area, and it is from an analysis of them that it is possible to find out in what direction unnecessary expenditure is occurring. The objective of reduced expenditure cannot, however, be pursued indefinitely. The first point to be borne in mind is, of course, that it is better to sell a large gallonage at a rather higher cost of distribution than a small gallonage slightly more economically. It is therefore a matter of some difficulty to decide just where to economise in transport costs. The actual work of transportation must be done as efficiently as possible, but, on the other hand, the cost may be higher for a technically efficient transport system serving every possible customer in an area, whether they are easy to get at or not, than for an inefficient

transport system confining its activities to supplying garages on the main roads. A bald comparison of transport figures must never be made without the other factors bearing on the question also being carefully considered.

The industrial costs of filling and refining packages, maintaining bulk equipment, etc., must be cut down as much as is compatible with efficiency. The greatest economy obtained in recent years has largely been obtained under this heading, a low expenditure on bulk storage equipments having been substituted for a much higher expenditure on filling charges, repairs to packages, and scrapped packages, through the transfer of trade from cans to bulk.

Expenditure on rents, rates, maintenance of premises, insurance and depreciation is for the most part not directly controllable, and if the premises are really needed cannot very well be reduced.

In a sense expenditure on supervision and on advertising is in both cases a dead loss, as it is always a matter of opinion how far sales are affected by this type of expenditure. It is also possible that money expended on supervision and advertising is the best investment made by a company distributing an article of popular consumption : this, in fact, is probable, but it cannot be proved. Similarly there are no data to show whether, say, a 10 per cent. increase of expenditure on this account would be reflected in an adequate increase in sales, or whether a 10 per cent. decrease would bring about a decrease in sales. The human element plays such a large part in both supervision and advertising that such questions are practically incapable of statistical proof.

The above are the principal costs entering into distribution. There are two ways in which they can be reduced. Either the same work can be done more efficiently by securing a larger return per unit of expenditure through better organisation and better equipment, or a more expensive method of distribution can be replaced by a less expensive—as, for instance, the substitution of bulk for cans—or possibly of road vehicles owned and operated by the distributing company in the place of tank cars running on the railways. The effect of changes can be gauged fairly quickly from the records of costs.

The most important general factors affecting the cost of distribution are the size of the overhead organisation to be carried relatively to the trade done, and the degree of competition between the different companies engaged in the

business. Intensity of competition leads to unnecessary expenditure on advertising, the provision of unnecessarily good service and overlapping of services, the general spoiling of customers with undue credit and other facilities, and, as a result, an all-round stiffening of distribution costs. Within limits which it is rather difficult to determine exactly, a large organisation is more economical than a small organisation, since the extra labour required to deal with a somewhat larger gallonage is not proportionate to the increase in gallonage. This is true at any rate up to the stage reached by many very large concerns, when the organisation becomes cumbersome and involved, and the economies of large-scale distribution cease to be apparent.

A comparative study of distribution costs in detail will give a number of suggestions for the selection of the most efficient equipment, quite apart from any special technical knowledge. The cost of delivery by motor lorry, for instance, can be subdivided into cost of repairs, cost of wages, cost of petrol, and so on, and a comparison of the cost of repairs over a period for sufficient numbers of various makes of lorry may often be illuminating, and show clearly the types of vehicle which are not suitable for motor spirit distribution. This is perhaps the direction in which such inquiries can most profitably be pursued, but there are as well other fields for research of almost equal value.

Comparisons of costs by areas frequently yield useful results. An actual case of this may be cited in which a certain area suffering from acute trade depression was found to have relatively far heavier charges for depot wages and for filling cans at depots than any other comparable area. This was investigated, and it was found to be due to the fact that the depots were over-manned and each man had barely enough work to do. A further examination brought to light the fact that over-staffing was made easy because wages were so low on account of unemployment and trade depression that less reluctance had been shown in allowing increases in staff, on account of the small additional cost of employing an extra man, than in more prosperous districts, and greater reluctance manifested to discharge anybody on account of the state of the labour market and the difficulty of finding other employment.

The general system of distributing motor spirit by a large company is fairly typical of all large-scale distribution of articles of popular consumption, such as tobacco and cigarettes

and beer, where one brand may have a more than nation-wide reputation, and of the method of costing the process of distribution and using the costs when they have been ascertained. An elaborate and detailed system of costing is of even more vital importance to a distributor than to a manufacturer, since the latter can, through his managers and foremen, watch and supervise every employee at his work, while in a distributing service this is impossible, because all the roads in the country are the factory, and supervision and inspection must of necessity be occasional and incomplete. Indirect supervision by means of costs, taken in conjunction with local conditions and the extent of sales, may, however, be very effective, and is certainly the most economical and efficient way of controlling a large but widely dispersed staff.

Bulk versus *Can Deliveries*

It is possible to have either a small number of large depots centrally placed or a large number of small depots scattered over the country. From the point of view of distribution costs only, the former is much the better system, as it enables economies to be made in the number of depot staff, and it makes possible specialisation as between the different lorries, a consideration of the first importance since the substitution of bulk for can business. The introduction of the bulk delivery system threatened to result in a serious disorganisation of the distribution system, for it involved a totally different principle of delivery. In addition to vehicles following the daily routes for can spirit deliveries which had been mapped out ahead, they had also to be ready to deliver special orders for bulk spirit, which might and did come in at the most inconvenient times. Bulk spirit sales at a depot in the early days were not large enough, on the one hand, to justify keeping a vehicle solely for that work, while it was fatal, on the other hand, to create any lack of confidence in the regularity of hawking visits by taking regular hawking vehicles away on all sorts of occasions to make special deliveries of bulk petrol.

In the larger depots it was found possible to overcome this difficulty. Special lorries were set aside for bulk deliveries and other lorries for can deliveries, the two systems of delivery being kept separate. In small depots, however, there was no alternative but to use one of the hawking

lorries for special bulk deliveries also. Every attempt was made to keep those hawking lorries which worked at a distance from their depot solely on their regular rounds, for it is essential to give a strictly regular service both to keep existing trade and to secure new trade. As long as customers knew that a lorry would call, say between eleven and twelve o'clock on Wednesdays and Fridays, they were content to let their stocks drop down to a minimum. If services were to become irregular, not only would trade be lost, but more special orders would come through, which would mean taking more vehicles off their regular routes, and so would lead to a breakdown in the hawking system. Where possible a solution to this difficulty was found by specialising the functions of the lorries, and giving one solely can deliveries and another solely bulk. In the two-lorry depot what actually happened was that one lorry was given an inner circle round about the depot to work for can spirit, say, alternate mornings and afternoons, leaving it free for the rest of the time to make bulk deliveries over the whole of the area by means of a portable tank. This lorry worked within a short distance of the depot, so that it had not far to return when a bulk delivery was required. The other lorry was given circular routes to follow regularly in the outer circle of the depot.

With the continued growth of bulk spirit the original difficulties have more or less disappeared, but other problems have arisen in their place. It is now possible to specialise the functions of lorries to a very high degree in the larger depots, thus separating the lorries used for special delivery work from those used for hawking. It is not advisable, if it can be avoided, to divide a territory up between various lorries, each of which has to cater for both cans and bulk in its particular area. A recognition of the difference between the underlying principles of hawking and delivering to order will make it obvious why such a method leads neither to the satisfaction of the customer nor to economy in working.

This development has also made it possible in many places to supersede the lorry and portable spirit tank by a fixed bulk tank wagon. As long as hawking lorries had to be used partly for delivering bulk petrol, it was necessary to have a spirit tank which could be put on or taken off the lorry as and when required. As soon as, with the growth of bulk sales, it was possible to set lorries aside solely for

FROM TANK WAGON TO CAR. A PETROL DELIVERY AT A WAYSIDE GARAGE.

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bulk deliveries, the large and permanent bulk tank wagon came into extended use. Whereas the largest portable tank it was considered advisable to use in the early days of bulk deliveries was only of 600 gallons capacity, the permanent bulk tank wagons now used have a much larger carrying capacity of 1000 to 1500 gallons.

In the case of the bulk spirit vehicles, an endeavour is made to use them to their full capacity as far as possible on each of their journeys. If the capacity of a wagon is 1000 gallons, and orders are received for no more than 500 gallons in a certain part of the depot area, an attempt is made to find other customers in the same district who are willing to take the remaining 500 gallons. This is done by keeping a close watch on customer's stocks, which makes it possible, through knowing when the last delivery was made to a customer and what is the usual weekly consumption or throughput of his pump, to gauge fairly accurately when a further load of spirit is required.

The continued growth of bulk sales through the pump at the expense of can sales has made it possible to effect economies in the case of hawking lorries in a way which was impossible a few years ago. Each hawking lorry had in those days to be left a considerable margin so that it would be able to pick up substantial new business. With can sales steadily falling, it afterwards became possible to map out routes for can lorries which would work them to their utmost capacity. The fall in can sales has, of course, reduced the number of customers to be called on, and has also made it possible to reduce the frequency of service, although the same effort is made as previously to maintain regularity of service. Thus, although previously it was considered advisable to keep hawking lorries confined to particular depot areas, on the assumption that any over-equipment would soon be absorbed by increased can business, it is now thought best to work two or three adjoining areas, even though controlled by different Superintendents, by pooling the hawking lorries, so that each is worked to the full. Hence, if work can be found for one and a half lorries in each of the two adjoining districts, instead of having two lorries in each of the areas so that they may both be water-tight and independent, three vehicles can now work both areas without any loss of efficiency in the service given. This same ability to work hawking lorries to the very utmost has made it possible to manipulate depot territories to a

greater extent than previously, although in this case, of course, care has to be taken to ensure that the saving on lorries is a real one, and is not turned into a loss by substantially increasing the cost of transportation through running the lorry from one area to the other.

The present relation between bulk spirit and can spirit deliveries has emphasised the necessity for making different arrangements for distribution during the summer and during the winter months. Although, even when can spirit predominated, there was always the necessity in a number of seasonal places to provide additional equipment for the busy seasons, this has become all the more necessary now that sales through the pump predominate.

Previously it was often necessary to give the same can spirit service in the winter as in the summer, in spite of the fact that the sales per call were considerably less, and thus the same equipments had to be kept all the year round. It is now possible in a large number of places to reduce bulk equipment during the winter, because with the fall in sales the number of special calls for bulk spirit falls too. The surplus vehicles which thus become available during the winter are used in the main as relief vehicles, to act as substitutes during the painting and overhaul of the fleet. In this way it is possible to work with fewer lorries as permanent reliefs than would otherwise be safe.

There are three main types of delivery area to be found. There is the first type of area, the large town where special bulk lorries are used, and also special can lorries independently. There is the second type of area, where, although a special bulk lorry is used, can lorries are shared with neighbouring areas. Finally there is the third type of area, where one vehicle only is required for both bulk and cans. Bulk spirit forms in such areas, as elsewhere, by far the larger part of the trade. Journeys are made primarily for the delivery of bulk spirit, although the opportunity is at the same time taken to deliver can spirit too. Although routes depend in the first place on the bulk orders which are at hand, it is also found possible to maintain a fairly regular can service as well. Recently, however, with the decline in can deliveries almost to vanishing point in some areas, it has been found possible to do a certain amount of routing of bulk vehicles.

In most areas there is still, however, a substantial proportion, at any rate of commercial consumer business, in cans.

This mixed business can be conveniently dealt with by large depots, each with several lorries which can specialise, or even by medium-sized depots, and considerable saving in transport costs will result, but for small depots this is not possible. The actual costs of delivery by motor lorry are almost invariably high in small depots, since the same vehicle must be used for both bulk and cans. There are, nevertheless, advantages in having a number of small depots rather than a few large ones which are not reflected in the distribution costs. It is often possible to cover the ground much better in a small depot. There is more likelihood that a Superintendent or driver-salesman residing in a small town and with a small area to work will explore all the possible places where business might be obtained. In a larger town, where the area is worked as a whole, the tendency is to concentrate on the obvious. A further point is that, where depots are small, the personal element becomes much more important. The representatives of the distributing company can get into touch with the life of the district, and will make contacts with their customers on other than a business footing, which is, of course, a very valuable asset. If two distributing companies of similar popularity are covering the same ground, one with large depots and the other with small, the one with the large depots is likely to obtain the most favourable distribution costs, but the one with the small depots will obtain the larger gallonage.

The ideal is probably in between the two extremes. Depots must be big enough to allow a certain amount of specialisation of function, at any rate to the extent of having one lorry for bulk only, and one or a share of one for cans. On the other hand, they must not be so big that the covering of the area by the representatives of the distributing company becomes partial and incomplete.

The service given to the customers must, of course, be good, but intensity of competition leads to giving too good a service, and hence to extravagance with equipment. It would be possible to save considerably in equipment if customers were required to give forty-eight hours notice of requiring a fresh load, and thereby enable routes to be planned beforehand, but human nature being what it is, this would scarcely do, since customers would constantly be letting their pumps run dry, and the effect on the distributing company would not be good when the public

found themselves unable to buy their favourite brand through the pump having run out. Business might be permanently lost in this way.

The Petrol Pump

The most important and the most obvious piece of equipment in the motor spirit business to-day is the pump from which motor spirit is sold to the public. Except in the Inner London Zone, every dealer with any pretensions even to a moderate business must have one or preferably more pumps. These he can either buy outright from the makers, which is expensive, or he can buy on the hire-purchase system through one of the distributing companies, payment being usually spread in monthly instalments over a period of three years. Most dealers do not like the capital outlay involved in buying several pumps direct, and take their pumps instead from the distributing companies, who hold the financial responsibility for the pump until all the instalments have been paid up. So long as a company holds the financial responsibility for a pump the dealer is tied down to that company's spirit for the pump in question, unless, as already explained, he can persuade another company to take over the financial responsibility and convert the pump to its spirit.

Commercial consumers can also buy their pumps from the distributing companies on the hire-purchase system, but a much bigger proportion of commercial consumers than of dealers purchase their pumps direct from the manufacturers, and so are not tied down to the products of any one company. Transfers of financial responsibility in cases where the pump is being bought on hire purchase, involving, of course, the conversion of the pump from one supplying company's products to another's, are permissible, but relatively rare, as there is little object in such a transaction. If a commercial consumer is satisfied with the spirit he is obtaining—and he presumably would not have taken a pump from a distributor unless he liked the spirit—there is no incentive for him to change, as he does not have to take into consideration changes in fashion and in the demand of the public. Commercial consumers' pumps are in no cases for re-sale of spirit to the public, thus there is less incentive for the distributor to try to tie up a commercial consumer's pump than a dealer's.

Dealers' pumps are not only a means of pumping up motor spirit from the underground storage tank into the motorist's car; they are also the principal means to-day of advertising the brands stocked in the tanks, and, from the point of view of the garage, the fact that spirit is on sale in bulk. This led, when bulk buying was inaugurated, to each of the distributing companies selecting a colour for its pumps, preferably gaudy and conspicuous, and painting all its pumps the same colour. In themselves the colours selected were often cheerful and pleasing, but the effect of a service station with several pumps of different colours side by side—red, blue, green and orange—was often less agreeable, and led to Press campaigns against the disfigurement of the countryside. This has resulted in many cases in a dealer having all the pumps on his site painted the same colour, often with the idea of toning with the landscape, and, in order to keep the pump as an advertisement for their brand, there has been a marked tendency amongst the distributing companies to issue globes for their pumps of distinctive shapes or including distinctive designs, instead of the old type, which were round in shape and merely described the contents of the tank boldly by their brand name.

The campaign in the Press was partly, no doubt, sincere, and inspired by æsthetic considerations. It was also apparently partly to be viewed as propaganda against motor transport in general by people who had their own reasons for wishing to see it throttled. For the most part, however, it seems to have been due to the fact that people have scarcely even yet recognised the full extent of the changes brought by motor transport, and have not made the necessary mental adjustments. After road transport had been killed by the railways a century ago, the countryside entered on a period of decline and became crippled and decadent. Those contacts with the outside world which had been provided by the stage-coach were broken, rural industries were disappearing before factory-made products and rural life became dull and stagnant. People of the Victorian period came to look on this state of affairs as normal, and even sentimentalised over it and pretended it was rather beautiful. Motor transport has breathed new life into the countryside, and has covered the borders of the main traffic arteries for miles with bungalows and service stations, and as electricity becomes cheaper and better distributed, factories

and works will follow. It is absurd to expect or wish these traffic arteries to present the same appearance as the byways between decaying Victorian villages and market towns. People can still find plenty that is picturesque, old-fashioned and rustic if they will take the trouble to turn their cars off the main highways, but on them they have no right to expect unbroken solitudes of rustic lanes, and they ought to be thankful that the new life growing up around these highways, although suffering still from the almost inevitable ugliness of newness, is at least happier, healthier and more virile than the old life of populations concentrated in the smoke-laden atmosphere of the industrial districts.

From the point of view of the distributing company it is very necessary to make sure that the pump which it is selling on hire purchase terms, and for which it holds the financial responsibility, is actually being used to stock its own spirit. There is obviously a possibility that an unscrupulous dealer, who has a pump which is being sold to him by a company distributing high-grade and therefore expensive petrol, may wish to put into the tank some cheap motor spirit and pass it off to the public as the high-grade petrol of the distributing company which holds the financial responsibility of the pump. The distributor in such a case is not only losing business through not supplying all the spirit to a pump for which he advanced the purchase price, but is also losing business in a much more serious way through consumers buying inferior petrol under the impression that it is the superior brand as advertised, finding it unsatisfactory, and in consequence ceasing in future to be buyers of that particular brand. In order to obviate this, it became the rule, where possible, to seal the tank—that is, for the distributor to lock it and retain the key, the retailer thus being unable to open the tank except with the knowledge of the representative of the distributing company. Pumps thus sealed have a disc fitted to the side known as a "sealing certificate." The better known No. 1 spirits are usually sealed, in the case of Shell invariably, as the Shell Company refuses to supply Shell Spirit to unsealed pumps. Many commercial grade pumps and pumps retailing cheap spirit are also sealed, but the practice is not so usual with these pumps, as there is less point in sealing. A dealer has nothing in particular to gain by dumping one kind of cheap spirit into a tank, the pump of which states that another kind is being stocked. Sealing of commercial consumers'

pumps is, of course, not practised, as spirit from these pumps is not retailed to the public.

Since most petrol is nowadays purchased in bulk, very great attention is paid to the pumps by the distributing companies. The motorist wishing to buy petrol stops where he sees pumps, and, after stopping, selects the brand of petrol he prefers. He is, as already explained, rarely a sufficiently enthusiastic user of any particular brand to drive on to the next station if he does not see his favourite, but instead he will choose the one he likes the best of the brands which are represented on the site. Hence a most important factor in getting and keeping a large share of the dealer business is to have adequate pump representation. One of the most important duties of Spirit Sales Managers is to watch this, and take steps to see that better representation is obtained in weak districts. There are, of course, many difficulties to be surmounted in obtaining good representation. Garages are often bitter rivals of their neighbours up and down the road, and, if representation is obtained for a popular brand at one garage, it is often a matter requiring great tact and caution to obtain representation for the same brand at other garages in the district without upsetting the proprietor of the first station.

Another difficult problem is the garage at an important strategical position which is financially unsound, and the decision of the advisability or otherwise of taking the risk. There are also many small garages up side streets, and at small outlying villages, where the throughput of spirit is not sufficient to justify the capital outlay on more than one pump. At such garages it is obviously impossible for more than one company to secure representation, and the successful company is likely to be the one offering the best service. It is a fact, although not well known, that numerically the majority of garages have only one pump.

Where pump representation is discovered to be weak, means have to be found for improving it. There are two ways in which this can be done. Either a dealer can be persuaded to put up an additional pump for the products of the company requiring it, or one of the existing pumps on the site may be "converted." If an additional pump is erected, business may be attracted from the pumps already on the site, and if the brand sold from the new pump is not well represented in the district, business may also be attracted from other dealers. From the point of view of the dis-

tributing company, however, a conversion is much more to be desired than a new erection. In the first place, it is cheaper. If the pump is already paid for, it costs nothing. If it is only partly paid for, all that is necessary is for the distributor to take over the financial responsibility on the outstanding portion instead of on the whole, as in the case of a new erection. The throughput of the converted pump is also likely to be greater than that of the new erection, since in most cases the new pump, in addition to attracting business from the other pumps and from neighbouring garages, will also inherit a great deal of the business which was done in the brand previously stocked. This is especially true of commercial grade and cheap motor spirits, but nevertheless holds good to a certain extent for No. 1 grade spirit and benzol mixtures.

Detailed records of the pump position are kept by the larger distributors. The history of every pump in the country is noted, and from time to time censuses are held and comparisons made of the representation of the different companies in different areas. In this way each company can see where it is weak, and where it is strong; where it is losing ground compared with the previous census, and who is gaining ground at its expense; where its representation has improved and which companies have lost ground to it. Armed with this knowledge, it is relatively an easy matter to direct a campaign for more pumps, since it is known exactly where better representation should be sought and which companies' pumps should be attacked.

Similar records are kept for commercial consumers' pumps. The kind of representation aimed at with them is to secure a high percentage of the pumps supplied, not, as with garages, to secure a high percentage of representation on the sites, since almost all commercial consumers have only one pump. The general trend of garage business is for a pump not to change about from one spirit to another apart from definite conversion. Many commercial consumers, however, are different, and take a load of spirit from any distributor who happens to call on them when they are needing a load, or perhaps deliberately give each of the companies a load in turn. A good distribution service tells in the long run on commercial consumers, but so long as tanks are not sealed there is always the risk of poaching.

There are still a strong minority of commercial consumers who continue to buy their spirit in cans, although this is a

diminishing trade, and the point will be reached in time when almost all commercial consumers will buy in bulk. It may be hoped then that, as is now the case in the United States, the main distributors will agree only to supply in bulk. This will make possible very large economies, as the " packed " trade—*i.e.* the trade in cans and barrels—occupies far too much of the time of the storekeeper, depot staff, drivers and divisional clerical staff relatively to its importance. The cost of distribution of spirit in cans is almost twice as high as the cost of distribution of bulk spirit. For various reasons, however, such as the fad some motorists have of keeping a few cans of petrol in the garage, it will not be possible completely to destroy the can trade except by a general agreement among distributors, which must come sooner or later, to cease supplying spirit in cans. This would evoke numerous protests, but would in due course make it possible to reduce distribution costs, and so reduce the price of motor spirit to the public.

Problems of the Trade

A certain saving in distribution costs might be made by the adoption of what is known as a " Consignment " system of distribution of bulk spirit, although as a matter of fact the present system almost amounts to a consignment system in the best-run depots. Although, theoretically, the customer gives orders for spirit when he requires it, and the depot executes the orders, in fact it is generally arranged that a lorry with an organised round shall call on each customer at about the time when, bearing in mind the normal throughput of his pump, his stocks are running low. By a " consignment " system is meant a system under which the petrol company has the right of filling up a customer's tank at its own convenience, but charges the customer, not with the amount of spirit delivered to his tank, but with the amount sold from his tank since the last call. Under this system it would be possible to work out with almost mathematical nicety the routes for the vehicles, and to effect large savings in lorry-mileage. Against this has to be put the fact that most of the advantages of the system are already obtained by the larger companies in their well-organised areas by the exercise of tact and with the help of the goodwill of their customers. On the other hand, the great disadvantage of the system, which is the extended credit given to the customer who obviously must

always have credit at least up to the amount of spirit in his tank, is a serious one, which is avoided where it is possible to operate the system informally through the goodwill of the trade. If, however, the credit difficulty could be overcome, the system would undoubtedly be of great value in areas where the standard of organisation obtained under the present system is low.

A further direction in which improving technique may make possible economies in distribution is in the long-distance transport of motor spirit. In a few cases it is possible to transport benzine by barge on canals or rivers, but obviously this can only be done where such canals or rivers exist between the ocean installation and the depot. In the majority of cases the choice is simply between road and rail. The method which is still most used is the rail tank-car. Spirit is pumped into these cars on the sidings at installations. They are then hauled by rail to the depots, and there the spirit is pumped out in due course into the depot storage tanks. The system is reliable and works fairly well. It is especially convenient from the distributors' point of view, since to a certain extent the rail tank-cars can themselves be used for storing petrol, which can conveniently be left in railway sidings for considerable periods. On the other hand, the system has disadvantages. The transport of the spirit necessarily is not under the control of the distributing company when it goes by rail, and therefore it is impossible to attain such a degree of reliability as when it is controlled entirely by the distributing company.

The alternative to the use of rail tank-cars is the use of very large road tank wagons of 10 or 12 tons capacity, and usually six wheels, which can render the service of transport conveniently, and, provided the distance is small enough for the out and return journey to be performed in one day, economically. If this is not possible, such a system is apt to be rather expensive. On routes where the distance is twice that of a one-day out and return journey, it is sometimes possible to double the radius over which a vehicle can work by arranging for drivers of two vehicles to change over, one driver taking a loaded vehicle every day half-way from " A " to " B," and then changing over and bringing back an unloaded vehicle to " A," while the other driver each day brings an unloaded vehicle half-way from " B " to " A " and returns to " B " with a loaded vehicle.

Large Scammell lorries are used a good deal for long-distance work of this kind, which is usually called "bridging." For delivery work it is not thought practicable to utilise them, except for making very large deliveries to omnibus companies or other very big buyers, on account of the high cost per mile of running. It might be possible to employ them more extensively were the average size of storage tanks, and thereby the average amount delivered per delivery, increased, especially if such a move were backed by the introduction of a "consignment" system, or by the allowance of appreciable rebates to buyers buying in large quantities, but it is probable that these considerations would be more than sufficient to outweigh any saving which might be obtained in delivery costs, which, as a matter of fact, are already extremely low in well-managed areas—so low, in fact, in such areas that it is not worth while at the present time to risk customers' goodwill and convenience for any further possible reduction in their amount. The British distribution system has gone so far in the direction of many pumps and small throughputs per pump, which means small amounts delivered per delivery, that it is too late to alter it.

In addition to general economies of the type already discussed, which make it possible to reduce the cost of distribution, it is also the object of the distributing companies to increase their sales. This may be done either by increasing the total consumption of motor spirit, and so, without any relative change in positions, increasing the gallonage done by each company, or by increasing the share of one company at the expense of its competitors. Both these objectives are, of course, pursued simultaneously. With regard to the former, there is a wide field over which the interests of the different distributors are identical, and therefore where there is a possibility of common action. There is room for a good deal of development in this direction, a great deal more than has at present been accomplished. Much more might be done by the various interests dependent on the motor industry for their prosperity in the direction of common action with regard to motor taxation. Pressure might be brought to bear on Governments, for instance, to a much greater extent in matters such as the provision of better roads, the expenditure on roads of all taxes collected from motor vehicles, and the encouragement of the building of private garages attached to all new houses

which are put up. A certain amount is, of course, done in this direction, but, taking the trade as a whole, it would not be unfair to say that the directness of the connection between such matters and the sale of motor spirit has not been recognised anything like so clearly as it should have been, and that the whole of the motor interests have been backward in their willingness to co-operate for what are clearly most desirable ends.

Although over a wide field the interests of the different distributing companies are identical, there is still plenty of room for competition. Each company naturally wishes to obtain as large a proportion of the trade as possible, and this can only be done at the expense of other companies. The most profitable business is that with large dealers and fairly large commercial consumers in the premium grades. The least profitable is probably the large rebate business with very big commercial consumers, and can business with the smallest class of dealers and commercial consumers. There is a tendency perhaps for the various distributors to spoil their most profitable customers and to give them undesirable facilities, this tendency being especially strong with the weaker companies, who hope in this way to cadge business.

The fight for business in general and for the more profitable business in particular is the function of the sales staff supported by the management and by advertising campaigns. The latter are undoubtedly often very useful, more particularly, of course, when the brand advertised deserves at any rate a part of the compliments it pays itself through the medium of publicity experts.

As by far the greater part of the motor spirit business is now done in bulk, the fight of each company against its competitors tends to resolve itself into a fight for pumps. The value of a pump from the point of view of its throughput varies very much, of course, according to the situation of the pump—*e.g.* whether it is on a busy main road or not—and the throughputs of different pumps on the same site depend of course on the popularity of the brands being sold from them, which in turn varies a certain amount in different parts of the country, and also according to the class of customer catered for. An Aviation pump is naturally of little value at a garage which caters mainly for lorries, and similarly a pump selling " X Petrol : twopence a gallon cheaper than any other," is not likely to

flourish at a garage patronised by Rolls-Royce owners. The throughput of a pump also depends to a certain extent on its position in the garage or filling station, certain pumps always tending to have good throughputs on account of their ease of access, or the fact that they are conspicuous and attractive. It is not easy to convert dealers' pumps which are doing well and maintaining a good throughput, since the dealer, being a business man, does not readily take the risk of changing a pump stocked with a brand he knows to be a good seller, over to a rival, which may be a good seller for all he knows, but also may not.

There are, however, too many pumps on dealers' premises in view of the total amount of business to be catered for. Many of these pumps are bound to have a low throughput, but this is not always recognised in the trade, and there is a certain type of dealer who invariably attributes the low throughput of any of his pumps to the unpopularity of the brand he happens to be stocking in it, and drifts from one brand to another in the hope of finding one which will sell. It is thus easy for a company to obtain numerous conversions of a kind, which may make a good show on paper, but which do not necessarily mean an appreciably increased trade on account of their very low throughputs, and may even leave the company converting them worse off than before, if it also has to take over financial responsibility. Such conversions are usually particularly easy after an advertising campaign pushing some new brand of petrol, as, if the campaign is well conducted, large numbers of dealers will be impressed and assume that there will be a permanent demand for the new brand, although, as a matter of fact, it has been proved again and again that it is not easy to establish a new brand unless either there is a definite price-differential in favour of it or, alternatively, unless it really is of a superior quality. It is a great temptation to salesmen who are pressed by their management to obtain better representation—*i.e.* pumps on a larger proportion of the total sites—to do so by making conversions of this kind, and this is one of the chief dangers of making too great a use of statistics based on the number of pumps irrespective of their throughput.

If conversions are not possible, the alternative has always been the erection of more pumps. The indiscriminate erection of pumps in the past is at the root of most of the troubles of the trade to-day, and it is an evil which is not

yet by any means dead. The dealer erects a pump for a brand which is perhaps under-represented in the neighbourhood, or for a popular brand for the sale of which he may think his premises are better situated than those of his competitors. He may succeed in his object of attracting custom from other garages, but if he really has a good thing he will find that other dealers will before long also stock it and take part of his trade away from him. This has happened time after time with the so-called "Pirate" companies. The first man in a district to put in a pump for them does very well. Two or three other dealers follow suit, and also do very well. This leads to a grossly exaggerated idea in the district of the extent of the demand for the new brand. Everybody knows that Messrs. Smith, Johnson and Williams are making a very good thing of it, but they do not realise that Messrs. Smith, Johnson and Williams amongst them only control three out of 150 garages in the town. It is assumed that anybody else could do equally well with the new spirit, and most of the dealers in the area rush to convert pumps to it or instal new pumps for it, and are invariably surprised and chagrined when they find that the demand does not come nearly up to their expectations. Meanwhile Messrs. Smith, Johnson and Williams find that, instead of having a local monopoly of the brand, they have to share the trade with most of the other dealers, and accordingly are disappointed to find their own throughputs falling off. Many of the other dealers who have installed new pumps for the new brand decide to convert them to something else, in the hope of doing better, and in due course join the army of dealers with redundant pumps who make the round of the different brands on the market in the hope of finding one they can sell.

The position with commercial consumers' pumps is different. There is no question here of the throughput obtainable with different brands, as the total throughput is determined by the amount of work to be done by the customer's vehicles. It is usually more difficult to convert a commercial consumer's pump than a dealer's, when the consumer is an old customer of the company which is supplying him. There are, however, a number of commercial consumers who do not mind what spirit they use, and take a delivery from whichever company happens to call when they need more petrol, but the larger buyers are for the most part steady customers, and often pay more

attention to the price and quality of the spirit they select than does the private motorist. In order to convert a pump the salesman must persuade the buyer that he can, taking the long view, offer better value for money, and not merely, as with the dealer, appeal to his sporting instinct to give his brand a chance, and see if it will not sell better than the brand at present stocked, especially in view of the recent advertising campaign, etc. The alternative of erecting additional pumps on premises on which a pump has already been installed does not exist with commercial consumers, who normally do not have more than one pump on each of their premises, unless they are very large buyers, in which case they may find it worth while to instal two or three pumps for the sake of speed in filling up their vehicles.

The various distributing companies have a very fair idea of their relative strengths in different areas as compared with their competitors. Friendly dealers will often disclose the actual sales from their several pumps. If this is not possible, an estimate can usually be made from the number of times per month lorries are seen making deliveries and the average amount delivered on each occasion. Where supplies are received by rail tank-car, it is usually possible to ascertain the number of rail tank-cars received at a competitor's depot during a month, and where they are received by road, the approximate number of lorries which have come in. The number of lorries kept by competitors at their depots is, of course, also easy to find out, and the average number of lorry loads going out per day. If the local representatives are keen and observant, there is very little in any district which each company does not know about its competitors. This information is, of course, of the greatest value in enabling the sales organisations to manœuvre so as to obtain as large and as profitable a share of the trade as possible.

CHAPTER VIII

KEROSENE AND WHITE SPIRIT

The Market for Kerosene

In the process of refining, the fractions next lightest after benzine are white spirit and kerosene. Of the two, the business in kerosene is very much the more important. Kerosene, or lamp oil, usually known to domestic users as paraffin, is historically the oldest petroleum derivative other than medicinal oil to be marketed, and for many years it was the most important product, but in Great Britain, as in the world at large, its importance has declined relatively, in comparison with benzine. Against a British benzine trade in 1929 of some 3,000,000 tons, the kerosene trade amounted only to 700,000 tons.

The distribution of kerosene is carried on entirely by the same organisations which distribute motor spirit, and the method of distribution is roughly the same, from installations to depots and from depots to the storage tanks of dealers and commercial consumers. By far the greater part of the kerosene distributed, as of the benzine, is delivered in bulk. A small part is delivered in barrels, and in some districts, where kerosene consumption is light, lorries used mainly for delivering motor spirit carry with them 5 gallon churns of kerosene, the contents of which are dumped into the tanks of customers who require small quantities. It is usual at many depots for a lorry with a portable tank to be set aside specially for canned spirit and kerosene which can be delivered on alternate days, but where the kerosene trade is considerable it may be necessary to employ a full-time lorry on kerosene work and to make other arrangements for canned spirit.

The kerosene business is highly seasonal, and to a certain extent the seasonal demand is complementary to that for motor spirit. Motor spirit reaches its peak demand in the holiday season, July and August, when pleasure motoring is at its height. The demand for kerosene is then at its lowest. The peak months for kerosene depend, of course,

on the uses to which it is put in different places, but roughly the kerosene peak period is from November to March.

Rather less than half the kerosene used in Great Britain is delivered to shopkeepers in the hardware trade, and to hawkers for retailing to customers for use in lamps and cooking and heating stoves. This market is obviously greatest in the winter, when it absorbs more than half the total sales. It is not, however, a market which is spread evenly over the whole country. The demand is confined to relatively remote areas outside the scope of any gas or electricity undertakings, and to the older and poorer sections of many other districts where gas or electricity supplies have not been laid down to every house. It is clearly a market which must shrink annually with the spread of gas and electricity, but is nevertheless still of appreciable extent. Even where gas and electricity are available, there is still a certain market for kerosene for heating purposes, kerosene stoves often being used in lieu of coal fires for the heating of bedrooms, etc., and many houses keep kerosene stoves for use in spells of very cold weather in rooms where there are no fireplaces to prevent pipes from freezing. The spread of more modern methods of domestic heating is not likely ever to make the kerosene stove entirely obsolete, but it must nevertheless face a declining market for many years to come. Pressure from the management to increase sales of kerosene on this market must be applied very carefully, as it may be an uneconomic expenditure of energy to struggle hard to maintain or increase a particular company's gallonage in a market which is continually shrinking in extent.

The remainder of the kerosene business may be divided into several sections. One of the most important of these sections at the present time is the farming community, which with the steadily increasing use of agricultural machinery, is becoming a consumer of kerosene on a large scale. The peak of the agricultural demand for kerosene comes in the spring, when the ploughing season is at its height. This depends on the weather to a certain extent, but is usually in March. Kerosene is the most commonly used fuel for agricultural engines of all kinds, and, with the gradual supersession of horses for farm work, there is still room for a good deal of expansion in the trade with farmers. The agricultural demand naturally comes mainly from the arable districts, where machinery is mostly used, and would

undoubtedly boom if anything should happen which would make the arable farmer more prosperous. This would have the double effect of increasing the area under crops, and hence the use made of existing machinery, and of giving many farmers the capital wherewith to buy machinery. The reason why antiquated methods of working the land without machinery are continuing so long in these post-war days of re-organisation and reconstruction is that many farmers cannot afford the initial outlay necessary if they are to improve their methods. Agricultural depression thus tends to become a vicious circle. Lack of capital and antiquated methods go hand in hand. Antiquated methods result in inability to compete; lack of competitive power brings in its train agricultural depression, which in turn causes shortage of capital. There have, however, been signs of improvement in the situation of late, and of increasing purchases of machinery.

Garage proprietors are fairly large buyers of kerosene, which is used by them mainly for cleaning purposes. This market reaches its peak in the summer at the same time as the spirit market, and helps to a certain extent to level out the kerosene demand over the year.

A further substantial although highly localised market for kerosene is that provided by the fishing industry. Nowadays most of the smaller fishing-boats are fitted with an auxiliary kerosene motor, and their requirements in total are considerable. Kerosene motors are also used in a large number of general industries and trades, especially in those situated in the country, and these altogether account for a very large proportion of the trade, probably ranking next in importance to deliveries to dealers and farmers.

Distribution of Kerosene

The kerosene trade is on the whole not a difficult one to work for the big petroleum distributors, as a very large proportion of the customers for kerosene are also buyers of other products. It is, however, essentially a trade which will fall to the energetic canvasser and the firm with a good delivery system. Provided that lorries are available to go round calling at out-of-the way farms and other distant customers, trade can always be obtained. If buyers who live off the beaten track are neglected, a large proportion of whom are in very remote places, it is much more difficult

to obtain a share of the trade, on account of competition. As the brand-demand for kerosene is at the present time nowhere very strong, and little advertising of kerosene is indulged in by any of the distributors, the trade of the much-canvassed customer is usually likely to go to the distributor with the cheapest selling price. Spare equipment and time is required to be able to canvass effectively the buyer who is off the beaten track, and the over-equipped company therefore tends to score in the kerosene trade. The company which has only just enough equipment cannot afford to spare lorries to go round canvassing remote customers, and hence fails to get their trade. There is even a tendency for those distributors who are weak on spirit to do best on kerosene, since their weakness on spirit usually results in their having ample time to spend in dealing with orders for other products.

As the whole business of distributing kerosene is done through exactly the same organisation and channels as the business of distributing spirit, it is a matter of some difficulty to allocate costs equitably between the two products. There is no doubt that in most depots kerosene tends to be carried on the back of motor spirit, and that its cost of distribution is therefore, if anything, under-estimated. A false idea is thus given of the profitableness of the trade, as the c.i.f. price plus the cost of distribution appears too low in relation to the wholesale price. This is no peculiarity of kerosene. All products tend to a certain extent to have their distribution costs defrayed by bulk spirit owing to the inevitable unfair working of the system, but it is difficult to see how this can be improved. Where the distribution of two products is through exactly the same channel, it is natural to charge each product at the same rate per gallon. If this basis be departed from, it is a matter of the greatest difficulty to determine scientifically how much more of the costs one product should bear per gallon than the other. If the two products are not to be costed equally, it is not easy to justify any other ratio which may be chosen.

A lorry may deliver 90 per cent. of bulk spirit and 10 per cent. of kerosene. It may, in fact, take three times as much time and trouble to sell a gallon of kerosene as a gallon of spirit, but if both are costed pro rata to the gallonage delivered, it is obvious that the bulk spirit will be charged with rather more than its fair share of the total, and the

kerosene with a good deal less. Similarly with the clerical work in the Divisional Office. Clerical charges must also be allocated pro rata to gallonage, a system which tends on the whole to charge kerosene with too low a cost compared with spirit, since the average amount of kerosene delivered per delivery is very low.

Kerosene is usually marketed in two grades, a " standard white " and a " water white," the latter being one penny per gallon more expensive than the former. As brand-demand is weak, and is not being built up by advertising to any extent, the sales of the more expensive grade are relatively rather low. The average kerosene buyer, where he is given a choice, prefers the cheaper grade. He has not yet been " sold the idea " of quality in kerosene, and is not inclined to pay extra for the better qualities. It might be possible to change this by judicious advertising, but it is doubtful whether it would be worth while to take so much trouble over a market which will not increase, and which therefore does not offer to a firm the same scope for obtaining additional business as motor spirit, lubricating oils or fuel oil.

It is not possible for the various distributing companies to keep track so accurately of the allocation of the kerosene trade as of the spirit trade. Imports of lamp oil are published monthly in the Trade and Navigation Returns, and can be allocated to the various importers according to country of origin. This, however, is only a very partial picture. A large quantity of kerosene is refined in Great Britain by the National Oil Refineries at Llandarcy and by the Shell Company at Shell Haven. This total can, however, only be estimated. From the combined total of net imports plus home production various items have to be deducted, as a large part of the kerosene imported by the Medway Oil and Storage Company, for instance, is for cracking purposes, and is therefore not bought by the public as kerosene.

With motor spirit it is easy to keep track of the more important tendencies of the trade, by means of the petrol pumps, but no such records are possible with kerosene. The number of kerosene tanks in the country cannot be ascertained, and even if known, it would be of little use, as many of them are not used for kerosene, and, in addition many containers other than kerosene tanks are used for its storage. Furthermore, the tanks are not in any way marked to show the company supplying, and are not sealed.

There is nothing to prevent a man with a kerosene tank from having the products of three or four companies in it at the same time, and from selling the mixture simply as kerosene. It is possible, of course, to form some idea of a depot throughput of kerosene from watching the number of rail tank-cars of kerosene going into the depot, and in this way it may be possible to obtain a fair idea of the rough allocation of the trade. Records are, however, bound to be much less complete than those for spirit, and on the whole it is not possible to do more than make guesses of the trade of particular kerosene buyers, and the trade in particular areas.

The main market for kerosene is, of course, found in backward countries where gas and electricity are the exception. China, for example, has a big demand for kerosene, and so has India. In more advanced countries the market is very limited, and is continually being whittled down on the one side by the extension of gas and electricity and on the other by the incentive given by the continued low price of the rather heavier oils, to construct engines which will run on gas oil or the lighter fuel oils, and so economise on kerosene, which is somewhat expensive if a heavier oil can be used. With the spread of technical progress a decline in the market is to be expected, and kerosene will more and more be cracked for the production of motor spirit.

As with motor spirit, the distributors of kerosene are for the most part parties to an agreement for the better organisation of the trade. The " Combine " confines its attention to price agreement, agreements as to the terms on which kerosene tanks will be sold to customers and minor matters of interest to the trade. Companies which are not parties to the agreement usually sell at a little below the agreed price. There is less in the way of price maintenance among dealers in kerosene than in motor spirit. Retail prices depend too often on competition, and on what the dealer thinks the traffic will bear. The dealer class includes for kerosene, a very wide range of persons, from the owners of large competitive hardware shops down to pedlars hawking kerosene and other commodities to remote farms and cottages, and enjoying a quasi-monopoly of their rounds.

Although most lorries are used to deliver two or three different products over any period for which costs are calculated, it is nevertheless possible to pick out certain lorries which have been employed for the greater part of the

time on kerosene. It is invariably found that the mileages of such vehicles are high, and the cost of delivery per gallon disappointing compared with spirit lorries. This is true even in areas where there is a fairly heavy consumption of kerosene, and the reason is that there are too many buyers of kerosene obtaining deliveries direct from the distributing companies, and if a distributor wishes to obtain a fair share of the trade, far too much unprofitable peddling, and too little delivery work pure and simple. Something might be done to remedy this by fixing the minimum delivery to be made by agreement between the distributors at a fairly high figure, as in the case of bulk spirit, but on the whole it might be best for the distributing companies to devolve the responsibility of themselves undertaking small-scale peddling work, and instead appoint agents who would receive supplies in fairly large quantities and undertake the peddling thereof. The expensive vehicles and highly-paid staffs of the distributing companies are not ideally suited to the work of delivering kerosene in lots of 5 or 10 gallons to small buyers. Local agents ought to be able to show a large saving in distribution work of this type. Here and there some of the largest hawkers actually hold similar positions. The system might well be extended, as it is hard to see how the distributing company could fail to gain by it, and the profit for the hawkers ought also to be an attractive one. There is always a danger of large organisations such as the distributing companies growing cumbersome and unwieldy if they attempt to undertake too many petty tasks which might better be left to other people.

The original work of the petroleum distributing companies in Great Britain was the peddling of kerosene. With the growth of the motor spirit trade they became wholesalers, and, to a certain extent, large-scale retailers of benzine (except for some of the commercial consumer can trade). They adjusted their organisation accordingly, but still continued to burden themselves with the task of peddling kerosene to tinkers' shops and even smaller buyers. If sufficient attention is given to trade of this kind to bring success it is bound to detract from the time and energy required to obtain the big business in motor spirit and lubricating oils. On the other hand, so long as a market exists for kerosene, it is not wise to neglect it. A carefully selected agent would, however, be able to give proper attention to the business, and, in the absence of a strong

brand-demand for kerosene on the part of the consumer, it is difficult to see in what way the interest of the distributing company could be harmed. Arrangements could, if necessary, quite easily be made for the distributing company to retain on its books those customers for kerosene who were also customers for other products, and who could therefore take their kerosene deliveries economically at the same time that other products were being delivered. The agent, assuming his profits on kerosene were a main source of income, might reasonably be expected to be even more enthusiastic in pushing sales than the Superintendent had been, as the latter may sometimes be apt to feel that his kerosene record is relatively unimportant if he is strong on spirit and lubricating oils.

Uses of White Spirit

The fraction intermediate between benzine and kerosene is usually called " white spirit." It has a large number of uses, and, although the total trade is small compared with the more important petroleum products, being in 1929 not very much in excess of 50,000 tons a year, it is by no means negligible. White spirit is distilled to a narrow boiling point range, so that in spite of the fact that it is much more volatile than kerosene, its flash point is still nearly as high. It is sometimes called mineral turpentine, and its industrial use is broadly as a substitute for vegetable turpentine, the motive being economy. At the present time (1930) the price of vegetable turpentine is some four shillings a gallon, compared with one shilling and threepence a gallon for white spirit. White spirit is a fairly complete substitute, except for medicinal purposes. Vegetable turpentine is used as a counter-irritant, owing to the fact that it produces slight blistering of the skin which the mineral product does not.

White spirit is largely used in the manufacture of paints, enamels, polishes and varnishes, where its function is mainly as a solvent and thinner, for which purposes the rapidity with which it evaporates and dries makes it particularly suitable. As a solvent and thinner its function is to absorb the other elements and spread them economically and evenly over the surface. The percentage of solvent in the paint varies considerably, being highest in general in the cheaper paints and lowest in the more expensive. In distemper the paint

is diluted or thinned with water instead of with spirit or turpentine, but in all true paints one of the latter is used. In recent years, turpentine has been largely replaced by white spirit, on account of the price differential.

Large quantities of white spirit are used by wallpaper manufacturers, chiefly for making up and thinning the ink or paint used for painting the pattern on the paper. White spirit is also essential for the manufacture of linoleum, cork carpet and floor cloth, which latter is, in fact, only painted canvas with a suitable pattern printed on it and covered by a protective coat of varnish. Linoleum and cork carpet, which is really a thick and expensive linoleum, are manufactured by spreading a cement composed of oxidised linseed oil, cork or wood fibre, pigments and mineral filler in sheets over a fabric supporting base. White spirit is used in the preparation of the cheap paints employed in coating the exposed side of the fabric base, and also in the manufacture of the inks or paints used in printing the pattern on the surface of the linoleum.

Further uses of white spirit are in the first processes of japanning and enamelling leather, which is, after the hide has been tanned, to stretch it tightly over frames and give the grain surface a coating of highly oxidised linseed oil, thinned to a working consistency with volatile petroleum spirit or white spirit. The object of this process is to prevent the subsequent coats of japan or paint from penetrating to the body of the hide. White spirit is also frequently used in making the japan, which is a paint consisting of linseed oil, or oil and gum as the vehicle, suitable pigments and a thinner, usually white spirit.

In the manufacture of artificial leather both for upholstery and shoe soles white spirit is widely used, and also in all kinds of leather polish. The function of a leather polish is threefold. First, to clean the leather; secondly, to treat the leather in such a way that it remains pliable, and thirdly, to provide a film of sufficient consistency to be waterproof. Leather polish was originally manufactured from beeswax and turpentine, the former being dissolved in the latter with the assistance of heat, the mixture subsequently cooling to a nearly solid consistency. Nowadays harder waxes are more frequently used, and sometimes paraffin wax, in order to reduce the cost of manufacture. White spirit is used as a solvent in place of turpentine for the same reason. The same principle and mainly the same ingredients

are employed in boot polishes, furniture polishes and car polishes. In furniture cream and some metal polishes such a high proportion of volatile solvent is added that the polish remains a liquid, and turpentine is largely used on account of the prejudice in favour of a strong smell of turpentine. White spirit is equally suitable, however, from all points of view.

There are other uses for white spirit in the manufacture of soaps, dry cleaning, and in cleaning paint and enamel. In all cases the white spirit acts as a solvent, and is particularly useful on account of its powers of removing grease and fat.

White spirit may also be employed in the manufacture of gas. Coal gas manufactured from coal inevitably contains in vapour form a certain small proportion of naphthalene, which causes trouble by deposition in the pipes of the distributing system. Such deposits can be prevented or cured in two ways. The first is by washing or scrubbing the gas in a machine for the purpose, in which gas oil is brought into close rotary contact with the gas, during which process it takes up the naphthalene, so that the purified gas continues on its way into the gas holders. The same or a similar effect is produced as in those gas works where carburetted water-gas is manufactured with gas oil.

The second process is by injecting mineral turpentine into the gas either in the form of vapour or in a finely broken-up mist, the two processes being described as "vaporising" and "atomising." The mineral turpentine has the same effect as the gas oil mentioned above, but to a more intensive extent, as the naphthalene is actually dissolved and taken up in vapour form, incorporated in the gas, and burned with it, thereby tending to improve the quality and calorific value of the gas.

There are possibilities of employing white spirit for power purposes in internal combustion engines, but at present these are not likely to be explored, as there is little object in doing so, since the economy offered by white spirit over benzine is not very great. An internal combustion engine would run on white spirit, but, as the I.B.P. is as high as 140° C., it could not start up on it, and the trouble of starting up on one spirit and changing to another for running would be considerable.

The uses of white spirit are almost entirely industrial, and are, on the whole, such as to offer a steady and expanding, although not over the long period a very rapidly expanding,

market for the product. Where it is a case of substituting white spirit for turpentine, there is, of course, a possibility of rapid expansion, but where it is a case of waiting for the natural growth in demand, this can only be a slow process. Painting and papering are undertaken periodically by most householders. It might be possible by advertising to sharpen the public conscience on the subject of shabby paint, but in the main the amount of painting done is determined by the number of houses, tending, of course, to decrease in times of trade depression. Increased building means increased painting, and also a bigger sale of linoleum and cork carpet. The market for polishes is steady, car polishes being more extensively used with the increasing number of motor vehicles, but the use of other polishes is only increasing slowly. The market for polishes is fairly independent of trade fluctuations, as the amount any one individual spends on them is too small to constitute an item worthy of consideration in an economy campaign. The same applies to dry-cleaning, which many people regard in itself as an economy, since it extends the life of clothes they might otherwise be unable to continue to wear.

There is still, however, a good deal of room for the replacement of turpentine by white spirit, which is the direction in which immediate increases in trade must be sought. The process is bound to continue, since the competitive prices made possible by the use of mineral turpentine offer such a saving as to make it inevitable.

White Spirit Distribution

Most of the large distributors of petroleum products are interested in white spirit, but there are two distinct methods of putting the product on the market. Some firms distribute white spirit in the same way as motor spirit or kerosene—that is, they sell it direct to the manufacturers of paints, polishes and wallpapers and other users, themselves undertaking the whole of the business of distribution. By this method it is easy to keep in touch with customers, to canvass for new buyers, and to encourage the use of white spirit for all possible purposes. On the other hand, it has its disadvantages. It is necessary, if buyers are to be approached direct, to provide storage for white spirit at depots, and the total business is too small in most districts really to make this justifiable. This means either that uneconomical tank storage must be laid down in areas where the expenditure

cannot be justified by the throughput of the depot, or, alternatively, that, if required in bulk, the spirit must be transported a long distance from the nearest depot with suitable storage.

The other method is not to distribute to the final buyers at all, but to sell the whole of the product available to white spirit distributors who are officially represented by the White Spirit Association, and to leave the work of distribution to them. This method is the one adopted by several of the largest distributors, and certainly saves the distributors of petroleum products a good deal of trouble. Canvassing by the petroleum distributors is not entirely eliminated, but business obtained in this way must be done through members of the White Spirit Association, a body representative of white spirit distributors and principally interested in price fixing and price maintenance. The white spirit distributor who thus undertakes the service of distribution obtains his requirements from the petroleum company's installation. He may either call at the installation with his own bulk wagon and fetch his spirit, usually transporting it direct to his customers, or he may have it barrelled by the petroleum company at the installation, paying rather more for this, and arrange for it to be collected by the railway company, and consigned to his customers. He may also arrange for the railway company to transport the spirit in his own rail tank-car from the installation to his customers' works.

In effect this is simply a division of labour. The white spirit distributor undertakes a service, which is rendered by the petroleum company for other products, and thus relieves the latter of a good deal of arduous work. The white spirit distributor, of course, receives payment on a scale fixed by the White Spirit Association at so many pence per gallon for his trouble, the amount of his profit depending on the part of the country in which he resides, as with this commodity, just as with other petroleum products, prices are fixed on the zone system.

There are " pirates " in the white spirit business just as in the other branches of petroleum distribution, who try to sell for less than the price agreed on by the White Spirit Association as reasonable. White spirit buyers are usually manufacturers in a large way of business, with proper systems of costing. The appeal of a product which is merely cheap without reference to its quality is therefore very slight, and,

except where they are distributing spirit of a fairly high standard, the " pirates " do not find a great demand for their wares.

The greater part of the white spirit sold in Great Britain is distributed in bulk; large buyers, such as paint manufacturers, take practically all their supplies in bulk. A large number of the smaller buyers, however, do not possess bulk storage facilities, and therefore buy in steel barrels. A substantial minority of the business—something in excess of 25 per cent.—is done in barrels, and the remainder in bulk. From the point of view of distribution costs, bulk deliveries are, of course, much the cheaper.

The products already dealt with—benzine, kerosene and white spirit—form what are known as " white oils," as distinct from the heavier fractions of petroleum known as " black oils." The distinction is an important one from the point of view of bulk storage, because tanks which have been used for storing black oils cannot without a great deal of cleaning be converted to the use of white oils. Tanks for one kind of white oil may, however, be used for other kinds with a minimum of cleaning. There is a big difference between white and black oils on the commercial side, white oils being mainly sold to very large numbers of small buyers, and black oils to a relatively small number of large buyers, but an exception to this is found in white spirit which resembles the black oils in so far as it is distributed to a comparatively small number of large buyers.

The sales organisation for white spirit is directed towards two objectives. In the first place, there is competition between distributors in quality rather than in prices for customers' trade, white spirit which, for instance, comes up to the B.E.S.A. (British Engineering Standards Association) specification being, of course, more in demand than spirit which does not. The competition between distributors does not extend to price, but takes the form mainly of canvassing by sales representatives, who stress the good qualities of their own particular grade to prospective buyers. It is backed up a little, but relatively not very much, by advertising. There is, of course, none of the utilisation of advertising as a medium for a hard-fought but good-humoured war between the rival companies which is found in the motor spirit trade, because white spirit is not an article of popular consumption, but a commodity sold to a comparatively small number of large buyers.

The other objective is a common one to all white spirit distributors—that is, to make the total sales of white spirit as high as possible, thus making it relatively easy for everybody to do a good trade. General industrial conditions which might possibly affect the total obviously cannot easily be changed by people working on such a small scale as the white spirit distributors, but there is ample scope for common action and common advertising in campaigns undertaken with the object of speeding up the conversion of turpentine buyers to the use of white spirit. A certain amount is already attempted in this direction, and no doubt more will be done.

CHAPTER IX

FUEL, GAS AND DIESEL OIL

Growth and Extent of Trade in Liquid Fuel

FUEL oils fall into two main categories: distillate oils, *i.e.* oils distilled from crude petroleum, and residual oils, *i.e.* the residue left after the lighter fractions have been taken off. Gas oil, the lightest type of oil fuel, is the fraction next to kerosene, and is a distillate. It is used as a fuel for certain types of Diesel engines. Further uses are as a means of producing gas for lighting and heating in small installations, and in large gas works for enriching and supplementing the gas made from coal. Diesel oils are rather heavier than gas oils, and are usually produced by blending gas oil with a fuel oil, fuel oil being the heaviest type of all, and either a distillate or a residual oil. The lighter fuel oils are sometimes used for heavy, high-compression Diesel engines, but the main use of fuel oils, and almost the only use of the medium and heavier grades, is for furnace work. The function of fuel oil is the production of hot water and steam, both on sea and on land.

From the commercial point of view the United Kingdom trade in liquid fuels is a very young one, even younger than the trade in benzine. A small trade was done in barrels, mainly for special purposes, in the early years of the century, but it was not until 1912 that the first bulk cargo was imported by the Anglo-Mexican Petroleum Company, and the fuel oil business as it is understood to-day may be taken as dating from that time.

The large demand for motor spirit occasioned by the growth of motoring in the second and third decades of the century caused a steady rise in the production of crude petroleum. In spite of various processes designed with the object of increasing the percentage of benzine obtained from the crude, the remaining fractions and residues after the benzine has been taken off (the bulk of which are suitable for oil fuel) have continually increased. There has thus been every incentive for the distributing companies, finding them-

selves laden with large quantities of fuel oil for disposal, to make every effort to find or create markets. The trade has accordingly reached considerable dimensions, and has been greatly assisted by the low price of fuel oil consequent on its relative over-production.

In 1928, 417,000 tons of gas oil were imported into this country for domestic consumption—that is, it was imported and not re-exported elsewhere, and, in addition, perhaps some 60,000 tons were produced here from crude oil or as a by-product of cracking processes. The total consumption of gas oil was therefore 477,000 tons, although a proportion of this was not consumed as gas oil, but was blended with fuel oil to produce Diesel oil. Retained imports of fuel oil (including ships' bunkers) amounted to 1,178,000 tons, and some 1,140,000 tons more were obtained from crude in the country, making a total of 2,318,000 tons; of this 967,000 tons were ships' bunkers, and, in addition, possibly 700,000 tons Admiralty imports for the Navy, leaving 750,000 tons either to be used as fuel oil or to be blended with gas oil for the production of Diesel oil. The grand total of retained imports plus home production of all types of oil fuel, including bunkers, for 1928 was approximately 2,800,000 tons. Apart from this, exports and re-exports of oil fuels amount to quite an appreciable figure, which in 1928 exceeded 36,000 tons for gas oil and 168,000 tons for fuel oil. The official figure for bunkers in 1928 of 967,000 tons is below the average, which normally is some 80,000 to 90,000 tons in excess of this figure. The industrial slackness of the latter months of the year may partly be responsible for this.

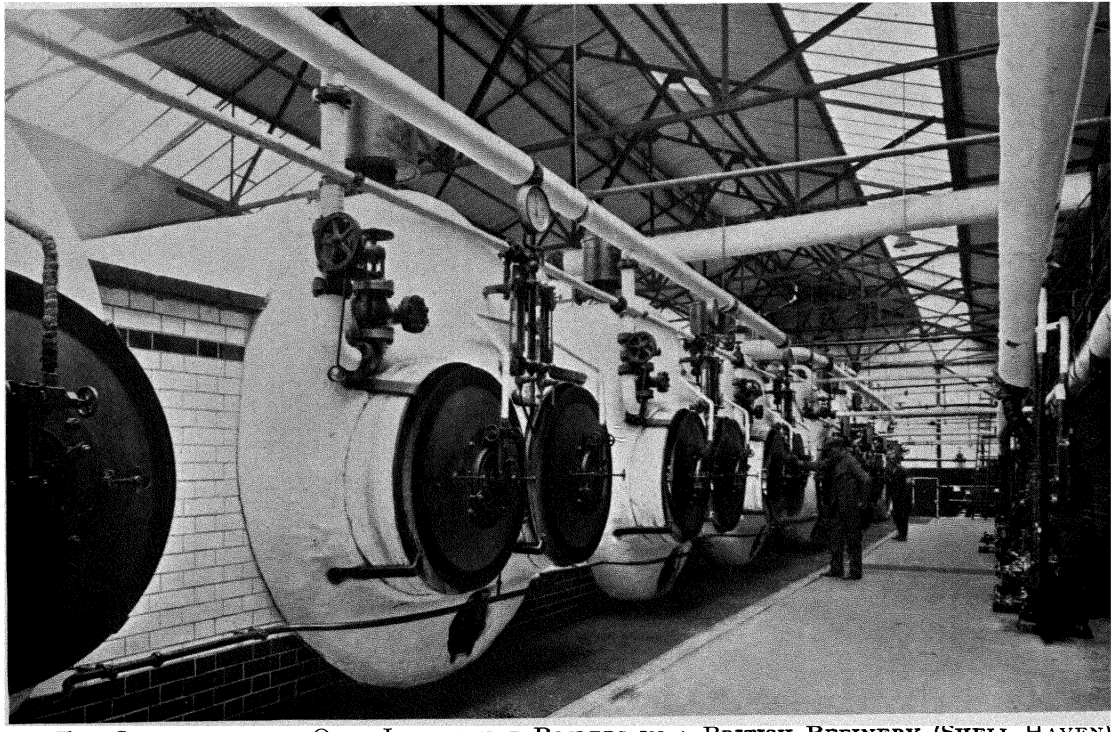
Oil fuels are in competition with coal over nearly the whole range of their use. Although the total consumption of 2,800,000 tons of oil fuels may appear very small by comparison with the 195,000,000 tons of coal consumed annually in the country, the discrepancy is not actually anything like so great as would appear to be suggested by this figure. In the first place, the calorific value of fuel oil is appreciably in excess of that of coal. Ordinary fuel oil averages at least 19,000 B.T.U.'s per lb. against approximately 9000 B.T.U.'s for coal slack, and up to 13,000 B.T.U.'s per lb. for steam coal and anthracite, but this is by no means the whole difference, as, in addition to the heat value theoretically obtainable from the two types of fuel, the relative efficiency of each, *i.e.* the heat, in fact, recovered and used from each must be taken into account also, and it is here that fuel oil

scores even more heavily, as an efficiency of 65 per cent. is a good average for coal-fired boilers under ordinary working conditions, whereas oil-fired boilers average 80 per cent. and upwards. Weight for weight fuel oil may therefore be taken to be from two to three times as effective as coal, according to the grade of the latter being used. Further, oil, when used in a Diesel engine, produces power much more economically than coal burnt under a boiler. In 1929 the proportion of the world's Mercantile Marine using oil in one form or another as a fuel was over 38 per cent., compared with 3 per cent. in 1914, and the navies of the world now use oil to the exclusion of coal. The proportion of the Mercantile Marine using coal was less than 60 per cent. in 1929 compared with nearly 89 per cent. before the War.

Oil versus *Coal*

In addition to the number of units of effective heat obtained per penny of expenditure, oil offers many general advantages over coal. Some of these are of an economic nature, while others are merely a matter of convenience. Oil is liquid, whereas coal is solid. Oil therefore is relatively easy to store in a small space, whereas with coal storage a large amount of storage space is wasted, since coal, being in solid blocks, cannot be packed without interstices being left between the lumps. Coal is, moreover, difficult to handle. The individual blocks are heavy and dirty, and, unless care is exercised, may all too easily be broken down into dust and so made even dirtier, less valuable and more awkward to handle. Oil, however, being a liquid, flows readily, and may easily be pumped through pipes. The difference may be seen at its greatest with a domestic central heating plant in a country house. Oil is pumped from the tank wagon into the customer's tank expeditiously, cleanly and without damage or harm to itself. Coal is brought up to a convenient spot in a cart or lorry. Then it is tipped out and often much broken up in the process; next it is carried in a wheelbarrow to the coal-shed or coal-cellar. At the best it is laboriously transported in sacks on men's backs. The saving in labour, and therefore in delivery costs, is considerable with oil, and of almost equal importance is the cleanliness and convenience of not having the premises covered by a liberal sprinkling of coal dust.

Oil requires approximately half the storage space of coal



THE CLEANLINESS OF OIL. LANCASHIRE BOILERS IN A BRITISH REFINERY (SHELL HAVEN).

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per unit of heating value. In use, however, there are many disadvantages with coal. It is difficult to ignite in the first place, and takes time before it burns properly, whereas oil can be lighted at once. Coal fires also take time to die down when no longer required, whereas oil can be extinguished instantaneously. The exact rate of burning of coal is difficult to regulate, while oil can be regulated to a fraction. Coal, moreover, produces smoke while burning and leaves a considerable residue of ashes when combustion has been completed; oil when properly used produces no smoke at all and little or no ash. The intrinsic dirtiness of coal means constant cleaning of flues and equipment, and continual sweeping; cleaning with an oil fire is only necessary at very rare intervals.

The use of coal at every stage involves the employment of much labour on hard, dirty and objectionable work, some of which might not unjustly be described as degrading. The use of oil eliminates such work to a large extent. Many burners are automatic, and in general the duty of the labour employed is to supervise and regulate under clean conditions, instead of toiling in smoke and grime at a peculiarly arduous type of work.

Uses of Gas Oil

Gas oil has a wide market in Great Britain, and there is still a growing demand. It is used extensively by the fishing industry. Almost all the trawlers and deep-sea fishing craft which are now being built, and most of those constructed since the War, are fitted with oil engines instead of boilers and steam engines. The steam trawler is, in fact, gradually becoming obsolete. The smaller type of oil engines, and especially those of the Bolinder and Kromhout type, which are fitted to large numbers of motor vessels, consume gas oil. The continental fishing fleets have moved much further than the British in the direction of becoming 100 per cent. converts to oil engines, and there is a very large business at the principal British fishing centres, Grimsby and Hull, Lowestoft, Fleetwood and Aberdeen, in supplying gas oil to continental trawlers calling for supplies. The market offered by the deep-sea fishing fleet will continue to expand as sailing-boats disappear and the remainder of the trawling fleet becomes converted to oil. The growing popularity of the motor-boat or small motor ship may also be expected to stimulate the demand even further. At

present the motor-boat and motor ship are most popular among the Scandinavian countries, and are the carrying agents for the greater part of the trade between the different Baltic ports. Their cleanliness, ease of manipulation and economy in labour and fuel will no doubt in time make them equally popular for the North Sea and coastal trade, for which they should prove at least as suitable as for the Baltic trade.

A further market is to be found on the inland waterways and canals, to which, after more than two generations of neglect, attention is again being paid with the object of developing their usefulness as carriers of low-grade merchandise, by a proper system of transport co-ordination. On the smaller canals the power for moving the barges has in the past mainly been provided by horses using the tow-path as a road, and drawing the barge by means of a chain; on the larger canals and the navigable rivers it has been found more practicable to use a steam tug. Some of these tugs have already been converted to oil fuel, and the advantages are so obvious that the remainder will probably follow suit in due course. The old-fashioned barges drawn by horses on the smaller canals would also be replaced by motor-boats if any scheme for the reconstruction of the latter should be launched which would reduce the number of locks, or alternatively, offer a speedier means of passing through them.

In addition to the increasing demand for oil-driven vessels and boats of various kinds, there is a certain amount of scope with agricultural tractors. Most tractors now use kerosene, but there is every incentive for the development of the use of gas oil in the relatively low price and low consumption of gas oil compared with kerosene. During the last few years, however, the total number of tractors has not shown signs of increasing, partly, no doubt, on account of the declining acreage of arable land, and partly also because the horse is making a very good fight for existence with the smaller farmer who is not in a position readily to afford to purchase a tractor, and who, in Great Britain, is somewhat averse to co-operative enterprise.

A further market for gas oil is as a benzol wash-oil. Since the imposition of the tax on petrol of fourpence a gallon in April 1928, which did not apply to home-produced benzol, and especially since the reduction in the price of benzol mixtures to the same level as the price of No. 1 petrol in

July 1929, there has been an increase in the demand for benzol mixtures both absolutely and relatively to the demand for other motor spirits. As this increase may be maintained, there is obviously scope for a greater use of gas oil as a benzol wash-oil. Formerly coal-tar creosote was most generally used for this purpose, but certain advantages are offered by gas oil, which is free from naphthalene and possesses excellent benzene and toluene-absorbing powers. The use of gas oil is altogether a cleaner process than that of creosote.

However, by far the most important use of gas oil is, as the name implies, the production of gas. This use absorbs approximately 250,000 tons a year. Fairly complete information about the gas industry of Great Britain is published annually by the Board of Trade, so that it is very easy to keep track of the total consumption of gas oil by the gas industry. Each distributor can thus calculate the share of the business falling to him. The gas industry is relatively in the hands of fairly large producers, and there is some, tendency for the smaller producers to become absorbed in the large, mainly through the extension by large towns of their radius of activities, and by the absorption of smaller companies operating in the suburbs or in satellite towns. There are nearly 800 undertakings in all, but forty-seven of these are responsible for 67 per cent. of the total sales of gas.

The principal product of the gas industry is coal gas. This is usually produced in a condition quite suitable for distribution through the mains to the ordinary user. The production of coal gas has increased fairly regularly since the war, with the exceptions of 1921 and 1926, when there were prolonged coal stoppages. Immediately after the war the average annual consumption was in the neighbourhood of 200,000 million cubic feet, but this has since increased to approximately 250,000 million cubic feet per year for the last years of the decade. One of the principal by-products in the manufacture of coal-gas is coke. The gas industry of Great Britain purchases approximately 18,000,000 tons of coal a year, a quantity which is only increasing very slowly, owing to more economical use and to improved methods of recovering the gas. Approximately 12,000,000 tons of coke and breeze remain to be disposed of after the gas has been manufactured. The market for coke is very limited, as stoves burning coke are not popular, and the

industrial demand cannot easily be expanded. In some districts it is possible to dispose of all the coke manufactured, but in most areas there is a surplus which the gas companies, rather than sell at a loss or have left on their hands, are glad to use themselves for the manufacture of water-gas.

Water-gas is produced by passing steam through red-hot coke. The resultant gas has too low a heat value to be fit for sale to ordinary consumers, and is accordingly improved and enriched by an admixture of gas produced from gas oil, the product thus obtained being quite suitable for passing on immediately to the mains. The production of water-gas tends to increase steadily over a period with the growing demand for gas for domestic heating and cooking and various industrial purposes. From year to year, however, its production fluctuates, often widely, depending largely on the scarcity or otherwise of coal. The function of a gas undertaking is to manufacture gas. When coal is short, as during a stoppage in the coal trade, it is necessary for the gas company to increase its production of water-gas from coke in order to supplement, so far as is possible, the reduced production of coal-gas occasioned by the shortage and difficulty of obtaining coal, and in order to obtain the largest gas yield possible from the coal available. The increased production of water-gas naturally involves an increased demand for gas oil from gas works. In 1926, for instance, a record was created, very much higher than the totals reached in the succeeding years, both for the production of water-gas and for the consumption of gas oil by the gas companies. The production of water-gas in 1926 exceeded 65,000 million cubic feet, against an average of some 42,500 million cubic feet for the four preceding years. In 1927 it fell to 47,000 million cubic feet, and in 1928 to 45,200 million cubic feet. The consumption of gas oil by the gas industry exceeded 375,000 tons in 1926, from which it is apparent that not only was the proportion of water-gas increased owing to the coal shortage, but the proportion of gas oil added to the water-gas before using it commercially was also increased.

Retained imports and home production of gas oil for 1928 therefore amounted to some 474,000 tons, of which some 250,000 tons may be allocated to the gas industry, while the remainder was either sold as gas oil for other purposes, or blended with fuel oil for the production of Diesel oil. The latter use undoubtedly accounted for considerably the greater part of it.

Uses of Diesel Oil

Diesel oil takes an intermediate position between gas oil and fuel oil in its properties, and is usually a blend of the two. As its name implies, it is mainly used as a fuel for Diesel and semi-Diesel engines. The Diesel engine developed out of the semi-Diesel engine. Both represented successful attempts to utilise a relatively cheap fuel for internal combustion engines, the price of Diesel oil being only from a third to a quarter the price of petrol. The advantage with this type of engine was that it was simple and had no electrical ignition. Further, it would run at a slow speed, and thus could be coupled directly to the propeller. A chamber was separated from the cylinder head by means of a narrow neck; the chamber was heated by means of a blow-lamp, and, on the inlet stroke, air was taken into this chamber, where it was heated. Kerosene or gas oil was then injected by means of a pump, and the resultant burning and explosion delivered the power stroke to the engine. On the modern semi-Diesel engine the blow lamp has been discarded. An electrical plug which produces a hot spot in the cylinder head is now the favourite method employed for starting up this particular type of prime mover.

The two-stroke cycle is a popular article of manufacture with makers of semi-Diesel engines, and is of simple construction. A compression of some 250 lbs. per square inch precludes high maximum pressures being obtained, and so is designed to give greater life to the engine. The two-stroke principle obviates the necessity of valves and valve gear, with resultant ease in handling, and reduces the number of moving parts which may give trouble. This type of engine nowadays may run either on Diesel oil, which is, in fact, a heavy gas oil, or more usually on ordinary gas oil, and is in extensive use on barges, tugs and small coastal vessels.

To-day there are engines used with a compression of 400 lbs. The heat of the compression alone is sufficient to fire the charge, thus making it possible for the engine to start up from cold without external heat being applied to the head. Owing to the perfect combustion obtained, low-grade fuels are used. These naturally give very economical running, especially as consumptions in the neighbourhood of 0·4 lb. per b.h.p. hour are obtained. As these fuels always have

very high flash points, there is no fire risk attached to this type of engine.

Until recent years, the Diesel or semi-Diesel engine was built to give not more than 400 r.p.m. The result was a great weight per h.p., the universal figure being about 80 lbs. weight per rated h.p. Engines of this class were admirable for large craft requiring slow speeds where there was ample room for their installation, but were less suitable where speed and very limited accommodation were factors to be taken into account. Recently the high-speed Diesel engine has been perfected, and it is now possible to obtain small engines running at 800 to 1000 r.p.m. with a very low weight, somewhere in the neighbourhood of 20 lbs. weight per rated h.p. Cheap fuel of the Diesel oil class is thoroughly suitable, and engines of this type down to as low as 8 h.p. per cylinder are now being built. Simplicity is the keynote of this type of prime mover, as their motors are not complicated with magnetos and carburettors. Great flexibility is obtained, and it is possible to use a cheap and safe fuel. Although this type of engine is not as yet widely known by motor-boat and yacht-builders, there is little doubt that the high-speed Diesel engine has a great future for all types of pleasure boats.

There are so many advantages in the employment of Diesel and semi-Diesel engines for marine work that the percentage of 9·73 of the gross tonnage of the mercantile marine using them in 1929 may be expected to rise much higher. Diesel-engined craft have a greater compactness of engine space than any other, and hence a proportionately higher cargo space, which means higher earning capacity. A high and uniform speed is obtainable, and no losses are incurred when the boat is standing by, but it remains nevertheless in constant readiness for immediate departure. Economy is obtained in the fuel bill, and fuel consumption is made independent of the human factor. Labour is reduced to a minimum. The maximum degree of flexibility and power of manœuvring is reached, and vessels of this kind are ideal for coastal and similar work. Cheap fuels may be used, but it is not true that any type of fuel is suitable, as, unless efficiency is to be reduced, there must be practically no asphalt residue or solid impurities in the fuel selected.

There are, as well as marine engines, stationary types of Diesel engines which are used for power production for a variety of purposes. Their advantages are the same as those

of the Diesel engine for marine uses: economy in fuel, labour and space, absence of stand-by losses, little risk of fire, and the maintenance of a guaranteed fuel consumption over long periods. Although mainly used for Diesel engines, Diesel oil has a number of other uses, the most important of which is as a fuel in the more delicate domestic central heating plants previously mentioned.

The calorific value of Diesel oil is about 19,000 B.T.U.'s per lb. Specifications for Diesel oil are laid down by the B.E.S.A. in Great Britain and by the U.S.A. Government; these deal mainly with the flash point, which should exceed 150° F. for the sake of safety from fire risk, the cold test, viscosity and ash and asphalt residues. The viscosity is important, for the ease of pumping a fuel depends on it, so that in the case of thick heavy oils it may be advantageous to heat them, and so render them more fluid. The viscosity has, moreover, an important bearing on the efficiency of pulverisation of the fuel, and so on the thermal efficiency. High viscosity means the formation of larger globules in the spray, which take a longer time for combustion, and thereby cause late or incomplete burning. This is associated with loss of thermal efficiency and dirty running of the engine. The viscosity of thick fuels falls off very rapidly with increase of temperature. Solid impurities in the oil cause clogging and abrasion. The best criterion of the freedom or otherwise of the fuel in this respect, is the ash content. Sulphur is relatively harmless, as on combustion it is converted into sulphur dioxide. Asphalt residue is, however, important, since the presence of a high proportion of asphalt makes an oil viscous and comparatively difficult to spray. The specific gravity which is usually given with a specification is of no special importance except for calculating weights from gravity. The cold test is of great practical value, as oils which have solidified owing to the separation of paraffin wax cannot easily be pumped.

The adoption of the Diesel engine for use on road vehicles may in time have far-reaching effects. At present this development has barely passed beyond the experimental stage, and its further development has been somewhat handicapped by the fact that the engine is too heavy and noisy for any but the larger type of road vehicle. For such vehicles, and possibly also for small cars and lorries, there is scope for a considerable employment of Diesel engines, and consequently an expanding market for Diesel oil. If, however,

general distribution, such as is now afforded for motor spirit, should be required for Diesel oil, distribution costs would be increased considerably and a large part of the economy of using the Diesel engine would be lost. The Mercedes-Benz Diesel lorry made its appearance on the British market in 1928, but up to the present its use has been very limited. In addition to economy, the virtues of reliability and quick-starting in any weather are claimed for the Diesel lorry. In due course Diesel-engined omnibuses, and even private cars, may make their appearance in appreciable numbers, but it is not probable that this will take place in the immediate future.

The general outlook for the Diesel engine, however, is promising. The ordinary " explosion " type of engine has apparently, apart from minor improvements in the design of the combustion chambers, reached its limit in compression pressure, as gas when compressed beyond a certain point now reached explodes. With Diesel and semi-Diesel engines, however, air only is inhaled and compressed, so that there is no theoretical limit to the amount of compression used, and pressures of 500 lb. per square inch are common. The potential development of the Diesel type of engine is therefore enormous.

Uses of Fuel Oil

Fuel oil, the heaviest of the three types of liquid fuel, can be used almost universally where heat is required. The calorific value purchased for a penny is not so great as that of coal or anthracite, but is very much greater than that of gas or electricity. The uses to which fuel oil can be put are therefore normally those where factors other than the expense of the fuel have to be taken into account.

Bakeries, of which there are thought to be some 60,000 in this country, are large consumers of fuel oil, owing to the exactitude with which the temperature can be controlled for heating the ovens, and to the elimination of any waste of time in starting up or damping down the fire. The control of temperature is of more importance in baking than economy in the form of heating obtainable. Oil fuel is also found to be particularly suitable for bakeries by reason of its cleanliness, and although it costs more per unit of potential heat obtainable, there is often a saving through oil being more efficiently applied than coal, especially when the lessened wear and tear of the oven is taken into consideration.

Other "clean industries" besides bakeries are large consumers of fuel oil by reason of the reliable temperature it affords and the absence of smoke and ash. Industries coming into this category include all factories for food, such as chocolate, patent foods of various kinds, cooked foods, tinned foods and cereal breakfast foods, dairies and dairy products, and tobacco. These are a prosperous and expanding group of industries and offer an extensive market.

Further groups of industries using oil on a large scale on account of its controllability, include those engaged in the manufacture of glass, pottery and china. The two latter became converted to oil fuel during the coal stoppage of 1926. They discovered that for their purposes oil fuel was not only more suitable than coal, but also cheaper, and have continued to use oil ever since. The even temperature obtained saved the initial additional cost of oil several times over, by the consequent reduction in breakages. This latter constitutes, of course, by far the biggest loss in the pottery, china and earthenware industry, and accounts for several peculiarities in organisation. The potteries, for instance, for the most part ship their products by canal in order to reduce breakages, which are substantially fewer when transported by the placid medium of the canals than when jolted over roads or railways.

The glass industry is in a similar position to the pottery and china industries, in so far as the most obvious way to cut down production costs is always to reduce losses from breakages, amounting to an appreciable proportion of the total cost of production. There are, however, other factors in favour of oil fuel in the glass industry, including ability to maintain the high temperature required for melting, and a higher ratio of glass output to fuel consumption and furnace capacity. There is, of course, in glass, as in all other industries, a reduction in handling and labour costs where oil is used. The elimination of the slacking-down periods which are inevitable with coal is easily attained with oil: heat from a coal furnace must almost inevitably come in waves. More coal is put on a fire; the immediate effect is a cooling down, but as combustion spreads there is a steady increase in heat to a maximum, after which the fire begins to die down, and in due course has to be replenished with fresh coal, a disadvantage obviated by the use of automatically controlled oil-burners.

In addition to pottery, glass and china, there is a wide

scope for fuel oil in the metallurgical industry, where either a high flame temperature is required, or a constant temperature, as in smelting and enamelling furnaces, in certain branches of the iron and steel trades, and also in the making of cables and electrical equipment. Many other industries, such as cement making, offer some scope for oil fuel which can be used in most processes of heat treatment where metals are concerned. In all cases oil fuel is in direct competition with coal, and its price, although now on a higher level, must be competitive.

Fuel oil, in addition to being burnt in furnaces, is also suitable as a fuel for several types of oil engine, although these more frequently run on gas oil or Diesel oil. Oil engines are much used where relatively small quantities of power are required, as in small factories, especially in country areas, in locomotives, stationary or otherwise, for pumping stations, electric lighting sets, mills and heavy agricultural machinery.

The greatest use of fuel oil of all is for ships' bunkers. The Navies of all the great Powers use oil, and over one quarter of the Mercantile Marine uses fuel oil instead of coal for firing the boilers. The advantages of oil-fired boilers are numerous and self-evident. Oil is clean and should be smokeless. It is more compact for storage purposes, and therefore leaves more room for passengers or cargo. There is a big saving in labour both in stoking and in bunkering. Increased speed and reduction in running costs are also usually obtainable on oil-fired boats, although the last is, of course, dependent on the relative cost of fuel oil.

The question of comparative economy determines the spheres of oil and coal in the Mercantile Marine, and this, in turn, often depends ultimately on geographical considerations. Where coal is scarce and oil relatively plentiful, oil fuel is commonly used. Where coal is particularly cheap and plentiful, the position is reversed, although in some cases, as in the Baltic, oil can still hold its own in spite of large supplies of coal. In more or less sheltered waters, where somewhat small boats are used, oil is generally more popular than coal, the Baltic and Mediterranean being cases in point, but here it is attributable rather to Diesel engines than to oil-fired boilers, as the quickness of manœuvring of small boats fitted with Diesel engines tells very much in favour of their adoption by coasting craft.

Oil, in addition to its numerous advantages in speed, clean-

liness and compactness, does much less damage to the boilers than coal; the fact that with oil the temperature is always even, is said to double the life of boilers. The furnace doors of a coal-fired boiler are open half the time, and the inrush of cold air has a most destructive effect on the boiler metal. It is claimed that pulverised coal may in time replace oil for much marine work, and that it will combine all the advantages of a liquid fuel wth the cheapness of coal, and have the further advantage of being producable in Great Britain in any quantities required. There has as yet been little more than a tentative trying out of pulverised coal, and it is too early at present to prophesy whether the claims made for it will be substantiated, but it seems probable that pulverised coal, if it proves a success, will make greater inroads on the use of raw coal by the shipping companies than on the use of fuel oil. At any rate, it will be found easier to obtain business from the 59 per cent. of shipping burning raw coal (1929) than from the 28 per cent. using oil fuel for boilers.

Oil Central Heating

One of the most promising markets for fuel oil is in central heating. Central heating of one kind or another is employed in most public buildings, such as schools, offices, hotels, theatres and cinemas, and its use is being steadily extended to private residences. The general system is for heat to be supplied to a central boiler, from which it is circulated throughout the building by means of a system of pipes and radiators in the form either of hot water or of steam. The smaller plants usually have hot-water heating, and the larger steam-heating. In the earlier types of plant the boiler was heated by coal, coke or anthracite fires, or even occasionally by wood or charcoal, but there has in recent years been a tendency, originating in America, to substitute some form of fuel oil for these. Fuel oil is cleaner, easier to regulate, quicker to start up or turn off, and more economical from the labour point of view than coal or similar fuels. Its use has become almost standard practice in America, and is rapidly gaining ground in Great Britain.

The ordinary central-heating boiler was designed for solid fuel, but conversions to liquid fuel can easily be effected. The makers of burners for central-heating plants have been quick to realise the potentialities of the development of oil central heating, and the market is well supplied. The

burner consists of a pump to feed the oil and a fan to supply the draught of air. These are both worked from an electric motor. There is also some means provided for igniting the oil spray, usually an electrical or a gas device. The whole can be switched on or off as desired.

A large proportion of the burners now on the market are automatic; some are semi-automatic and a few hand-controlled. Automatic burners are fitted with a " Thermostat," a mechanism which reacts to changes in temperature. It can be set to any desired temperature at which it will maintain the building which is being heated. When the temperature falls below the point which has been fixed, the electric current is switched on and the burner thereby starts to operate. When the temperature rises above the point fixed, the current is automatically switched off until such time as the fall in temperature causes it to be switched on again.

Several grades of fuel oil are used on central-heating plants. The most popular is domestic fuel oil, a rather light grade. which is suitable for most central-heating burners. The more delicate, however, may require Diesel oil, while, on the other hand, some run quite successfully on ordinary fuel oil.

In America the number of private houses equipped with oil central heating has increased from 14,000 in 1920 to 490,000 in 1928, and appears still to be increasing at a rate in the neighbourhood of 100,000 per year. As there are over 29,000,000 houses in America, and the standard of living is such that over 60 per cent. have private telephones and nearly one-quarter such luxuries as washing machines, there is obviously plenty of room for this expansion, in spite of the fact that oil central heating is rather expensive to instal, the minimum cost of a private installation being about £200, or $1000. America had in 1928 over 30,000 commercial installations of oil central heating in public buildings, a figure which is perhaps rather smaller than might be expected in view of its popularity in private houses.

Perhaps the biggest factor in the development of the use of oil for central heating has been the extremely low price of fuel oil during the past few years. This is due to the fact that the rapid expansion of the demand for benzine consequent on the world-wide growth of motoring has led to an extraordinary increase in the production of petroleum. The whole of the crude petroleum cannot, of course, be converted into benzine. In addition to the benzine, for which there is

a ready sale, the heavier fractions, mainly consisting of fuel oil, must also be produced, but cannot be sold except at a very low price, on account of the relation of supply to demand and the low price of coal. There is every indication that this state of affairs will last, and that low prices for fuel oil will continue to be the rule. Even in Great Britain fuel oil is obtainable at from seventy-five shillings a ton or about threepence halfpenny a gallon. In the United States it is still cheaper, and the consumption of fuel oil for domestic heating increased from 2,800,000 barrels (467,000 tons) in 1923 to over 12,000,000 barrels (2,000,000 tons) in 1927, a growth of nearly 500 per cent. in four years.

In Great Britain the principle and practice of central heating have never been so popular as in America or the Continent, partly because there have in the past usually been ample supplies of cheap coal available for open fires on domestic grades, and partly because, for some reason, the average Englishman has apparently never learnt to appreciate the advantages of even heating all over his house and consequent freedom from draughts, and on that account suffers more than he need or should, from rheumatic complaints, influenza and common colds. Nevertheless, oil central heating, both for private houses and for public buildings, is making great strides, although Great Britain still counts her installations in hundreds where America counts in thousands.

The British climate is one in which central heating should prove particularly popular. In the winters there is a raw damp cold, strong biting winds and a rather heavy rainfall, which together conspire to make outdoor conditions much more miserable than where the more "Continental" type of climate, which is usually associated with bright dry weather and sharp frosts, prevails. The raw British climate is universally considered much the more trying, and could be even more successfully combated than the Continental type of climate by central heating, since this ensures warm even heating, and a dry atmosphere. Central heating ought therefore to provide an ideal antidote for the British climate, and undoubtedly will do so as tradition is gradually broken down. The British tradition is entirely in favour of the open fire of coal or wood or sometimes peat, and the cosy "chimney corner," and has been set resolutely against stoves and other systems of radiant heating. The open fire has the admitted advantage of a cheerful appearance, but otherwise

there is little to be said in its favour. It causes draughts and dirt, and fails to heat the atmosphere. It is suitable for cooking, and offers a furnace-like heat in the immediate vicinity of objects facing it, but their reverse side remains cold, on account of the lack of atmospheric warmth. It is extravagant and largely responsible for the smoke nuisance in towns. Central heating attains a much more rapid popularity in countries where the stove is popular, as the type of heat provided is similar, being caused in a similar way by radiation from a hot metal or tiled surface (hot pipes, hot radiator or hot stove). This type of heating is far more healthy than the other, as it eliminates draughts to a very large extent and does not permit any wide variations in temperature in a small area. The body is not alternately roasted and chilled, and consequently is less liable to circulatory or rheumatic complaints, while the freedom from draughts reduces the risk of affections of the respiratory organs.

Once the principle of central heating has found favour, the advantages in favour of oil as against coal are too overwhelming for there to be any doubt which will prove the more popular under any conditions where prices are competitive. The various points in favour of oil will always allow oil central heating to be rather more expensive than coal so far as fuel costs are concerned. If the differential should, however, become too wide, conversions to coal might be contemplated. Although at present in its infancy in Great Britain, oil central heating probably offers, relatively to its present development, greater opportunities for rapid expansion in the immediate future in the demand for petroleum products than any other line of development.

Distribution of Fuel, Gas and Diesel Oil

Fuel, gas and Diesel oil are either imported or refined in this country from imported crude petroleum, but in either case the process of distribution begins, as with other petroleum products, at the installation. Customers situated within an economic radius of an installation receive their supplies direct, either by barge, rail tank-car or road wagon. The deliveries may be effected in vehicles owned by the distributing company or by the customer, according to arrangement and mutual convenience. A substantial proportion of the barge deliveries are made in barges owned

by customers; the proportion of rail car and road wagon deliveries made in customer's vehicles is, however, much smaller.

The proportion of deliveries in these three ways appears to be fairly constant now, although of recent years much progress has been made in road deliveries. Road wagons are probably the most popular, taking the country as a whole, and the other two of more or less equal popularity. There is no tendency by the distributing companies to cut out or limit the sphere of the customers' own instruments of transport, which are used for a fair section of the business. Barges of varying capacities are commonly employed for customers with premises adjacent to rivers, canals and inland waterways. Barges of 50 to 250 tons are usual on river estuaries, such as the Thames and Humber, on the Bristol Channel, Clyde and Mersey, and on first-class canals, such as the Aire and Calder Navigation and the Manchester Ship Canal. On the smaller canals a capacity of about 25 tons is the rule. Barges are the most economical system of distribution, but their sphere is limited by geographical considerations. Business at points alongside inland waterways will be catered for by barge so long as barges offer the cheapest means of distribution.

Where barges are not used, fuel oil may be sent either by rail or by road. If fuel oil is being delivered to premises with railway sidings, rail deliveries usually offer the greatest economy and convenience. Deliveries to premises not equipped with railway sidings are most often by road wagon, but in some cases deliveries are made by rail tank-car to a rail-head, and thence the local deliveries are made by road wagon. Rail tank-cars are of various capacities, from 10 to 15 tons. Road wagons vary according to the type of trade. Five-ton vehicles are used for the smaller buyers, and also by the smaller distributing companies, but 10- and 12-ton Scammell lorries are extensively used by the larger companies. These have a capacity almost equal to that of a rail tank-car, and can make driect deliveries to a wider circle of customers. Their movements are, of course, under the sole control of the distributing company, so that there are many points in their favour in a comparison with rail deliveries.

In addition to the ocean installations, there are sub-installations at various points in the country for serving areas outside the economic radius of the larger installations. The sub-installations are situated in places which combine

convenience for making deliveries with that of receiving supplies from the main installations. The transport work between the main installation and the sub-installation is usually by barge, or in some cases by coastal craft, where the sub-installation is conveniently situated. Deliveries from the sub-installations are carried out in exactly the same way as from the main installations.

In addition to bulk deliveries in barges, rail tanks-car and road wagons, a small amount of fuel oil is delivered in barrels to customers who do not hire any bulk storage. Barrel deliveries are much more expensive than bulk deliveries, but are necessary in the present state of organisation of the industry for certain customers, especially gas oil customers, such as fishermen, and road contractors taking Diesel oil.

Fuel, gas and Diesel oils do not pass through the local depots. As the average customer is still a comparatively large buyer, a considerable proportion of the business is controlled either from Head Office or by special representatives of the distributing companies. The smaller buyers are mainly consumers of fuel oil or Diesel oil on central-heating plants who only take a few tons a year. As central heating becomes popularised for small and medium-sized houses, buyers of 5 or 6 tons a year will become numerous, and modifications will be necessary in the system of organisation catering for them. The distributing companies will either find it necessary to extend their organisation to canvass and serve the small buyers, or a new type of dealer comparable to a coal merchant will have to be called into being, to find and supply the requirements of the small buyers in return for a fixed retailer's profit. It is probable, however, that development will be by means of an extension in the activities of the distributing company.

The cost of distribution of fuel oil is kept down to a very low figure by reason of the large proportion of big deliveries. Generally speaking, the bigger the customer's storage tank, the bigger will be the average delivery to that tank, and the smaller the cost to the distributing company, as it costs far less to make one delivery of 10 tons than it does to make five deliveries of 2 tons each.

The bulk of the costs included in the distribution of fuel oil are transport costs, and by far the largest item in the remainder consists of installation charges, which include handling and storage at the installation. No cost applicable to depots is included, as fuel oil is not sold through them, and

charges in respect of scrapped packages are negligible, as most of the trade is in bulk. Clerical, selling and management charges are also very low, on account of the large average size of contracts and deliveries. Fuel oil is little advertised at present, perhaps less so than might be advisable in view of the great possibilities for creating a market at the expense of coal and of finding and extending new markets.

The competition for trade between the different distributing companies is probably rather less acute for fuel, gas and Diesel oil than for other products, by reason of the fact that all the companies recognise that at the present stage there is far more to be gained by fighting for a general expansion of the fuel oil market, which is what the industry as a whole requires, than by fighting each other for an increased share of the trade with those parties who are already buyers of the products. There is, in fact, a good deal of common ground between distributors, who are all interested in extending the use of a clean fuel against other fuels, in encouraging people to spend a larger part of their incomes buying heat, and in creating a general demand for a higher standard of heating than has heretofore been deemed sufficient.

Judged purely on their respective merits, there is no comparison between an oil-burning and a coal-burning system in respect of cleanliness and economy in labour. Considerations of national policy may in some cases appear to favour coal, but the extreme dirtiness of coal in its raw state is likely progressively to weaken the case of its protagonists, except in so far as cleaner methods of using it may be introduced. The greater attention now being paid to questions of public health will undoubtedly considerably assist the case of oil fuel. Its extended use, together with the better distribution of electric power, will contribute largely to the decentralisation of industry, and thereby of population, which most social reformers consider necessary. Proximity of industrial undertakings to large towns, coalfields and railway sidings will become unnecessary, and it will be possible for new industrial establishments to be located in the healthier areas, and for the mistakes of the nineteenth century, which concentrated the population in unhealthy conditions in those areas of the north and north-west which enjoy the fewest bounties of Nature in respect of climate, to be rectified.

CHAPTER X

LUBRICATING OIL

Motor Lubricating Oil Trade

THE lubricating oil trade, from the point of view of distribution, falls naturally into two sections: the trade in motor lubricating oils and the trade in general or industrial lubricating oils. The two sections of the trade are utterly unlike each other and must be considered separately.

The total consumption of motor lubricating oil throughout the country is not known exactly, and would be extremely difficult to calculate with absolute accuracy, but it may be estimated fairly closely, as being in the neighbourhood of 115,000 tons for 1929. The total imports of lubricating oil are known, and also the total production from crude in the country, within a small margin of error. Exports and re-exports are also easily ascertainable, and thus the amount retained in the country for home consumption may be calculated. No figures are available, however, separating motor from industrial oil, and the estimate of the consumption of the former must be approached from a different direction. It has been found by examining the published figures of a large number of motor fleets that the ratio of motor oil to motor spirit is roughly $3\frac{1}{4}$ per cent. by volume. It is known that the total consumption of spirit for 1929 was roughly 3,000,000 tons, or 900,000,000 gallons, of which $3\frac{1}{4}$ per cent. would be 29,250,000 gallons, or, at 250 gallons to the ton, 117,000 tons. An error of one-quarter of a unit one way or the other in the proportion of oil to spirit would correspond to a discrepancy in the estimated consumption of 9000 tons.

The ratio depends very largely on the age of the vehicle under consideration. The older type of vehicle has a heavier oil consumption than the more modern, both because the latter is new and the engine should therefore be working at maximum efficiency, and because the trend of modern design is towards greater economy in oil consumption. There is thus undoubtedly a natural tendency

for the total oil consumption of the country to increase more slowly than the spirit consumption, but up to the present this tendency appears to have been offset by the fact that the average age of vehicles on the road has been increasing during the past few years, since the ratio of increase in vehicles has been steadily diminishing. The proportion of vehicles over three years old on the roads is thus constantly growing.

Superficially the organisation of the motor oil business bears a good deal of resemblance to that of the spirit business, but there are nevertheless big differences. In the early days the selling and distribution of motor oils was undertaken by the same companies which were already established in the lubricating oil business, many of which had been in the trade before petroleum was marketed at all. Several of these small companies are even yet in operation and doing business on the same old-fashioned lines.

The three largest companies distributing motor lubricating oils on the British market are Shell-Mex, Ltd., who have been engaged in the business since 1921, and hold the distinction of being the first company to introduce the motor oil cabinet in this country, the Vacuum Oil Company, who are associated with the Standard group and have been operating since 1901, and Wakefield & Company, who also go back to before the war. The remainder of the trade is in the hands of a large number of small companies, some of which distribute nationally, while others are merely local blenders operating on an insignificant scale. Many of these small blenders are in much the same position as some of the " Pirates " in the spirit trade. They do not import directly on their own account, but buy from wholesalers. Lubricants Producers, a company in the Shell group, are purely wholesalers, and operate on a considerable scale; the Standard interests are in the same position, importing a good deal more oil than is distributed directly through the Vacuum Oil Company or the Anglo-American Oil Company.

Distributors of motor oils who are also in the motor spirit trade make use of their spirit distribution system for motor oils, and are thus able to distribute the latter very cheaply, making use of the same depots and often of the same lorries for both products. The smaller companies usually consign barrels by rail to the addresses of their customers.

There are official retail prices for motor oils, agreed upon by the Motor Trade Association, but no standard profit per gallon for retailers for all grades. The reason for this is to be sought in the nature of the business. Distributors of motor spirit feel that, if different rates of profit are allowed to the retailer for different spirits, he will exert his energies, probably with some success, to sell the maximum possible quantity of that spirit which brings in the highest profit to himself. This might lead to competition between wholesale distributors in giving the highest profit to dealers, and the fear of this has undoubtedly been one of the factors bringing the great majority of wholesalers into line in the matter of standard dealers' profits. From the dealer's point of view motor spirit forms such a considerable item in his business that he cannot afford to press the sale of a brand or grade of spirit on which he is not receiving the maximum rate of profit paid in the trade. He is also interested, unless he be very short-sighted, in maintaining standard wholesale and retail prices and a standard profit for himself, because he is afraid that, without standard wholesale prices, larger buyers than he would be able to obtain their supplies more cheaply, and undersell him.

Sales of motor oil are not large compared with sales of spirit, and on this account, although the profit per gallon made by the dealer is usually quite considerable, and sometimes very large indeed, dealers seldom show the same interest in pressing the sales of those brands and grades of motor oils which show the largest profit, as they do with spirit. Further, many motorists have strong views on the subject of lubricating oil, and would possibly lose faith in a dealer who showed too great an eagerness to make them buy a brand of oil not officially recommended by the manufacturer. The ordinary motorist is also influenced by the same psychology as the dealer, in that the proportion of his lubrication bill to the total cost of his motoring is so small that he is disinclined to risk " spoiling the ship for a ha'p'orth of tar," and is usually quite prepared to pay a good deal more than the minimum price at which oil is obtainable for the grade which for any reason he considers most suitable for his car. As the dealer's profit is usually fairly high on the more expensive oils, the latter is not likely to try to dissuade his customer from buying whatever he has chosen, even if the profit per gallon on a similar but competitive grade be still higher.

It is this factor of the comparative readiness with which the private motorist, and especially the motor-cyclist, will pay for his fancy, which is the root cause of the enormous amount of advertising of motor oils which fills such a large part of the advertising space in the Press. Motor oil advertising is out of all proportion to the part played by oil in the motorist's budget, and frequently takes very foolish forms, as when crack motor cyclists receive a bonus for using a particular brand of oil in a race, and, if they win, the advertisement sections of the papers are duly filled with the fact that the so-and-so trophy was won on such and such an oil for the third year in succession. In the first place, the conditions in a race are so different from those experienced in ordinary touring that the information is not really of much value to the motorist in assisting him to choose the correct grade of oil for his car or motor-cycle, and, in the second place, the implication of the advertisement that the rider and machine in question would not have won the race had they been using anybody else's oil is obviously ridiculous, and is recognised as such by practically every motorist, as the bonus system for racing motorists and cyclists has reached the stage of being something more than a trade secret. Endurance tests are, of course, of much more value than races, as at any rate they take place under conditions more like those under which cars and motor-cycles are actually used. If an excessive expenditure is incurred by a firm for advertising, and yet the price of the oil is the same as that of the oil supplied by other distributors of similar size, then clearly the firm must be supplying an inferior oil, as otherwise it could not afford to follow such a course.

Grades of Motor Oils

Motor oil is divided into two classes, standard grades and service grades, corresponding more or less to No. 1 and No. 3 Motor Spirit, the standard grades being for the most part used by private motorists and the service grades by commercial vehicle owners, although a considerable proportion of the latter prefer to use standard grades. The demand for standard grades is a branded demand, and the advertising is, of course, concentrated on them. The various competing distributors all market their own standard grades and advertise them one against the other.

The standard grades marketed comprise not less than four main grades suitable for different types of engine. The four grades are light, medium, heavy and extra heavy. Each distributor attempts to sell each of these grades under his brand-name against the corresponding grades of the other companies. The classification of oil into these grades is according to viscosity, the greater the viscosity the heavier the oil.

The theory of lubrication is that the lubricant should reduce the wear on machinery by adhering to the bearings and moving parts, and so prevent direct contact and reduce friction, or, more accurately, substitute the friction of two surfaces of lubricant for metallic friction. Friction of metal on metal causes wear and tear of machinery, loss of power and over-heating. The test of the efficiency of a lubricant is the completeness with which metallic friction is replaced by the friction of the lubricant under the conditions of temperature, speed and pressure in which the machine is actually used. Practically, of course, efficiency is a matter of relativity, and the efficiency of the lubricant used must be judged in relation to its cost, wastefulness or economy in use, cleanliness, and the value of the machinery which it is lubricating. The greater the pressure the greater the viscosity of oil required. For many purposes a cheap and not particularly efficient lubricant may be good enough. Grease, for instance, is used a good deal as a lubricant for some parts of machinery, but, *qua* lubricant is not very efficient. It is, however, both cheap and relatively clean.

A viscous oil, however, causes an oiliness at points of contact through its adhesiveness, and thus a greater expenditure of power than would be incurred with oil of a lower viscosity. Obviously the more mobile the oil, the less its viscosity, and hence the less its oiliness and resistance, and the less the loss of power. Viscosity must, of course, refer to the viscosity at the temperature at which the oil is used, not the viscosity at air-temperature.

The viscosity of the oil must therefore be adjusted to the work to be undertaken. An oil must be sufficiently viscous at the temperature at which it is normally used to prevent metallic friction and to withstand the pressure involved in the work to be done, and there should be some margin for abnormal circumstances, but a greater degree of viscosity than is necessary to meet these is undesirable, since it

involves a waste of power. To use a lubricant of a lower viscosity than is necessary is equally undesirable, as this means either that the oil is being pressed out on account of the excessive pressure in relation to its viscosity, and so is not functioning as a lubricant at all, and thus is allowing metallic friction, or that fresh supplies of oil are constantly coming in and being pressed out again, which involves a tremendous waste of lubricant.

In addition to maintaining a correct viscosity in the conditions of use, it is also necessary that oil should not solidify if the machine is left idle in cold weather to such an extent as to make it difficult to restart it through the mechanism being clogged with congealed oil. It is further important that the oil should not evaporate at the maximum temperatures at which it is used, as, if it does so, it obviously loses its power to reduce friction, and moreover it should in no circumstances become gummy or sticky. Should this occur, it will tend to hinder the working of the machine and will cause a great waste of power. The oil must also be clean in the sense that it should contain no grit or particles which might damage or scratch the metal parts of the machinery, and it must be completely free from any substances which might induce chemical change or otherwise spoil the metal surfaces lubricated.

The flash and burning points of the oil must be high enough to eliminate all risk of the oil causing a fire in any possible conditions of its use. The flash point is the temperature at which a sufficient quantity of vapour can be evaporated from the oil to ignite, and the burning point is the point at which the oil will burn continuously.

A most important consideration with oil for use in the engines of motor vehicles is the carbon deposit left as a residue. Where the carbon residue is high, accumulation of carbon and inefficient working rapidly ensue. The usual causes of a high carbon deposit are bad refining and blending, or the mixing of an ordinary distilled oil with too high a proportion of cylinder stock, which is the residue obtained from distilling certain light crude oils with steam and taking off the lighter fractions. It is sometimes added to a distilled oil to give an appearance of " body " in the oil, and most of the more viscous oils contain some. The right colour is also a characteristic on which the public insists, although it has practically no bearing on the efficiency of the oil as a lubricant, and so long as the public remains

uneducated and demands inessentials, it is necessary for distributors to continue to pay attention to them.

The four main grades of motor oil are, as already explained, classified according to their viscosity, and the engines of the different makes of car are also classified according to the pressure of speed involved. Where the pressure is low, as in the old Ford, the oil of the lowest viscosity, the " light " grade, is recommended by the makers. Few modern cars have engines of a type which can be suitably lubricated by oil of this kind, and its total sales throughout the country have been dwindling for the past few years. As the market is restricted and declining, there is little advertising of this grade. It is, however, the cheapest of the branded standard grade oils to buy, the prices of the various grades of oil increasing with their viscosity. Medium oil is somewhat more viscous, and the various brands of it which are marketed are recommended for the majority of the more popular cars of the Morris type, and also for most American cars. Sales of brands of medium grade oil are in all cases much greater than of either light or heavy oils. The heavy grade is recommended for high compression engines such as the Austin and Bentley, and for a large proportion of motor cycles, while the extra heavy grade is recommended for a few sports and air-cooled cars and also for many motor-cycles. The heavy grade in the summer and the medium in the winter are recommended for certain cars, but there is some evidence that a considerable proportion of motorists running such cars are prejudiced against a heavy oil, and use the medium grade throughout the year. There are, of course, subsidiary standard grades in addition to the four main grades enumerated above, such as gear oil, and special super-heavy oil and super-light oils for various purposes.

In addition to the standard grades, there are the so-called service grades of oil, which are mainly used by commercial vehicles. Very large commercial vehicle operators, such as omnibus companies, frequently buy their oil according to specification, inviting those companies able to meet it to submit tenders for its supply. The small commercial vehicle owner has not the technical knowledge to do this, and therefore, if he is unwilling to afford the cost of using standard grades, contents himself with buying a cheap service grade oil. Service grades are obtainable in different grades varying, according to their viscosity, in exactly the

same way as standard grades, but they are less carefully refined and blended, and, of course, much cheaper. They are, however, quite suitable for many classes of commercial vehicle. For private cars they are not so much to be recommended, as their viscosity is considerably less stable under changes of temperature, the oil becoming thin at high temperatures and clogging and congealing at low temperatures to a much greater extent than is the case with standard grades. The clogging and thickening in cold weather make the engine stiff and difficult to start, as the oil, instead of assisting the " cranking up " by lubrication, is hampering the process by causing adjacent surfaces to stick together. On the other hand, at high temperatures, the oil, by becoming thin, is used wastefully and extravagantly, and ceases to lubricate with complete efficiency, thus giving rise to friction and undue wear on the bearings and parts.

The lightest grade of service oil is called " Ford oil " by several of the distributing companies, and is mainly used for the old Ford lorries. There are also medium, heavy and extra-heavy service grades, and a large number of special grades, most of them blended individually to meet the specifications of the various omnibus companies and other large buyers.

Service grade oils are largely sold direct to commercial consumers by the distributing companies, but they are also marketed through dealers in considerable quantities, since many commercial vehicles take their supplies of spirit and oil from dealers. It is not really to the advantage of dealers to sell service grades if they are able to sell standard grades instead, since it pays them to sell the latter, on account of the greater profit per gallon. Service grades are not advertised, and therefore do not have to carry the cost of advertising in the price charged to the public, and for this and other reasons, being of a cheaper quality and bearing a smaller retailer's, and probably on an average, a smaller wholesaler's profit also, their price is less than that of the standard grades. The proportion of standard grades sold to total has increased of late years, as the public has been gradually educated as to the importance of using oil of good quality. The proportion of the sales of standard and service grades, however, varies fairly widely as between different parts of the country, being highest for service grades in poor areas where commercial vehicles are relatively

numerous compared with private vehicles, and lowest in residential areas where the reverse is the case.

In addition to dealer and ordinary commercial consumer business, there is some special trade in motor lubricating oil at special prices, just as for spirit, but, unlike spirit, there is no agreed rebate scale between the distributing companies, based on the consumption of the buyer. With spirit, large buyers are listed for rebates of one penny, penny farthing, penny three farthings or twopence a gallon, etc., according to the total gallonage consumed, but with motor oils there is much more cut-throat competition for big business, especially for business involving the supply of oil coming up to a special specification. In this case the companies usually calculate their actual costs for supplying the oil, and allow themselves above that the smallest profit necessary to make the business worth their while, in submitting their estimate, and the contract is usually given to the firm putting in the lowest quotation, provided it is thought to be reliable. The company with an efficient distribution system, and consequently low transport costs, is therefore at a big advantage, as the price at which it can deliver the oil is likely to be less than that of its competitors, other things being equal.

Distribution of Motor Oils

The cost of distribution of motor oil is in general very heavy, compared with spirit, owing to the fact that the total consumption of motor oil is so much less, but the overhead organisation necessary for putting it on the market is relatively considerable. In the first place, compared with spirit, there are many different ways in which it is sold. Spirit is sold only in bulk, in 40-gallon barrels, or in 2-gallon cans. Motor oil, with a much smaller consumption, is sold in bulk, in barrels, in churns, in drums of several different sizes, and also in cans of different capacities.

Drums and cans are an extravagant method of distribution on account of the cost of supplying the packages, which are, of course, not used on a sufficiently large scale to make possible the same degree of mass production as is attained for spirit cans. However, both drums and cans are very popular with a large class of private motorists, albeit they appear to be declining somewhat compared with the cheaper and more scientific methods now in use.

The drum is especially popular with the motorist who has his own garage attached to his house and wishes to keep a reserve of oil on the spot. A 5-gallon drum will last him for some time and meet his requirements admirably. It is precisely this class of motorist who still buys part of his spirit requirements in cans from the dealer in order to have a reserve for emergencies. He is naturally penalised for buying in such small containers, but is glad to pay for them for the sake of the feeling of greater security he apparently obtains from having his reserve supplies on the premises.

The buyer in cans is in a somewhat similar position, except that the reason he buys in this way, which involves an even greater expenditure per gallon on the container than buying in drums, is that he wishes to carry a spare can of oil about with him in the car, in case of emergency. There are few parts of the country where this is really necessary, as garages are so numerous and the rate of consumption of oil is so slow, that, if the oil is getting low, there is usually ample opportunity for filling up again at a garage, long before the danger-line is reached. In spite of this, there is a certain class which, for various reasons, so long as oil is marketed in small containers, will continue to buy it in this way, and be quite willing to pay for the convenience of so doing. The same, of course, applies to spirit purchased in cans, although in this case the tendency is rather to purchase a 2-gallon can outright and fill it up as required from the dealer's pump, thus securing both the advantage of the lower price for bulk and the convenience of having a spare can of spirit in case supplies run low, which, on account of the quicker rate of consumption, is much more likely to cause inconvenience.

On account of the small proportion of the total cost of motoring attributable to lubrication, and the fact that some people are prepared to pay heavily for the convenience of having lubricating oil always on the premises and in the car, it would probably be quite safe for the distributing companies to allow themselves a considerably larger profit per gallon over and above the full cost of distribution than they do on oil sold by other methods, and for the retailers to do the same, as the purchaser in small containers is apparently only influenced to a limited extent by economic motives. Unlike spirit cans, which may be purchased or returned at a fixed price (1930) of three shillings each,

neither drums nor cans used for motor oils are returnable, and a customer who buys his requirements in quart cans must therefore pay for a new can every time he purchases a quart of oil.

The original system of distribution was in barrels. Barrels were either dispatched by rail to customers, or delivered in the distributors' own vehicles. The customer, if he were a dealer, usually kept several barrels of different kinds of oil at the back of his premises, and, if asked for a particular brand, disappeared with a measure and brought back the required amount. The motorist had to rely on the honesty of the dealer in supplying the brand asked for in these circumstances, but, as a matter of fact, a great deal of buying was not by brand. It was simply a case of the motorist asking for oil and being served with whatever the garage proprietor might think suitable. A certain amount of business is still done in this way, but the cumulative effect of advertising during the past decade has greatly increased the brand-demand for oil; also various other circumstances have contributed to a decline in the demand for barrelled oil. In the first place, this system of distribution was rather expensive, as it was necessary to charge against the oil the cost of filling the barrels, the cost of replacements and repairs of barrels, and the cost of collecting the barrels when empty, but more important than any of these was the fact that the barrel at the back of the premises was just oil, and there was no guarantee either that the motorist would get the brand for which he asked, or, from the point of view of the distributing company, that a demand created by advertising for their oils would be reflected adequately in sales, as an unscrupulous dealer was quite easily able to supply a different oil from the one demanded by his client without fear of detection.

These considerations, among others, led to the institution of bulk equipments for motor oils, after this method of selling had already been proved a success with spirit. The first motor oil cabinets, as these were called, were installed in 1923 by Shell-Mex, the other distributors following suit rather later. The usual type of bulk equipment used was a tank of 50-gallons capacity and a small pump, the whole enclosed in a cabinet which could be placed in a conspicuous position outside the garage. This was a very big improvement in many ways over the old-fashioned barrel. The garage proprietor had an advertisement of the brands of

oil he sold, and the fact that they were quickly available for customers, who in turn were constantly reminded that oil was stocked every time they passed a garage. The distributors in particular found that attractively painted cabinets were the best possible advertisement for their oils, as they were kept always before the motorist's eye at exactly the places where they were required. The motorist himself became the purchaser of the oil rather than the dealer, and decided on what oil should be used. By thus bringing motorist and wholesaler into closer touch, the dealer became an agent for the oils of the various wholesalers, rather than a purchaser of whatever oil he was pleased to retail to his clients on his own terms.

Instead of leaving barrels on the customer's premises, it became more usual to dump the contents of the barrel straight into the tank of the appropriate cabinet, which is now usually sealed by the more reliable companies in the same way as, and for the same reasons as, a spirit tank, and a certain saving was effected in this way. However, it soon became obvious that, in the more densely populated areas, where the consumption of oil was great enough to make it worth while, further economies could be secured by introducing bulk distribution of motor lubricating oil in bulk tank wagons, similar to spirit wagons, but usually divided into more compartments, as there are many more grades of oil than of spirit. From these the lubricating oil was pumped into the bulk equipments at the garage. This system proved a success whenever there was sufficient business to give a bulk wagon used solely for delivering lubricating oil full-time employment, as, for instance, in a large town. In scattered areas this might not always be possible, and if a lorry were idle any considerable part of its time, naturally every gallon delivered by it had to carry a relatively large burden of overhead charges, and so made bulk delivery rather expensive. In such areas bulk vehicles were not used, and at first the system of distribution was to dump the contents of barrels into bulk equipments, but of late this system has largely been superseded for standard grades by 5-gallon churns, which it was found could easily be carried on the spirit lorries, and the contents of which could be dumped into bulk equipments and handled more easily than barrels.

A further tendency worked in favour of churn deliveries. The number of motor oil cabinets multiplied to such an

extent that in many parts the sales from any particular cabinet were very slow, as the total sales of motor lubricating oil are not really very considerable, and there were too many cabinets for all to have a good throughput. Garage proprietors became unwilling to buy cabinets for additional grades, both on account of the expense and on account of the space occupied by them. A new type of equipment therefore came into use, consisting of several containers usually of 8 or 10 gallons each placed in a shelter or cabinet of some kind, each container being fitted with a tap through which the oil could be drawn off, and the various containers and their cabinet painted and branded to serve as an advertisement for the grades of oil stocked. In a sense this was a reversion to the old idea of the barrel, but differed through the fact that these containers were much smaller, and were always branded. They were, of course, very easy to fill from churns, and became particularly popular at those garages where the total throughput of oil was low, and at other garages, for the heavier grades of oil used mainly for motor-cycles, the demand for which was alone seldom large enough to justify the installation of a full-sized cabinet.

Other equipments have also made their appearance. At large garages underground storage tanks with pumps attached are sometimes found worth while, on account of the heavy throughput of oil. These are usually attached to multiple compartment tanks, so that representation from one pump is obtained for many grades of oil. The best-known equipment of this type is the Bowser fountain. The great advantage of this type of equipment, especially at a busy town garage, is the economy in space, which is not wasted in finding room for a row of cabinets, and especially where the equipment is all inside a building, as is usual at town garages which also serve as showrooms for new or second-hand cars. On the open road equipments of this kind are less in demand, because there is more space, and the garage or filling station proprietor has learned to value the advertisement given to his premises by a number of smart cabinets.

There is far more variety among motor oil equipments than among spirit equipments. The reason seems to be that the bulk treatment of motor oil was tried because similar treatment of spirit had proved so successful, and it was assumed that the same methods could be applied equally well to oil as to spirit, but, on trying out various

types of delivery and equipment, it was found that the motor lubricating oil trade, although amounting to little over 3 per cent. of the spirit trade in volume, nevertheless involved the marketing of an even greater number of grades. Experiments are continually being made to find a means of applying successfully to motor oil distribution the technique learnt in spirit distribution.

Industrial Lubricating Oils

The market for general industrial and marine lubricating oil is appreciably larger than that for motor lubricating oil and infinitely more diverse. The consumption of general lubricating oil—*i.e.* mineral lubricating oil other than motor oil—can only be obtained by subtraction. The total imports of lubricating oil retained in the country were 398,000 tons in 1928, and to this must be added some 54,000 tons produced from imported crude and sold during the year. This would give an apparent total consumption of lubricating oil in the United Kingdom of 452,000 tons; this figure may be a little on the high side, as stocks of lubricating oil in the country may have been rather higher at the end of the year than at the beginning, but the probable error on this account is not very great. If the motor oil market amounts to 115,000 tons, as previously calculated, it might be reasonable to take the general oil market at perhaps 325,000 tons. This is not an excessive figure, in view of the fact that Great Britain is an industrial country living on and by machinery, all of which must be lubricated.

With motor spirit, the importer of the commodity is usually the distributor also, but this is not the case with general lubricating oils. By far the greater part of the lubricating oil imported into Great Britain is imported by three groups: Lubricants Producers, Ltd., representing the Shell group, the Standard Oil Interests, and Lubricating and Fuel Oils, Ltd. Although marketing direct to a certain extent, the importers also act largely as wholesalers, selling their oil to various small blenders, who in turn may find themselves in competition with those subsidiaries of the groups which are marketing direct. Competition is very keen in general lubricating oils, and profits are low. As practically all general oils are sold to people who are commercial consumers, there is no such distinction between branded and unbranded, as with motor oil.

Many grades of general oils are marketed for different purposes, varying in viscosity and other qualities, over the whole range of possibilities, according to the use for which they are required, or sometimes to the special specification of the customer. The larger distributors market several hundreds of different grades.

A very large part of the general oil business is at " cut " rates. A firm consuming large quantities of oil invites tenders for a contract for oil of a certain specification, and usually accepts the lowest quotation. Competition is so keen that the figure is likely to be not much more than the cost price of the oil. Agreement between distributors on minimum prices would be very difficult, if not impossible, for general oils, on account of the number of grades to be covered and the different types of customer to be served. There also appears to be doubt in the minds of those responsible for deciding on the policy of the large groups as to whether it is better to distribute directly themselves, or whether it may not be more desirable to act only as wholesalers, and distribute to small blenders, leaving the finding and exploiting of the market to them. In view of the amount of blending and the attention paid to individual requirements in lubricating oils, it is difficult to see how price fixing could be a success. In the present state of organisation the existing system of calculating the cost of supplying the oil, adding a small profit and thus arriving at the price to be charged, seems likely to continue, although it may be possible with some special oils to charge a somewhat higher price than the minimum, if the product of one distributor has, for instance, obtained a specially good reputation among a group of manufacturers by reason of its suitability for the purpose for which it is required. Oils bought by the cotton, woollen and artificial silk trade in particular may be in this position, as, with textiles, a manufacturer naturally cannot afford to buy a cheap oil which might spoil his products. For this reason standardisation of prices and conditions is obviously very difficult with general oils. Manufacturers in a certain trade may be sufficiently impressed with the suitability of an oil for a particular purpose and willing to pay a fairly good price for that oil. It may, however, be produced in quantities greater than the requirements of the trade, and the surplus, being possibly a good deal less suitable for other trades, may have to be disposed of at a lower price.

In most fields, however, competition is sufficiently keen to prevent this occurring on a large scale, in spite of the fact that lubricating oil is clearly a commodity in which a tendency might be expected to charge "what the traffic will bear," since the demand for it is extremely inelastic. No works have ever closed down on account of the high cost of lubricating oil, or opened up on account of its cheapness. Its proportion to total manufacturing costs or operating costs is very low, but nevertheless it is indispensable. Commodities in this position are usually expensive in relation to their cost to the distributors, but general lubricating oils form an exception to the rule.

There are a large number of different classes of general oils, such as spindle oils, axle oils, cutting oils, steam wagon oils, leather oils, transformer oils, dynamo oils, gas and oil engine oils, marine oils, engine oils, cylinder oils and bearing oils. The classification is by uses, and the demand for any one use depends, of course, in large measure on the degree of industrial activity in the industry concerned. The prosperity of the textile industries thus determines the demand for spindle oils, of the shipping industry the demand for marine oils, and of the haulage contracting industry the demand for steam wagon oils.

The larger consumers of general oils are well known, and can be handled effectively by a centralised organisation, but the smaller consumers are much more difficult to find, as they do not advertise their existence in the same way as garage proprietors or the commercial consumer owners of motor vehicles, who may be traced fairly easily by seeing their vehicles on the street and noting the name and the address of the proprietor, if it is a vehicle operated by a private firm. The names and addresses of haulage contractors who are commercial consumers of spirit can also be obtained without great difficulty, as a haulage contractor who is himself looking for business naturally advertises his existence rather than hides his light under a bushel.

Consumers of general oils must be sought out, and to find them the ground must be covered very thoroughly and in great detail. For this reason the small local blender, knowing his district and himself well known in it, is at an advantage compared with the big firm whose representatives must spend valuable time in canvassing. In any case, it is obvious that the canvassing of small customers must be

done by the man on the spot, and for this reason the canvassing of general oils is done through the depot, in the same way as the canvassing of spirit, kerosene and motor oils, by those firms which sell all kinds of petroleum products. The trade is almost entirely one with the final consumer, as there is really no dealer in general oils nor any occasion for one. The ordinary member of the public does not buy lubricating oil for anything other than his car, except in minute quantities; a small tin for his boots or typewriter, but not more. In these instances the manufacturers simply supply the oil as a side-line along with their main products. The general oils consumer is thus normally in the same position as a commercial consumer of motor oils or motor spirit.

General oils are distributed either in barrels or in bulk. Barrel deliveries still considerably exceed bulk deliveries, but the latter are nevertheless increasing more rapidly. The small blenders deliver almost exclusively in barrels. The larger distributors also deliver mainly in barrels; although the installation of bulk storage by the larger consumers is on the increase, the size of the tanks varying according to requirements from 50 gallons to 3000 gallons and upwards. Bulk deliveries represent an enormous economy, the cost of delivery in bulk being little more than half the cost of deliveries in barrels. There is first of all the actual saving in the cost of the barrels. There is also the saving in charges at the installation, as bulk oil takes up less storage space, is easier to handle, and is not charged up with barrelling expenses; in addition, there are very appreciable savings in transport costs for transportation both to depots and to customers, because bulk is easy to handle and compact to store.

Small quantities of general oils are delivered in drums, cans and kegs as well as in barrels and bulk, but these methods of delivery are exceptional, because the expense of the package inflates the cost of delivery of the oil to such an extent that no commercial consumer buying any appreciable quantity would carry the charge unless it were unavoidable.

Although the canvassing of customers for general oils is based on the unit of the depot, and local sales are credited to the depot, distribution is not done through the depot, as it is not a trade suitable, like motor oils, for peddling, and the quantities for delivery are apt to be irregular to such

an extent as to interfere seriously with the ordinary work of the depot. Deliveries are therefore normally made from the nearest installation by the large distributors, and from the blending plant by the small men. The depot superintendent thus acts merely as a canvasser, and is not required to superintend the handling or delivery of the oil, or to be responsible for its storage at his depot.

Although the motor lubricating oil trade is only one branch of the general lubricating oil trade, there is much to be said for dealing with the two as though they were distinct commodities, since motor oils are consumption goods so far as the general public are concerned, and general oils are not. Motor oils, like other " consumption " goods, such as tobacco and alcohol, are sold by brand, and largely through the intermediary of a third party, the dealer. The object of the distributor is to keep in touch with the ultimate consumer, with whom he has no personal dealings, mainly by means of advertising, and to make his position so strong that a sufficient proportion of the ultimate consumers will refuse to accept other brands as to make it impossible for any fair-sized dealer to refuse to stock his motor oil. In addition to direct advertising, he wishes to keep his brand prominently before the public by means of conspicuous bulk equipment outside garages, and also to have dealers well disposed towards his products. The advertising, in addition to impressing the public, impresses dealers also, especially if it is concrete and directed towards the increased sales of the brand. The advertising involves heavy expenditure, but the public is apparently always willing to pay for this. A cheap and unadvertised or little-advertised commodity for consumption cannot sell in competition with a rather more expensive commodity of similar quality which is backed by sound advertising.

Where purchases are made for institutional or commercial rather than for private consumption, and especially where the customer is a large one employing his own experts, advertising is of little use, as the customer is in a position to draw his own conclusions as to comparative costs and comparative qualities. Small commercial users may be susceptible to advertising to a certain extent, in the same way as private consumers, but even they on the whole are less so. Hence it is necessary to go about the business of marketing general oils in a different way from that adopted for motor oils. The psychology of the buyer of general oils

is comparable with that of the buyer (other than the domestic buyer) of fuel oil, while the psychology of the motor oils customer may be taken to be identical with that of the buyer of motor spirit. In the latter case it is the same individual purchasing the two commodities for the same general purpose of causing a car to run. He is more prepared to spend readily than the commercial buyer, less likely to haggle over the price, and usually in a less favourable position to judge whether the difference in price between two more or less similar commodities is greater or less than the difference in quality. For this reason the distribution of motor oils, like all trades dealing in goods for private consumption, is more profitable than the distribution of general oils to commercial users. This is a phenomenon which has been very marked in most industries of recent years. Retail prices throughout the economic system tend to be high in relation to wholesale prices, and the profits from dealing with private buyers much greater than the profits from dealing with commercial buyers.

Various causes appear to be operative in bringing about this state of affairs. In a period of falling prices it is more difficult to bring down retail prices than wholesale, owing largely to the strength of habit, people rarely objecting to paying a price which has been hallowed by custom, and, more particularly, to scientific salesmanship, intensive advertising and in some trades instalment buying. These have all helped to induce a large proportion of the population to fall into the habit of ready spending. Commercial buyers, however, especially those in depressed areas, keep prices down to a competitive minimum, and, as industry has for nearly a decade been sufficiently slack to make everybody in a responsible position alive to the importance of careful costing and systematic searching out of the cheapest market for all supplies, there has been a tightening up all round of slipshod, slack and easy-going systems of doing business. Moreover, the process is apparently still continuing. People are becoming increasingly different in the buying habits of their private and business lives. Privately they are becoming less thrifty and acquiring the spending habit. They are encouraged to do this by advertising, by the increasing frequency of insurance, rather than of saving and investment as a means for safeguarding against old age and other risks, by the large number of luxuries available in the nature of cars, wireless, gramophones and

amusements on which money can be spent, and also by the declining social prestige attaching to the mere possession of wealth as distinct from its spending. In business, people are at the same time becoming keener and more efficient, and, under the influence of trade slackness, are turning to studying costs in many decimals of a penny, and possibly are tending to overdo this by indulging in cheese-paring economies and a merciless beating down of production costs in the realm of industry, all to be thrown light-heartedly away in excessive advertising and extravagant retailers' profits before the goods ultimately reach the public.

CHAPTER XI

BITUMEN

Bituminous Road Surfaces

ASPHALTIC bitumen is the residue left after the distillation of certain crude oils, including a large proportion of those produced in Mexico, Venezuela and California. Two main types are produced, steam-heated bitumen and blown bitumen. The method of production of steam-heated bitumen is to pass the crude oil through a pipe-still at a high velocity and inject superheated steam to control the heat treatment. The hot oil is then discharged into a vertical cylinder, known as an evaporator, where more steam is injected, which enables the light fractions to be removed by a reduction of the vapour pressure. The high-pressure steam and light distillates pass away at the top of the evaporator, and the bitumen, which has been brought to the desired consistency, can be run off from the bottom of this vessel. The actual grade of material produced is controlled by the rate of throughput of the crude oil, and, of course, by the temperature to which it is subjected.

In the case of blown bitumen, the production of a suitable grade in this instance relies on progressive oxidation. Crude oil or a soft grade of steam distilled bitumen may be used as the starting product, but the process of preparation is much the same. The raw material is placed in a cylindrical still, and heat is applied, air being blown through the mass for a period of from 12 to 72 hours. The resulting product obtained by this method differs from the steam-refined bitumen, in that the blown bitumen retains a certain amount of resilience, and is free from the brittleness which is characteristic of a steam-refined product of high melting point. In addition, the blown bitumen is not so susceptible to temperature changes as the steam-refined product.

Bitumen is a highly complex mixture of cyclic and olefinic and saturated hydrocarbons, and, in view of the great number of individual hydrocarbons present, it is more usual to rely on physical than chemical tests for its examination. However, the approximate ratio in which the elements,

carbon, hydrogen, oxygen, etc., are combined in asphaltic bitumen derived from petroleum is as follows :—

	Per cent.
Carbon	83
Hydrogen	10
Sulphur	5
Oxygen and Nitrogen	1·8
Ash	0·2

The principal tests of bitumen are for penetration, ductility and solubility. The penetration test is to determine the hardness or consistency. The ductility test is to ascertain how far a given quantity at a given temperature will stretch without breaking. The solubility test is to test the actual percentage of bitumen in any given sample. The bitumen is dissolved in carbon disulphide, and so much of it as is not soluble consists of impurities.

There are a number of grades of bitumen manufactured, both hard and soft, different grades varying widely in physical properties such as hardness, melting point and ductility, thus supplying the requirements of a great number of industrial processes. Bitumen is waterproof and weatherproof in addition to being ductile. Its great industrial value arises from the fact that it has the property of transferring these qualities to any material carrying it in appreciable quantities, such as sand or fabrics. The total consumption of bitumen in the British Isles exceeds 400,000 tons per annum.

Bitumen comes into direct competition with tar over the greater part of its field of usefulness, and, as tar is a coal by-product mainly produced at blast-furnaces and gas-works, and therefore entirely a British-made product, there is a certain amount of prejudice in favour of tar in some quarters where so-called patriotic motives are given precedence over utility. This demonstration of a national inferiority complex is unworthy and not a little ill-judged, in so far as it is disinterested. Since bitumen was first imported into this country in 1910, a refining industry has grown up mainly since 1922, and the greater part of the bitumen now used is imported in the crude state and refined in Great Britain. So successful has this been, that a considerable export trade has grown up in refined bitumen for the continental markets, and, with the rising standard of European roads, there will be scope for a great deal more development in this direction. The crude oil from which the bitumen is refined is for the

most part produced by companies financed by British capital, and giving employment to many British nationals in their managerial and supervisory grades. These companies, by developing the oilfields of backward tropical countries, are playing a prominent part in increasing their wealth, and so giving them greater purchasing power for British manufacturers, in addition to being themselves large buyers of British machinery. The crude oil is transported in tankers which are British-owned and have British crews. It will be a sad day when parochialism has gone so far that Great Britain voluntarily relinquishes her position as the entrepôt for the world's trade and the possessor of the largest Mercantile Marine, in order to protect less efficient products possessing the virtue of being 100 per cent " made in England " against those that are more suitable. The world cannot afford to buy British manufactures without selling something in return.

The principal use of bitumen, accounting for the greater proportion of the sales on the British market, is as a surface-binder for roads. A good road must be cheap, taking the long-period view, and durable, which is largely the same requirement seen from a different angle. Further, it must, if it is to be cheap, be easily cleaned and easily maintained. From the point of view of persons and traffic making use of it, it should be non-slippery, dustless and easy for wheeled traffic to move on, *i.e.* it should offer a low resistance to traffic

Cheapness depends very largely on durability. Durability in its turn depends on a number of different factors. In the first place, the road must resist the weather. In this country that means that it must be well drained, and so protected from infiltrations of water from above and below. The surface must be waterproof and weatherproof, and not liable to crack, and the sub-grade must be compact. There must be no badly filled in trenches and soft places. In addition to the wear and tear by the weather conditions—that is, the action on the road of water, sun and frost—there is the attrition of traffic on the road to be considered. The extent of the attrition depends on the amount and nature of the traffic. Arguments are often put forward in connection with motor taxation which rest on the premise that the wear and tear inflicted on a road by 200 tons of traffic passing over it is double that caused by 100 tons. This is, however, quite contrary to the facts. Within limits, traffic has a healing effect on many modern road surfaces, and

BITUMEN SURFACING (SPRAMEX).

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automatically tends to repair the ravages of the climate. The effect is to improve them rather than make them worse. Provided that the foundation of a road is strong enough to stand up to present-day traffic, it does not follow at all that the cost of maintenance of the road is a function of the amount of traffic it carries.

The cheapness or otherwise of a road must take into account the frequency of repairs. If frequent reconstructions are necessary, or if traffic is constantly prevented from using the road or part of the road on account of repair work being in hand, in the aggregate considerable losses are incurred by road users through waste of time, and, in the case of urban streets, by trades and shopkeepers whose premises adjoin the road. It is a far better proposition, from the point of view of ultimate economy, to all concerned to have a road which is relatively expensive in the first place, but which, once constructed, can be left for years with a minimum of repairs, than to have a road which is cheap to construct, but constantly out of use while maintenance work is being performed.

Ease of cleaning is most important. Apart from its unpleasantness, dirt retains moisture. On a wet day this makes almost any surface dangerous, and further, by prolonging the period of dampness, hastens the process of decomposition and decay. A surface which makes dust by attrition is therefore likely to be expensive in the long run. It will wear out earlier and require a relatively heavy expenditure on sweeping and cleaning. Atmospheric dust and dirt is a predisposing condition to many complaints affecting the respiratory organs, and on the grounds of public health it is undesirable for roads which produce dust under normal conditions to be tolerated, so long as dustless alternatives are available at a competitive cost.

A low resistance to traffic is necessary for a good road. If there is resistance to traffic, the friction between the wheel and the surface is increased, and hence the wear is heavier. The resistance of a surface to traffic depends, of course, to a great extent on climatic conditions. Slipperiness is also important, and depends on cleanliness, temperature, and the weather, although under certain circumstances all surfaces are slippery.

In connection with maintenance, the road surface must be determined entirely according to the type and weight of traffic to be carried. A surface which is the cheapest

available with one weight of traffic may with increased traffic be one of the most costly. From the point of view of the traffic using it, a road must be smooth. This minimises both the wear and tear to the road and to the tyres of the traffic, and reduces the amount of power necessary to move vehicles.

In the interests of public health more is required of a road than merely freedom from dust and dirt. Certain surfaces readily absorb moisture and filth which evaporates in dry weather. This can, however, be avoided if a surface is waterproof. With the great nervous strain of modern life, it is also desirable that a surface should be as quiet as possible. Rubber would be ideal from this point of view were it less expensive.

There must be a road surface which can withstand the onslaught of physical agents and at the same time guard against infiltration and incrustation. It should also be free from liability to irreparable fracture, and hence a resilient surface is preferable to a rigid surface. It is desirable that it should be, so far as possible, self-healing, and possess the capacity to benefit from the pressure and rolling of the traffic passing over it. It should act, moreover, as a shock absorber, thus dispersing the violence of impact of fast traffic and distributing the load.

There are four main types of road: water-bound, tar-macadam, asphalt mixture and concrete. The so-called dirt roads of compressed earth which are typical of many parts of the world are excluded as being already quite obsolete in Great Britain. Water-bound macadam roads were popular in the days of horse traffic. They gave a non-slippery foothold for the horses, except in very frosty weather, and were relatively cheap to maintain, as the action of the solid-tyred carts was to roll in the stones and strengthen the road. Repair was effected by spreading more stones in weak places. Roads of this type are quite unsuitable for pneumatic-tyred motor traffic. The suction of the tyres dislodges and disperses the individual stones, and in dry weather churns up dust, and in wet weather mud. The surface is non-shock-absorbing and fractures easily. Once fractured, disintegration is rapid, as pot-holes are formed, and a car, after a wheel has dropped into one and made it worse, bounces up and bumps down with tremendous force a yard or two farther on, thus beginning a second pot-hole.

Concrete roads have the disadvantage of being quite rigid. They cannot absorb shocks, and, owing to the absence of any cushioning material, steadily disintegrate. They are noisy, and, most important of all, they suffer, as all rigid materials must, from the drawback of being liable to irreparable fracture.

This leaves only tar and bitumen roads, which are resilient, quiet, smooth and reasonably clean. The dangers to be guarded against with these types of road are slipperiness and corrugation. The avoidance of these depends to a great extent on choosing a suitable graded aggregate, and applying properly the correct grade of cementing material. Both types of road are shock-absorbent, distribute the load well, are waterproof, and enable the constituent parts of the road to be sufficiently bonded together to give permanence to the structure.

Tar can bind materials together to the required extent. It is sufficiently resilient to meet normal requirements, but it fails, owing to its temperature coefficient being much too high. During winter frosts tar is nearly, but not quite devoid of resiliency, and therefore tends to crack. In the summer sun tar becomes plastic and again weak in resiliency, owing to its softness. It oxidises comparatively quickly when subjected to atmospheric changes; the volatile oils readily evaporate under the heat of the sun, leaving free carbon behind, which is of no value. Its low melting point causes it to " bleed " freely in hot weather. Tar, when first applied to a road, takes a day or two before it sets; in the meantime the paint of cars is spoilt by tar splashing. Even the best of road tars contain acids which are very poisonous to fish and vegetable life; 1 part per 100,000 parts of tar acid in water will kill trout in a very short time.

Tar also suffers from variability in quality. Tars produced from the carbonisation of coal vary according to the type of retort employed, *i.e.* vertical, inclined or horizontal. The horizontal type produces by far the best tar, but a smaller percentage of gas per ton of coal carbonised. Tar also varies according to the class of coal from which it is produced.

In bitumen there exists a bonding agent possessing all the cementing and binding powers required, toughness and resiliency, and, at least of equal importance, a low temperature coefficient. Provided a grade suitable for the purpose in hand is chosen, bitumen possesses resiliency during

winter, and, even in summer sun temperatures, while it is of necessity less hard than at lower temperatures, it still retains to a sufficient degree its normal cementing and cushioning effect. Bitumen has a much longer life than tar. Its high melting point means that it does not bleed to anything like the same extent under the sun's rays. Bitumen sets very quickly when applied to the road, and does not pick up or splash under traffic. It contains nothing which can damage paint, and is harmless to fish and vegetable life.

Bitumen is the most generally satisfactory type of road, although, of course, there are several kinds of bitumen roads, including both good and bad roads. The simplest form of bitumen road is one obtained by grouting partially consolidated graded mineral aggregate. This is probably the least satisfactory, since it is almost impossible to secure uniform application of the melted bitumen, and to ensure that every particle of the aggregate is satisfactorily coated.

The second form is bituminous concrete, either a single coat or two coats, and, provided that the aggregate in the wearing surface is so chosen as to keep down the percentage of voids to a minimum, thereby ensuring the necessary rigidity of the structure apart from the cementing material, a satisfactory surface can be obtained.

Undoubtedly the best method of employing bitumen is in the form of sheet asphalt. In this type of work an aggregate is used composed of coarse and fine sand and filling material, so that it is possible to secure the minimum percentage of voids. The fineness of division is such that the surface tension of the cementing substance plays an important part by helping to secure the required rigidity. When the initial cost can be met and a surface of maximum durability is required, sheet asphalt is undoubtedly the best surface available.

Where a bituminous surface is found to be faulty, the defects may usually be related to the physical properties of the constituents. Cracking may be due to different causes, the commonest being a faulty base, itself cracked or possibly uneven, and failing to give a rigid support. Lack of traffic and insufficient compression when laid may also be contributory causes. When due to the asphaltic cement itself, the faults causing cracking are insufficient ductility and too low penetration; too great economy in the use of the asphaltic cement may also have the same effect. Disintegration and

holes may be due to local weaknesses in the foundations, water, poor ductility and cementing value of the asphaltic cement, and unreasonable economy, resulting in failure to fill gaps and uneven spreading of the surface mixture. On the other hand, too much of the asphaltic cement gives a soft surface and leads to waviness and rutting. Lack of cementing power may have the same result. A certain amount of waviness is always found, even on steel rails where there is heavy traffic, and cannot altogether be avoided with any type of surface. Scaling of the surface takes place where the asphaltic cement is lacking in cementing power, where it is insufficient in quantity, and particularly where the sand is poor in quality and contains dirt. Waviness occurs where the asphaltic cement is too soft or has been applied extravagantly. Insufficient filler has the same effect, as it gives the surface too much of the asphaltic cement in proportion to the filler. Many of the faults in a road surface which are apt to be attributed to the bituminous binder have nothing to do with it directly, but occur because it has been applied either with undue economy or extravagance.

Industrial Uses of Bitumen

Although by far the greater part of the bitumen consumed in Great Britain is used on the roads, it has as well a wide variety of industrial uses. It is used in the manufacture of roofing felt, in various types of floor covering, in the making of waterproof paper and many other kinds of waterproofing. It is also commonly used in the preparation of brattice cloth, more particularly that of superior quality, and in a number of electrical appliances, including fuse boxes, electrical cables and insulating tape. Bitumen is also employed in the explosive industry in the manufacture of fuses, and in the making of bituminous paints, enamels and varnishes. Successful results have been obtained in the use of bitumen as a binder in the manufacture of coal briquettes.

The numerous and widely divergent uses of bitumen are attributable to a peculiar property which bitumen possesses of blending with many other quite different substances, such as rosin, fatty acid pitches, animal and vegetable oils, and many kinds of wax. It imparts its own properties to the substance with which it is blended, making them waterproof, ductile, and black and glossy.

Floor coverings prepared with bitumen are being used as a substitute for linoleum, and are becoming very popular on account of their lower cost, more complete waterproofing properties and good wearing qualities. The method of preparation is first of all to saturate rag felt with bitumen, then to size the upper surface with some glutinous substance together with silicate of soda, next to apply oil and yellow ochre thinned with white spirit; this gives the material the colour and general appearance of linoleum. After this coat has dried and set, the pattern chosen is printed in the usual way by passing the material through a printing machine.

Roofing felts, waterproofing membranes and similar fabrics may be either woven or felted, the woven type being the stronger and more pliable. To make them waterproof they are impregnated with bitumen. Stone surfaces are usually coated with an asphaltic paint and metal surfaces cleaned up before laying the membrance. When laid, the surface must be protected from mechanical injury by some suitable material, such as asphaltic mastic. Concrete structures are sometimes rendered waterproof by incorporating bitumen with Portland cement concrete in the course of its preparation.

Bituminized papers are made by saturating paper with bitumen in just the same way as roofing felt. The chief use of this kind of paper arises from the heat-insulating properties of bitumen, which make bituminised papers very useful for lining walls, floors and ceilings, and also for cold-storage plants. To obtain maximum results it is necessary to use several layers of paper. Bituminised papers are also used for electrical insulation in constructing automatic telephone switchboards, and for wrapping wires and cables, but this is more usually done by insulating tape, which consists simply of strips of cotton or muslin passed through a bath of molten bitumen.

Bitumen is extensively used throughout the electrical industry, sometimes alone, but more often blended with other substances such as resins, rubber, oils, fats, waxes, etc. Its very high dielectric strength and its great resistance to moisture, acid, alkalis, heat and cold make it extraordinarily useful.

Bitumen is also employed to a considerable extent in the rubber industry. It is sometimes incorporated with raw rubber, partly to soften the rubber, partly to increase its weather-resisting properties, and sometimes to cheapen its

cost. Bitumen can be vulcanised, and is often so treated before being blended with the rubber. The fact that bitumen can be vulcanised renders it very valuable in the rubber industry. When used for this class of work it is sometimes known as "mineral rubber." The method of manufacture is usually for the bitumen to be incorporated with the raw rubber on the masticating rollers, and sometimes for it to be mixed with reclaimed rubber and mineral filler.

Bitumen together with mineral filler and resinous substances is much used for the making of small moulded articles such as buttons, knobs and handles. The substances are melted, mixed together and then poured into the moulds and kept under pressure while heated. The resultant composition is dark in colour, but may be made pure black or tinted with dark shades of other colours by the addition of a suitable pigment.

Coats of bitumen and bituminous compositions are a favourite way of preventing metal pipes from corrosion. Corrosion may take place either inside or outside the pipe, and the best results are therefore obtained when both inside and outside coats are applied. Outside corrosion may be due to moisture, electrolysis, exposure to mineral salts in the soil and contact with acids. Inside corrosion may appear with pipes used for carrying liquids, illuminating gas, or as conduits for electric wires. A satisfactory coating must be impervious to air, moisture and acids, and a non-conductor of electricity. It must wear well and not chip off when exposed to ordinary conditions. It must obviously have no deteriorating effect on the metal, and should be easy to apply, and not unduly expensive. All these qualities are possessed to a sufficient degree by bitumen, which is steadily being substituted for the substances which were formerly used. An allied use for which bitumen and bituminous cement is used is for sealing joints in pipes.

Bituminous paints, enamels, varnishes, japans and cements are prepared from mixtures of bituminous materials and volatile solvents; cements are usually in the form of a paste, and paints, enamels, varnishes and japans in the form of liquids. The usual solvent used is white spirit. Vegetable drying oils, mineral filler and compounds are also added. The paints dry through the evaporation of the solvent, and leave a glossy, tough and hard, although non-brittle coat. The object of the mineral filler is usually to harden the base

and cheapen the paint. Bituminous paint is mainly used as a protective against damp on masonry, roofs, metal and wood structures. Bituminous varnishes are prepared in much the same way as ordinary varnishes, but they should carry enough oil to give the base a liquid or semi-liquid consistency, and harden at room temperature by the oxidation of the oil. Bituminous enamels are prepared by adding sufficiently intense pigments to bituminous varnishes. Their scope is, however, limited although they are durable and inexpensive, because only dark-coloured enamels can be prepared in this way. Bituminous japans are also increasingly popular on account of their cheapness, and bituminous cements find an outlet for repairing metal or composition roofing, for damp-proofing the inside of masonry walls above ground, and occasionally for waterproofing the outside of foundations below ground, as well as for pipe-jointing compositions.

Distribution

The bitumen trade of the country consists mainly of large distributors selling to large consumers. The amount of small business is strictly limited. Bitumen may be divided into two classes, according to the use to which it is put: industrial bitumen and road-making bitumen. Bitumen for use on the roads may be further sub-divided into bitumen supplied to municipal authorities and bitumen supplied to contractors.

As the trade in bitumen consists of large-scale business, it is not suitable for dealing with through the depots. Each traveller operates over a wide area, over which he is responsible for canvassing business. He keeps in close touch with Head Office, who are able to help a good deal with big contracts. Distribution is carried out from the installations, and may be either by rail tank-car, road wagon or canal barge.

There is an increasing tendency for bitumen to be distributed in bulk, although packed deliveries, usually in steel barrels, were formerly the rule. The cost of distribution in bulk is very much cheaper, more especially as Scammell lorries of 10 or 12 tons capacity are used. A barge load may be anything from 25 to 250 tons, and a rail tank-car about 14 tons. The road wagon is efficient over a radius of 50 miles from the installation. Barge deliveries are even cheaper, but are only possible in certain cases. Rail tank-car deliveries cover the whole of the country.

One of the difficulties and expenses connected with the delivery of bitumen by whatever method is the necessity, either of melting it by steam-heating, or of keeping it melted by the same means, in order to render it suitable for pumping. The natural state of bitumen is a solid or semi-solid.

The charge for heating is naturally higher for bulk than for packed bitumen, but this is compensated for by very big reductions in handling and transportation charges, and by the elimination of charges for repairs to packages and scrapped packages. The saving amounts to practically half the total cost of delivery, and is duly passed on to the consumer by a lower charge.

In a sense, bitumen completes the link between the petroleum industry and transport. Shipping burns fuel oil, either under boilers or in Diesel engines. Aeroplanes use benzine; so do motor vehicles of all kinds. All these are lubricated by lubricating oil derived from petroleum, and the roads over which the motor vehicles run are surfaced with bitumen. With the growth of motor transport, and the increasing attention paid in this country to work on the roads as a means of reducing unemployment, its use is bound to increase, more particularly as the advantages of asphaltic bitumen over tar and concrete become apparent. The other uses of bitumen are already extremely numerous, and in due course fresh markets will also no doubt be opened up, as the special characteristics of bitumen make it peculiarly valuable in many directions. The total consumption for industrial uses will, however, probably remain at a low figure compared with the consumption on the roads, as that is already enormous, and may yet expand very much more at the expense of the 600,000 tons of tar now used for the same purpose every year.

CHAPTER XII

THE FUTURE OF OIL

Substitutes for Petroleum Products

FOR the last fifteen or twenty years there have been periodical attempts by various interests such as the Federal Oil Conservation Board, both in this country, and even more in America, to organise a scare about a world petroleum shortage, which is usually represented as waiting just round the corner, when all the wells will rather suddenly run dry, and a civilisation almost entirely dependent on the internal combustion engine will be left, as it were, in a state of suspended animation. However, the whole question of the world's petroleum supplies has been thoroughly investigated, and is constantly kept under review by the American Petroleum Institute, while papers have even been read to the Chemical Section of the British Association hinting at such a chain of events. Fears may be laid to rest, for nothing of the kind is likely to happen. On the contrary, the problem for some time has been to try to limit a too abundant production. There is no evidence of a world shortage of oil in the immediate future, and, if such a thing were to take place, it would proceed very gradually. The deficiency in supply would lead to a rise in the price, and this would bring on to the market an almost unlimited supply of oil from oil shale, of which there are potentially vast reserves, especially in the United States, Canada and Brazil, and in various parts of Europe, including Russia, Scotland and France. Further, a tremendous impetus would be given to the production of oil from coal and to the use of substitutes, and, of course, more economical methods of utilising oil would be encouraged and adopted. Taking the long view, it may be necessary to seek the future fuel for internal combustion engines from sources which can be made good annually by a process of natural growth, *i.e.* the vegetable kingdom, perhaps alcohol, rather than from sources the total supply of which is diminished by each year's consumption, *i.e.* the mineral kingdom, which, of course,

includes coal as well as petroleum. This is, however, a problem of the future, and not one to which the present generation need give very anxious thought. The internal combustion engine has come to stay, and is an essential feature of twentieth-century civilisation, and for the immediate future its principal fuel is likely to continue to be benzine, produced by the methods now employed.

Oil shale, at present mainly worked in Scotland and Esthonia, yields about 54 gallons to the ton, of an oil resembling crude petroleum. Historically the oil shale industry is older than the petroleum industry, but it has been completely overshadowed by its younger rival. Nevertheless, it could easily come into its own again should the price of petroleum show a sufficient rise. The extent of the world's resources of shale oil may be gauged from the fact that it has been estimated that the reserves in Colorado alone amount to 20,000 million barrels. Shale oil is particularly rich in fuel oil, but much less rich in benzine. The extraction of oil from shale oil is a process which can only be undertaken by large-scale enterprises, on account of the relatively considerable amount of capital equipment required. There are various technical and other disadvantages attaching to shale oil, but these would be overcome without great difficulty if the price obtainable for it were sufficient to make the venture worth while. At present it is not, except in a few cases where the circumstances are especially favourable. However, the vast reserves of shale oil make unnecessary any anxiety about future supplies of petroleum.

In view of the peculiar conditions obtaining in Great Britain, where no petroleum is produced, but, on the other hand, much coal, if the markets can be shown to exist and the price is remunerative, the question of the production of oil from coal becomes one of particular interest and importance.

There are a number of possible ways of producing oil from coal, but the two best known and most effective are low-temperature carbonisation, which, in addition to producing oil, produces coke and coal gas, and the treatment of coal by hydrogenation by the Bergius or a similar process. The latter gives the higher yield of oil, but the residue, which consists largely of gas containing up to 75 per cent. of unabsorbed hydrogen and ash, is less valuable than that of the low-temperature carbonisation process.

Oil is manufactured from coal by low-temperature car-

bonisation on a small scale in the United States, Germany and England, but at present the process is too costly for wide application at the current ruling prices for the products obtained. With moderately good bituminous coal, the yield of oil, known as primary tar, may be up to 30 gallons per ton, and in selected coal even more, by the use of cracking methods similar to those used in cracking heavy petroleum. It is claimed that as much as 40 per cent. of motor spirit may be obtained from this primary tar, the remainder being divided equally between cresylic acid and pitch. The low-temperature carbonisation process is the most suitable for coals of the qualities found in the British Isles, but is disappointing when applied to lignites or brown coals, on account of the very low yield of oil obtained.

The other treatment of coal by hydrogenation has been chiefly exploited in Germany by the Bergius process. This process presents a number of technical difficulties in the way of commercial manufacture. Temperatures of between 400° and 500° C. are required, and a pressure of 1500 lb. per square inch. The tensile strength of steel begins to decrease at these temperatures, so that there is difficulty in constructing plant which will withstand the high internal pressures required. The temperature must be controlled very exactly, and the plant must be in operation all the time, so that it is necessary to devise some means for the continuous feeding of coal and hydrogen, and the withdrawal of the oil, gas and residue. The process is particularly suitable for the treatment of lignites, and not unsuitable for some British coals. As much as 130 gallons of oil, equivalent to a yield of 61·4 per cent. of liquid products, have been obtained experimentally from 1 ton of Lancashire coal by Dr. J. S. Haldane at the mining research laboratory of Birmingham University. Considerably higher figures, of 140 gallons per ton and upwards, have been claimed with various German coals; and even up to 80 and 90 per cent. yields of oil; the yield of oil per ton is stated to be approximately six times that obtained by low-temperature carbonisation, but, on the other hand, the process is costly, largely on account of the expense of hydrogen, the largest single item; if this could be produced more cheaply the future for oil from coal would be brighter.

Dr. Bergius, who first patented his process in 1913, was able to state by 1926 at the International Conference on Bituminous Coal at Pittsburgh that his process was a technical

and economic possibility. The development of this new industry was taken in hand by the I.G. Farbenindustrie (German Dye Trust). Plants began work in the Ruhr under the auspices of the Gesellschaft für Teer Verwertung, and in the lignite area under the I.G.F. and a subsidiary company, the Deutsche Gasolin, was formed for marketing the oil produced. The I.G.F., the Royal Dutch-Shell and Standard Oil groups all hold interests in the subsidiary. In 1928, 300,000 tons of coal were treated by the Bergius process in Germany, and the more optimistic advocates of the development of oil from coal hope that the day is in sight when Germany will be independent of imported oil. Outside Germany there have not yet been comparable developments on a commercial scale in the treatment of coal by hydrogenation, although a good deal of work is being done experimentally. It seems unlikely in the circumstances that a large proportion of the world's oil supplies, or even of Europe's oil supplies, will be obtained from coal, so long as there is no revolutionary change in the world markets and prices, or in the international political situation.

The desire to find a substitute for imported oil, which has been the *raison d'être* of the interest taken in Germany in the production of oil from coal, and is equally the cause of the attention paid to the subject in Great Britain, has taken a rather different turn in France, where the coal resources are less extensive, and experiments are constantly being made with a view to discovering means for the utilisation of French forest products for the propulsion of vehicles using internal combustion engines. It is not too much to say that the whole impetus to find substitutes for petroleum comes from European anxiety, grounded in the fact that the petroleum production of Europe outside Russia is hopelessly inadequate compared with her needs, and is not in relation to the part she has played, still plays and intends to play in world affairs. Oil is so necessary to modern civilisation and to modern warfare that every country and continent is compelled to consider the best means of ensuring proper supplies in time of emergency. Were this not the case, very little would be heard about substitutes for petroleum, which can hardly be justified on economic grounds alone, and, in view of this fact, it may be taken as axiomatic that the further the war clouds keep from the European horizon, the slower will be the development of these alternative fuels. On the other hand, the re-emergence

of a state of international affairs comparable to that which obtained in the decade previous to 1914 would compel Governments to take active steps to foster the development of any petroleum substitutes which could be produced entirely from native materials within the frontiers of their own countries. They would probably be compelled by public opinion to grant handsome subsidies towards the development of such home-produced oil, either in the form of a grant or of a punitive duty on imported petroleum.

Wherever a large forestry industry has grown up, there is a great deal of wood waste, and French experiments have been directed to find a use for this as a motor fuel. These experiments have met with a certain amount of success. The wood waste is converted into "carbonite," which is simple charcoal, fed to the gas producer in the shape of small egg-shaped briquettes about an inch in diameter. It is claimed that a lorry fitted with a gas producer can run as far on 75 kilogrammes of "carbonite" as on a 100 litres of petrol, and that there is moreover a saving in cost. In any case, the French Government endeavour to encourage the use of "carbonite" by allowing all vehicles driven by "gasogène" motors a 50 per cent. rebate in taxes. The chief objections to "gasogène" motors are that the apparatus is rather cumbersome, and hence only suitable for large and medium-sized lorries, and that there are certain difficulties in maintaining steady combustion, since the charcoal is apt to crumble because of the jarring and vibrating of the vehicle, especially at high speeds. It is not likely that "carbonite" will supplant petrol for internal combustion engines where the latter is readily available, but there may be a future for lorries driven by "gazogène" motors in districts where, for any reason, petrol is difficult to obtain or very expensive, and where, on the other hand, there is plenty of timber for making charcoal, as in certain parts of Africa for instance. In Europe this development is likely to be confined to France and possibly to Sweden.

Another substitute for petroleum which is to be counted among the possible reserve fuels for use on internal combustion engines is power alcohol. Like "carbonite," it has the advantage over mineral oils of being a vegetable product, and hence, as it can be produced from almost any vegetation which renews itself annually, there is no possibility of supplies giving out. Every barrel of oil and every ton of coal taken from the earth and burnt or destroyed makes the

total supply left in the world so much the less, but power alcohol is not subject to this law, and can always be reproduced so long as vegetation continues to grow.

The possibilities of power alcohol were investigated during 1926 by a Departmental Committee appointed by the Minister of Agriculture and Fisheries. There are a number of technical difficulties in the way of the adoption of alcohol as a fuel. It is not particularly suitable for internal combustion engines of the present design. These would have to be altered considerably in order to obtain the advantages of alcohol. Again, the consumption of alcohol is heavier than that of petrol; roughly 1 gallon of alcohol is equivalent to only three-quarters of a gallon of petrol. Ethyl alcohol has a much lower vapour pressure at atmospheric temperatures than either petrol or benzol, and hence starting is difficult with alcohol, and starting from cold practically impossible; with ethyl alcohol a temperature of 25° C. is required to form the weakest explosive mixture at atmospheric pressure. The great advantage of this alcohol is that with suitable engines the thermal efficiency with alcohol is some $2\frac{1}{2}$ per cent. greater than with petrol or benzol, and both the maximum power output and the normal power output are also considerably greater, on account of the high latent heat of the fuel content. For this reason mixtures containing alcohol are much in demand for racing, especially motor-cycle racing.

At the present time alcohol is more likely to be used as a mixture with petrol and benzol than by itself. Such a mixture is already being marketed by the German Government, and as far back as 1926 a request was put forward by the London General Omnibus Company that the Government should supply or allow to be supplied an alcohol–benzol–petrol mixture as a national fuel, but the request was not acceded to. Successful experiments had been made by the company with a fuel consisting of 70 per cent. benzol and 30 per cent. alcohol.

In Great Britain it was suggested that the alcohol should be obtained from sugar beet, and it was claimed that the average yield would be about 20 gallons to the ton of beet. The cost of manufacture of the alcohol would be ninepence a gallon. The cost of the beet at £1 a ton would be one shilling per gallon, and at £2 a ton two shillings a gallon. At an average cost of, say, thirty shillings a ton the price of power alcohol would be ninepence plus one shilling and

sixpence, *i.e.* two shillings and threepence, plus the cost of distribution and the wholesalers' and retailers' profit, scarcely less than three shillings to three shillings and threepence a gallon in all. There is clearly in existing circumstances of cost of beet and manufacturing costs, the former of which could scarcely be cut enough to make a real difference to the price, little likelihood of power alcohol becoming widely used commercially as a fuel for internal combustion engines. The production of beet is roughly 9 tons per acre, so that it would take 6,670,000 acres to supply 1,200,000,000 gallons of alcohol, the amount which would have been required in 1929 if alcohol had been completely substituted for petrol as a fuel for internal combustion engines. The arable area of England and Wales is, however, only 10,000,000 acres. Alcohol can also be manufactured from coal, either through water gas by the Fischer process or through ethylene. A plant for production by the latter method has been erected by the Compagnie des Mines de Bethune, and is to produce ultimately 300,000 gallons a week. The cheapest method of production, however, appears to be from wood. This method yields approximately 20 gallons to the ton, and, according to the U.S. Department of Agriculture Bulletin, may be produced at 16 cents (eightpence) a gallon. So low a figure may, however, be rather optimistic, and is nevertheless still too high to make power alcohol a really commercial proposition at the present time. In any case it would be inadvisable to deplete timber supplies in order to produce fuel for internal combustion engines, so long as there were any alternatives available.

Broadly speaking, there seems to be no reason to expect an extensive use of substitute fuels in the near future. The supplies of petroleum are adequate for many years to come, and the international situation is not such as to give rise to any acute nervousness on the part of Governments in securing fuel for internal combustion engines for emergencies. A very considerable advance in prices must take place if the various substitute fuels are ever to become commercial propositions, except for special markets and under limited conditions. On the side of demand there is likely to be a steady increase in the consumption of petroleum products throughout the world. The market for petroleum is, of course, a world market, and it is therefore useless to draw any inferences from facts which apply only to the United Kingdom. The demand for motor spirit naturally depends

on the number of motor vehicles, which is still increasing rapidly as shown below:—

	No. of Motor-Cars and Commercial Vehicles in World.
1926	24,348,796
1927	27,591,315
1928	29,686,189
1929	31,764,536

There is no sign yet of a general saturation point, and there is undoubtedly, apart from North America, Australia and Western Europe, where motor transport is highly developed, an enormous scope for the development of motoring in Central and Eastern Europe, Asia and Africa, and, most of all, in South America.

Rationalisation of Distribution

In view of the fact that, so far as can be judged, the present century is likely to be remembered as the age of the internal combustion engine, and that the greater part of the fuel used for internal combustion engines will be derived from petroleum for many years to come, it would appear that the business of distributing petroleum products is potentially a stable one, and ought therefore to be suitable for the introduction of a large measure of rationalisation. Rationalisation is a word which is enjoying an enormous vogue, and which is often employed rather loosely as a justification for any amalgamation of business interests, whatever the circumstances. Properly speaking, it means the application of scientific methods to business organisation, or, more plainly, the elimination of any avoidable waste caused through the organisation of an industry as a whole, rather than of individual firms in the industry. As rationalisation applies to an industry as a unit, it is obviously usually associated with agreements, combinations and amalgamations between firms within an industry.

The more obvious reforms in the distribution of petroleum products have already been indicated, but for convenience may be summarised here. So far as the cost of distribution is concerned, the great factor has been in all branches the gradual substitution of bulk for packages, and the consequent huge reduction in delivery costs, in many cases to much less than a half of what they previously were, which the con-

sumer has to thank so largely for much of the reduction in the price of petroleum products which occurred in the years previous to 1928. In the motor spirit trade it may be hoped that in due course deliveries in cans and even in barrels will become obsolete. This would result in an enormous saving in the cost of distribution. There is first the cost of handling in packages, and of filling, painting, cleaning and repairing the cans. Even more important is the actual cost of delivery. The minimum delivery made in bulk is 200 gallons, a substantial quantity of spirit to sell, but there is no minimum delivery in cans. A delivery of five 2-gallon cans to a customer takes practically as long, and involves almost as much clerical work in the way of accounts and records, as a delivery in bulk of 200 gallons. Many can deliveries are, of course, of more than five cans, of ten, twenty or even forty, but many bulk deliveries also are of very much more than 200 gallons.

Deliveries of motor spirit may be made either to dealers—*i.e.* retailers possessing either a garage or a filling-station—or to commercial consumers, and any person owning a vehicle with a commercial licence is entitled to require a distributing company to deliver spirit to him in cans or barrels, and, if he likes, he need only take 2 gallons at a time. Any person with three commercial vehicles may have a pump installed on deferred terms by the distributing companies, and, if he has less than three vehicles, he may have the pump put in at his own expense and take deliveries in bulk. Deliveries in cans to very small consumers are not really economical, and such people could be gradually squeezed out if a sufficiently big price differential were given them to act as an inducement either to make them take their supplies from the dealer's pump or to instal a pump; in fact, they could be as it were taxed out of existence, as can buyers. If they were gone, it would be possible to dispense with cans entirely, as, except in the London area, where there are difficulties in the way of erecting pumps, can deliveries to dealers are already negligible. Distribution must be done by the cheapest method possible, and in the largest quantities at a time practicable, in order to be really efficient. Can deliveries are not cheap, and the amount delivered each time is small. Deliveries should be large and infrequent, not small and frequent.

There is no objection to the small commercial consumer having a bulk outfit, provided he pays for it, and deliveries

are made in sufficiently large quantities. The cost per delivery of delivering, say, 300 gallons each time is not greater if deliveries are made once every six months than if they are made once every week.

There are not very many fundamental changes in the business of distribution to dealers which are practicable for the present. Can deliveries might be abolished altogether, but as bulk is already over 90 per cent. of the total, there would only be a comparatively slight change involved in abolishing cans. Such a step will certainly be taken in time, but it can hardly be considered revolutionary. Barrel deliveries to dealers are also of little importance, except in out-of-the-way places such as the Hebrides and Orkneys, where it may not be practicable to use a bulk wagon.

In Great Britain there has never been any great extension of the system of distributing direct to the consumer through a company-owned and operated filling-station which has been popularised a great deal abroad, especially in the U.S.A., neither has the "tied-house" garage system of some Continental countries proved suitable for British conditions. Both these methods make for economical distribution, but they are not likely to find favour in Great Britain, on account of the great influence of the free and independent garage proprietor, who has been able to establish himself and obtain recognition as practically the only channel of distribution between the oil company and the private motorist. The situation is certainly rather peculiar. When motoring and motor-cycling began to develop at the beginning of the century, the retailing of petrol became a profitable side-line for cycle-repairers, tinkers and kerosene-sellers, who naturally came to undertake the selling and repair of motor-cycles and motor-cars. Motoring grew very rapidly, and the profit on petrol still remained very high, thus attracting more and more people to the business. Not only were they naturally attracted by the possibilities of profitable trade, but the rivalry between the oil companies, each intent on having as many points as possible in the country where its particular brand could be bought, actually encouraged the undue multiplication of retailers, and thereby made distribution costs much heavier than was necessary.

The introduction of bulk distribution and the retailing of spirit to the public through pumps caused the race for pump erections and for site representation. Every company wanted to have pumps selling its various grades at

every garage of importance, and, if it could not obtain representation there, sought for another garage as close as possible to sell its products, or even encouraged somebody to start a competitive garage near by and sell them. To-day the motorist has in Great Britain a most convenient distribution system, in that he can pick up spirit at an enormous number of places, but it is not such a cheap system as it might have been, or perhaps might still be. In this country only three main grades of spirit are marketed in large quantities through pumps, No. 1 Spirit, Commercial Spirit and Benzol Mixture. Nevertheless there are many garages with seven, eight or even more separate equipments, representing a considerable capital outlay quite unjustified by the throughput of the pumps. The high rate of profit which has been maintained has caused far too many people to enter the business, including not only bona-fide garage owners, but also confectioners, tobacconists, tea-room proprietors, grocers and ironmongers, who find they can sell a cheap brand of " Pirate " spirit along with their more legitimate activities. Thus, although the profit per gallon has always been high, the throughput per garage has been low, because of the excessive number of dealers. In some areas the position has been made worse by dealers who, in order to attract or retain trade, have been tempted to cut their standard profit and " blackleg " each other until the bottom has been knocked out of the market and the little profit they do make is barely sufficient to cover their operating costs.

A first step in the right direction would be to widen the agreement of January 1929 to cover all companies to the extent of refusing to supply any further retailers who were not genuine garage or filling-station proprietors—in fact who were not in the motor trade. With regard to people who are already in the trade, it would be impossible at this stage to cease to supply any of them merely because they were redundant. It would also be very hard to dictate just who might and who might not enter the motor trade, if he felt so disposed. It is too late to change completely the system of distribution through the garage, whether of spirit or lubricating oil, so that it will obviously be necessary to make the best of the present system, and the way to do this is clearly by agreement on certain fundamentals between all distributors. This should not be difficult, as distributors are relatively few in number, and, up to a point, their

interests are identical. All at any rate prefer distribution to be cheap and prices to be profitable. It would not be possible at this stage arbitrarily to cut down the number of retailers, but it would certainly be possible, and in the interests of the best sections of the trade itself, to limit new entrants by a general agreement according to some recognised principle, such as an understanding that no new garage should be supplied within a certain distance of existing garages, unless a committee, including representatives of the distributors, the local traders, and the motorists, agreed that such a garage was called for by the needs of the district. The number of existing garages might usefully be cut down by a general refusal to supply garages at all which were guilty of not maintaining prices, of selling spirit which was wrongly described, where service at the pumps was not given for an adequate period during the day, or where the garage was technically incompetent. These are mainly faults of areas where there are too many garages. Co-operation of petrol distributors, reputable motor traders and representatives of private car and commercial vehicle owners is obviously necessary before an attack can be made on the unwanted or undesirable garage.

Limiting the number of dealers to the real needs of motor transport will be a slow and difficult task, but may be attempted partly by the weeding out of undesirable elements, as suggested above, and partly through the natural growth of motor transport catching up with the number of garages. The great difficulty is that every company wishes to be represented, often with two or three grades, at every site, and consequently an excessive number of pumps is erected. There is a good deal more than the capital outlay on pumps to be taken into consideration. After erection, pumps still require periodical examination, and must be repainted and repaired when necessary. Unless there is an appreciable throughput, this involves, proportionately to sales, a good deal of unnecessary expenditure. Two facts are, however, clear. The first is that, even after all possible weeding out has been done, there will still be an extremely large number of garages and filling stations to which petrol and oil must be distributed; the second is that all the companies operating will wish to be represented at all these garages. The only possible field for economy here is in the number of companies operating and the number of grades sold. The United States has proved that almost always the road to

prosperity and reduction of costs is by way of standardisation. In some cases it may be better to pay more and retain individuality, but in products such as petrol this is hardly the case. Pressure is likely, therefore, to be along the lines of reducing the number of brands and grades. This can come about in two ways—first, by buying up the smaller distributors and converting the pumps selling their grades to the grades of the purchasing company; secondly, by agreement between the larger companies by which a company weak on benzol mixture, for instance, might agree to hand over its benzol mixture pumps to a company which was strong on that grade. Similar agreements might of course be made to cover No. 1 and No. 3 pumps.

Very little advance will be possible along these lines until there is a general agreement among all companies as to the desirability of moving in this direction, and such an agreement is not yet in sight. So long as there is a state of extremely acute competition in the trade, there will continue to be a scramble by everybody for representation at every possible site, and in these circumstances there is bound to be a great deal of duplication and unnecessary capital outlay, and a much higher cost of distribution than is really necessary. With an agreement it would be possible, first to check pump erections by refusing to supply new pumps except for cash, and then gradually to get the situation more under control and pave the way towards a reduction in distribution costs. Any movement towards rationalisation and standardisation must grow naturally out of the present system. Revolutionary changes, such as the substitution of company-owned for private garages and filling stations, may appear attractive on paper, but it would be quite impossible to-day to change the system so radically; hence speculation along these lines is merely waste of time. Any change contemplated must be evolutionary.

The admittedly large amount of duplication in the distribution of petroleum products might appear to suggest that it is an industry to which some scheme of nationalisation could be applied with advantage. In Spain, for instance, there is a monopoly of the distributing business vested in the State, and at present leased to a group of Spanish banks. This is not exactly nationalisation, but approaches it, and in Great Britain a scheme for genuine nationalisation is far more likely to find supporters than a State monopoly leased to a group of capitalists, an arrangement which is usually

associated with the less highly-developed countries which find themselves in need of obtaining ready money. In Great Britain a State monopoly would be unpopular with all parties, with Conservatives and Liberals because it was quasi-nationalisation, and with Labour because it was not nationalisation, but an extension of capitalist monopolies in a field where they thought nationalisation ought to be introduced. For that reason it is unlikely that it would be tolerated, and it may therefore be excluded from the field of practical politics.

A scheme of nationalisation, if it were attempted, would hardly be likely to meet with the same success as rationalisation along the lines on which it seems to be moving. In the first place, even for a nationalised industry, it would be practically impossible to distribute direct to the public through national filling-stations. The greater part would have to be distributed to the existing organisation of independent garages. These are fairly well organised, and would rapidly develop into a privileged class with a vested interest similar to the tobacconists licensed under the French tobacco monopoly, who are more or less civil servants, and even enjoy a pension. The present trouble is that there are too many retailers, but the State would perforce have to license all of them, on account of the outcry which would otherwise be raised by those who failed to get licences. The garage proprietors are sufficiently organised to prevent the State from side-tracking them and selling direct to the public, which would in any case be inexpedient, on account of the enormous amount of capital already sunk in bulk equipments at garages, and, if their numbers were not reduced, there would be no advantage in this respect over the present system. There might even be disadvantages, as it would be more difficult, on account of the pressure of public opinion, to weed out undesirable garages under a State system than under a rationalised private system.

The second point against nationalisation is that the improvements made possible by rationalisation in the way of reduction in the number of brands and grades being marketed, and the elimination of the smaller companies, all ought to involve a reduction in the number of people employed in the business. A first requirement under any scheme of nationalisation would be security of tenure for all employees. Thus, although the State would undoubtedly cut down the number of brands of motor spirit on the

market, no economy would result, as the industry would be saddled with a lot of " passengers " whose services were not required, and who, under a system of rationalisation as against nationalisation, would gradually be dispensed with.

It might be thought that there would be a saving in the duplication of depot and lorry equipment under a State system, but this is doubtful. The depots and lorries of the larger companies are fully employed at the present time, or if in any cases they are not, the fault lies rather in the incompetence of the local management than in the impossibility of better organisation under the existing system. The smaller companies often distribute rather lightly and uneconomically over a wide area, but these companies would be eliminated with rationalisation.

In Great Britain especially there is a great danger in nationalisation, to all consumers of petroleum products. Oil is in direct rivalry with coal, both in respect of fuel oil and coal, and bitumen and tar. The oil industry constitutes, moreover, an integral part of the road transport interests, as petrol is the main fuel for internal combustion engines, and to that extent is in rivalry with the railways. As both coal and railways are very well organised politically, and control a tremendous number of votes, they would be two of the first industries to be nationalised, and hence would obtain even more power over the State than they have at present, and there would be an enormous temptation to the Government to inflate the price of petroleum products to such a level that their power of competing with coal and the railways would be very much restricted. Since the oil industry represents comparatively few votes, a weak or even an average Government would always tend to place political considerations above economic considerations or those of justice and fair-play. As oil represents a technical advance on coal for many purposes, the effect of such restriction would in the long run be to burden British industry with a much less efficient technical equipment than would have existed had there been no interference with supply and demand. The British economic system, which is still striving to adjust itself to post-war conditions, might not be able to stand the strain of such a burden.

In general, nationalisation may be suitable for a stabilised routine business like that of the Post Office, but it is hardly likely to be equally successful for a business in which innovations have constantly to be considered. The optimum

balance, at any particular time and for any particular product, of distribution in bulk and in packages, in road wagons and in rail cars, has to be considered very carefully, and revised in the light of changing circumstances. It is necessary to keep track of the progress of substitutes for petrol, of technical changes, such as the practicability of lorries using Diesel oil, or the possibility of opening up new markets for benzine and for kerosene, which is adversely effected by the spread of electricity and gas. The fuel oil business is highly competitive, as it is a direct rival of coals; the bitumen business also is competitive, being in rivalry with all other road surfaces, and especially with tar produced from coal. The persons controlling the distribution of petroleum products must possess an alertness of mind and willingness to experiment which has never hitherto characterised Government Departments. Hence the best method of distribution seems to be by way of a small number of large and well-organised private firms (there are now only six major distributors of petrol) co-operating with each other in order to promote the gradual rationalisation of the industry, to facilitate technical improvements, and in certain cases to present a united front to consumers. The presence of a profit incentive insures the right attitude towards improvement and change, an attitude which it is difficult to obtain when this is lacking.

APPENDIX

World Production of Petroleum (in tons)

(As published in "The Petroleum Times")

	1926.		1927.		1928.		1929.	
	Tons.	Per cent.	Tons.	Per cent.	Tons.	Per cent.	Tons.	Per cent.
U.S.A.	109,692,552	70·4	128,023,487	71·9	125,149,361	67·8	144,285,000	68·8
Venezuela	5,327,270	3·4	9,148,164	5·1	15,344,526	8·3	19,285,000	9·2
Russia	8,900,452	5·7	10,284,521	5·8	12,091,556	6·5	13,643,000	6·5
Mexico	12,900,654	8·3	9,119,762	5·1	7,534,288	4·1	6,000,000	2·9
Persia	5,091,448	3·3	5,227,465	2·9	5,511,936	3·0	6,143,000	2·9
Roumania	3,241,165	2·1	3,661,546	2·1	4,438,758	2·4	4,644,000	2·2
Dutch East Indies	2,950,757	1·9	3,628,300	2·0	4,133,850	2·2	4,286,000	2·0
Colombia	915,392	0·6	2,073,905	1·2	2,724,976	1·5	2,915,000	1·4
Peru	1,528,768	1·0	1,392,110	0·8	1,592,263	0·9	1,857,000	0·9
Argentine	930,200	0·6	1,235,853	0·7	1,281,704	0·7	1,286,000	0·6
Trinidad	749,753	0·5	738,709	0·4	1,164,322	0·6	1,171,000	0·6
India	1,249,643	0·8	1,164,829	0·7	1,128,759	0·6	1,214,000	0·6
Poland	796,041	0·5	823,902	0·5	761,575	0·4	743,000	0·4
Sarawak	711,673	0·4	711,792	0·4	739,262	0·4	800,000	0·4
Egypt	171,927	0·1	183,293	0·1	264,233	0·2	271,000	0·1
Japan	269,900	0·2	241,482	0·1	253,524	0·1	257,000	0·1
Other Countries	301,294	0·2	394,190	0·2	603,668	0·3	771,000	0·4
	155,728,889	100·0	178,053,310	100·0	184,718,561	100·0	209,571,000	100·0

U.K. Imports of Petroleum Products by Countries of Origin

	1926. Per cent.	1927. Per cent.	1928. Per cent.	1929. Per cent.
America (Mid.)	29·8	30·3	30·1	26·3
California	10·1	8·4	9·1	9·5
Persia	25·3	26·1	23·9	23·4
Venezuela	9·3	12·4	15·8	14·9
Russia	5·8	4·5	6·9	9·8
Mexico	13·9	12·2	5·2	6·1
Roumania	2·2	2·4	3·9	3·5
Trinidad	0·7	1·8	2·6	2·1
Orient	2·1	1·5	2·0	3·7
Continental	0·8	0·4	0·4	0·7
Peru	—	—	0·1	—
	100·0	100·0	100·0	100·0

U.K. Consumption of Petroleum Products (in tons)

(As published in "Board of Trade Journal")

(Retained Imports, plus Home Production, Refined in U.K., and Shale) [1]

	1926.	1927.	1928.
Benzine	2,256,133	2,295,167	2,710,466
Kerosene	727,179	777,000	662,286
Fuel, Gas and Diesel Oil [2]	2,042,115	2,259,448	2,016,583
Lubricating Oil	360,000	340,281	408,755
Total	5,385,427	5,671,896	5,798,090

[1] These figures do not correspond exactly with total consumption, as there is no record of the stocks on hand at particular dates. They approximately represent consumption, however, when averaged over a period of years.

[2] These figures do not include fuel oil shipped as bunkers, which amounts to about 1,000,000 tons a year, according to the Trade and Navigation Returns, or the consumption by the Royal Navy, which is thought to amount to some 700,000 tons annually.

Motor Vehicle Registrations in Great Britain

	1914.	1919.	1921.	1923.	1925.	1927.	1929.
Private Cars	132,015	109,715	242,500	383,525	579,901	786,610	970,275
Motor Cycles	123,678	114,722	373,200	430,138	571,552	681,410	705,025
Goods Vehicles	82,000	62,000	128,200	173,363	224,287	282,905	318,253
Hackney Vehicles	51,167	44,081	82,800	85,965	98,833	95,676	95,798
Miscellaneous Vehicles	—	—	17,170	32,204	34,536	36,783	41,277
Total	388,860	330,518	843,870	1,105,195	1,509,109	1,883,384	2,130,628

World's Mercantile Marine

Type of Machinery

	1914. Per cent. of Gross Tonnage.	1920. Per cent. of Gross Tonnage.	1923. Per cent. of Gross Tonnage.	1926. Per cent. of Gross Tonnage.	1929. Per cent. of Gross Tonnage.
Sailing Vessels	8·06	5·95	4·34	3·26	2·45
Oil in Internal Combustion Engines.	0·45	1·67	2·56	5·39	9·73
Oil Fuel for Boilers	2·65	16·30	24·23	28·16	28·53
Coal	88·84	76·08	68·87	63·19	59·29
	100·00	100·00	100·00	100·00	100·00

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PRINTED IN GREAT BRITAIN BY RICHARD CLAY & SONS, LIMITED,
BUNGAY, SUFFOLK.