THE FLOORS OF ANCIENT SEAS

The shaded areas in the map on this page are regions geologists believe have potential for oil production. These areas are mainly those known geologically as marine basins. They were the floors of ancient seas.

In the course of geologic time they have been periodically covered by seas. During these periods vast quantities of organic matter from former marine life have been deposited on the floors of these seas, along with mud and sand worked in from adjoining lands. These materials provided the source material, which, when compacted and transformed under conditions still not fully understood, may become oil or natural gas.

Once formed, oil may lie lost entirely by seepage or evaporation. In some cases, however, it collects in natural underground reservoirs. Thus, in the areas shown as potential sources of oil, the exact location of oil reservoirs therein is highly problematic. It is necessary to locate reservoirs exactly.

Of particular significance here is the fact that the only two commercially productive oil fields existing north of the U.S., despite the large potential area shown, are Turner Valley, a short distance north of the U.S. border, and Norman Wells, just south of the Arctic Circle. Between these two lie the enormous Canadian tar sands just north of McMurray, exposed principally by the gorges of the Athabaska and Clearwater rivers.

While geologists can thus classify the regions in which oil may be found, the exact location of underground reservoirs filled with oil is a problem which has challenged the oil industry since its inception. The existence of a producing oil field, such as that at Norman Wells was, therefore, of major importance when a source of oil in the Arctic region of this continent became an immediate necessity.

OIL FOR THE FUTURE

For nineteen hundred years, five young ladies have enjoyed notoriety, not for what they did, but for what they alleged to have done. They were the "Five Foolish Virgins" who allowed their oil lamps to go out before they started to look around for new sources of supply, the results being disastrous.

Whether your business calls for the burning of oil in lamps or the burning of it from the ground, you are dealing in a wasting asset. Having supplied you with light, the kerosene cannot again find its way into the lamp's reservoir; having once been released from its subterranean hiding place, crude oil has left a void which nature does not refill.

There lies the big difference between the animal cell and vegetable kingdom as compared with the mineral. You go out hunting and spare neither shot nor shell, with the assurance that the progeny of your next season's victims will be your target for next year. You carefully glut yourself with the fruits of the tree and field, with the knowledge that there will be a succeeding crop in due season. But the "Ghost Towns" that once echoed to the tread of coal miners and gold diggers and oil drillers are a stern reminder that Mother Nature's prodigality has its limitations and that in certain instances, you cannot have your cake and eat it.

Whatever may have been the sins of omission and commission of the progenitors of the oil industry, those who have inherited the hydrocarbon monster of their creation must be given credit for a certain amount of business acumen and it is not surprising to learn that they have given, and are giving, serious thought to the future and that, if the petroleum industry should ever find itself without petroleum, it will not be for lack of enterprise on their part.

This enterprise follows two main trends: first, the discovery of new sources of supply and, secondly, the utilization of existing supplies to the absolute limit. The present chaotic world conditions exercise a profound and diverse influence on the situation for, because of what has come to be termed 'global war,' vast areas of prospective oil lands are meanwhile unhealthy for the wild-cat drillers and, because of war's demands, never before was so much being wrong

**KNOWN CANADIAN SOURCES OF LIQUID HYDROCARBONS**

- **TAR SANDS**
  - 560,000,000,000,000,000,000 BTUs

- **NATURAL GAS**
  - 6,000,000,000,000,000,000 BTUs

- **CRUDE PETROLEUM**
  - 430,000,000,000,000,000,000 BTUs

- **COAL**
  - 27,140,000,000,000,000,000 BTUs
from a barrel of crude. In the field of discovery, war has retarded development; in the field of petroleum technology, it has been a stimulant. Of course if there are prospective oilfields beneath the present battlefields, they will eventually come to light with the dawn of peace, whilst any refinements in refining will have to be based on a permanent advantage to the industry, but the desperate need for petroleum and the interruption of the normal rate of discovery, both war babies, have resulted in our existing source of supply being exploited to an extent which will hasten the day of their ultimate exhaustion.

It has to be admitted that, in the past, there has been a tendency on the part of the oil industry to cry "Walt". Periodically the voice of the pessimist has been heard in the land, proclaiming the early liquidation of our oil reserves and, just as frequently, new fields have blossomed into being on the blanched fields with the roar of their gushers. But the time will most assuredly come when these warnings will have to be taken more seriously, and compared with the previously limitless possibilities of coals and lignites. Processes for converting coal into petroleum by the chemical addition of hydrogen are widely known and commercially used in England and Germany. The pioneer in this field was Dr. Frederick Bergius, whose discoveries were developed by IG Farbenindustrie. By 1928 high pressure catalytic techniques for coal hydrocarbonation had been perfected on a commercial scale and, at a time of anticipated famine in crude petroleum circles, Standard Oil of New York purchased the patents for these processes, ultimately making them available to the entire petroleum industry. This by no means exhausts the methods, already demonstrated as workable, by which the coal family can contribute to the relief of the oil industry should the need arise.

It would therefore appear that, when even the most pessimistic of the pessimists is right and petroleum is actually taking its last but certain call, there will be no revolution, but merely a readjustment, purgative to meet our needs as far into the future as the eye can see and the question naturally arises as to what part Canada will play in the new economy. Will she still be a poor relation dependent on her neighbour to the South, or will she be more or less self-supporting?

### WHAT OUR GASOLINE BILL WOULD BE
(At Refineries Using Various Processes)

<table>
<thead>
<tr>
<th>Process</th>
<th>Gasoline Production Cost per Barrel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>5.00</td>
</tr>
<tr>
<td>Lignite</td>
<td>6.00</td>
</tr>
<tr>
<td>Natural gas</td>
<td>3.00</td>
</tr>
</tbody>
</table>

### Estimated Investment Required for Plants to Produce 1,000,000 Barrels of Gasoline per Day
- From Natural Gas: $12,500,000
- From Lignite: $15,000,000
- From Coal: $20,000,000

In spite of the oil wells that have waxed and waned over Canada during the past twenty-five years, her possibilities are not yet exhausted. Somewhere in Alberta's far north or in another Turner Valley capable of producing a million barrels a year, nowhere on the Prairies provinces there may be a "Signal Hill" for Canada. The "Cannikin" is a more dim on the map of the vast northern hinterland still to be explored; Ontario once had gushers and may stage a revival of its own and the Maritimes may just be playing hard-to-get. "It's a long line that has no turning" and success may still lurk around the corner for the industrious and the patient.

But when we come to deal with resources from which synthetic products are obtainable there is no great need for apprehension; Canada's stock-pile is impressive and considerable.

First of all, we have the Athabasca Tar Sands, perhaps the greatest surface manifestation of oil in the world. Exposed in high cliffs for miles along the courses of Northern Alberta rivers; met with in bogs over a vast area, are places existing oil under the sun's rays; these sands have been a source of controversy for thirty years, but that will not deter them from being a source of oil. In any new industry, experts talked of a recovery of two billion barrels of oil from the tar-sands (equivalent to the world's entire output for a year) and Dr. Eds, who has devoted a lifetime to a study of this phenomenon, estimated that 750 million barrels could be obtained by open-out mining methods. Experiments in extracting the oil from the sand and its subsequent treatment are now being carried on at the behalf of the Dominion Government. There are admitted difficulties and so long as oil can be induced to flow from wells in adequate quantities it may be economically unwise to enter upon any extensive programme of exploitation of the Tar Sands, but in these Sands Canada has "an ace in the hole" for the synthetic era.

Just on the development of natural gas on the Canadian prairies gave a fillip to the search for oil, so the oil-seeker has uncovered substantial gas reserves for which there is now no present market. From the International Boundary to the Peace River, from the Red Roosie to the heart of the prairies, isolated gun wells have been capped without any definite attempt being made to divert the productive areas of their potentialities. These resources may lie dormant for a while but here again we have a reservoir of extensive possibilities and the liquidation of gas may become a common practice in the not too distant future.

A recently completed Government investigation reports adversely on the utilization of Canada's Maritime oil-shales under present conditions. To meet instances these shales have to be mined and their oil content, while greater than that of the Scottish shales, is not comparable to many known U.S. deposits which can be worked at the surface. Perhaps we should consider the oil-shales as a sort of forlorn hope if the seepage for petroleum substitutes gets really tough, unless richer and more easily mined deposits of the type now known in the Maritimes can be found.

One is almost tempted to use the word "ecological" in referring to Canada's coal resources. They are found from coast to coast and range from anthracites to lignites. Some areas have already been extensively worked but those remain virgin territory with a vast teenage yet untapped and there is a possibility that within our borders there are coal-bearing areas which have not, as yet, been referred to in geological reports.
POWER...

to Strike

from Alaska

In 1920, in the cold, desolate wilderness at the tip-
line of Canada, daring young geologists of Imperial
Oil Limited drilled for oil. They found it. They
called the spot “Norman Wells,” Fort Norman.

During the next twenty-one years not much oil was
pumped from these new finds—averaging less than
80 barrels a day. But it was enough for the needs of
trappers, mines, an occasional airplane, and river
boats which plied the water routes of the Canadian
Northwest when weather permitted.

In May of 1942—five months after jap treachery
at Pearl Harbor—high ranking officers of the U.S.
Army summoned officials of Imperial Oil Limited to
a conference in Washington. Millions of barrels of
gasoline and lubricants would be needed in Alaska.
Convoy of tankers could not be guaranteed—even if
they could get the tankers. Giant trucks trying to
haul gasoline up the new Alaska Highway would eat
up their loads going and coming.

Norman Wells was the only proved source of oil
anywhere near Alaska. Imperial Oil had to find more
oil there, said the Army. And Imperial had to get it
up out of the earth at the rate of thousands of barrels
daily. If they could do that, the Army would take
care of bringing it to the Alaskan Front.

Could Imperial do it? Imperial could try.
Secretly, without a wasted hour, drilling equipment
was assembled, the right men picked. Both men and
material were rushed to the railroad north of Edmon-
ton in time for the Army to transport them to Norman
Wells before lakes and rivers were closed by ice.

By the end of 1942 the miracle had happened.
More oil was produced—enough to insure the Army’s
goal.

“Good work!” said the Army, “but now we want
evemore.” New quotas were set. Those quotas will
be reached. And all of the oil thus far required by the
Army has come from wells on the original Imperial
leases.

The contract? Well, it was “cost” plus “fee.” The
fee was $1,000. Costs for the first quota, about $2,000,-
000; for the second quota, about $2,000,000. That’s
less than the cost of a single submarine. And even
those costs are to be repaid to the Army in oil through
a sliding scale of price.

Everybody connected with Imperial Oil Limited is
proud to be asked to carry out Army orders.

BACKGROUND MEMORANDUM

ON NORMAN WELLS

The entire development of oil supplies for military
purposes in the Northwest Territories of Canada and
Alaska, involving not only oil production but also its
transportation, refining and distribution, has been
referred to as the “Canol Project.” This memo-
randum refers only to Imperial Oil Limited’s activity
in supplying oil for the Canol Project. This is the only
portion of the project in which Imperial Oil Limited
has taken part.

In connection with the project, Imperial Oil con-
tacted to develop oil production of three thousand
barrels a day from its long-existing leases in the
neighborhood of Norman Wells, and from additional
leases in that region, obtained from the Dominion of
Canada, and sold this oil to the U.S. Government
at pipeline terminals near Norman Wells. Subse-
quently, the Army increased its requirement to
twenty thousand barrels a day.

The original requirement has been met and, surveys
are now under way to develop further production to
provide additional oil requested by the Army.

Both the original and supplementary contracts are
drawn on the U.S. Army’s regular cost-plus-fixed-fee
form. In each case the fixed fee is $1. The estimated
cost of the work under the first contract is $2,000,000;
under the supplementary contract, $5,000,000, both
sums in Canadian currency.

All land referred to in this memorandum, from
which oil is now produced, or from which production
is contemplated, is owned by the Dominion of
Canada.

The region where oil is being produced is in the
vicinity of Fort Norman, in the Canadian Northwest
 Territories (see accompanying map). This is on the
Mackenzie River, just west of Great Bear Lake and
within one hundred miles of the Arctic Circle. This
is the only proved oil field in the Far North on this
Continent. This entire geographical region is still
largely an undeveloped wilderness, although there is
a certain amount of mining activity for radium and
other highly critical ores.

Imperial Oil Limited has explored for oil in the
Northwest Territory since 1919 and since then has
invested well over $1,000,000 in exploratory and
development work there. The discovery well in the
Fort Norman area was drilled by Imperial in August,
1930, on land leased from the Canadian Government.
Since then, and until the early part of 1942, a total of
seven wells had been drilled, four of which were small
producers and three of which were dry holes.

Prior to 1942 most of the oil was produced during
the few summer months of each year and was pro-
cessed in a small refinery operated by Imperial Oil
Limited at Fort Norman during the summer. The
products of this refinery were used to supply adjacent
mining operations in the Northwest and for local
needs. The peak-time consumption of products in
that area is small. Imperial Oil’s entire production
from this area in the twelve years following discovery
totalled slightly less than 180,000 barrels. During
the year of highest peak-time production, 1938, the
production, spread over the year, was about 80
barrels a day.

Late in April, 1942, Imperial Oil was asked by the
U.S. Army to discuss with them the possibilities of
increasing the production of oil in the Fort Norman
area. It is assumed that the Army’s request came
because of Imperial’s knowledge of the region, its
long experience in operating under the difficult condi-
tions of climate and accessibility and, of great impor-
tance, its already developed oil production. Imperial
Oil is the only company which has produced oil in the
Northwest Territory in commercial quantity.

As requested, representatives of Imperial Oil met
with Army officials in Washington on April 29th,
1942, and reviewed in detail the prospects for increas-
ing production of oil in the Fort Norman area. The
Army urgently wanted a greater supply of oil in that
area. They proposed to transport this crude by pipe-
line to the vicinity of White Horse, where a refinery
would be built for conversion of this crude into
specific products. Of interest is the fact that the
crude produced at Norman Wells remains fluid at
temperatures far below zero and thus is especially
adapted to transportation by pipeline under Arctic
conditions.

WINTER "1943-44"
Imperial Oil Limited was directed to drill sufficient additional wells to increase, if possible, the production in the Fort Norman area.

Since such additional oil production had no normal commercial outlet, the U.S. War Department, whose military operations required the additional oil, financed the drilling of 70 new wells during the operation, but all funds advanced to Imperial Oil were to be repaid to the U.S. Government under conditions explained in the previous paragraph.

The first oil produced from the wells drilled would be sold to the U.S. Government at $1.25 (Canadian) per barrel. By way of comparison, the cost of delivering U.S. crude oil to the Fort Norman area by then-existing transportation facilities was about $5.60 per barrel. In the U.S., the price of crude oil varies from about $1.00 per barrel to over $2.00 per barrel, with an average price of about $1.25 (U.S.) per barrel.

Imperial Oil would produce oil at the maximum continuous rate consistent with good practice from its four production wells already existing, and process this oil, year-round, in Imperial's local refinery into desired products. The Government would buy these products at a price equivalent to $1.75 (Canadian) per barrel of crude (the $0.50 difference being over the $1.25 crude being to cover Imperial's existing investment in equipment, and the producing cost), plus a price of $0.61 (Canadian) per barrel refining costs for converting this crude oil into products, if such products were desired by the Army.

After purchase by the U.S. Government, 1,000,000 barrels of crude oil, the price paid for further amounts would be reduced to $0.90 (Canadian) per barrel, this price to be maintained until the Government had been repaid all advances made under (b) above. This requirement to be calculated at the rate of $0.75 (Canadian) per barrel.

The U.S. Government would continue to pay $0.60 (Canadian) per barrel of crude produced, but would put aside an additional $0.61 (Canadian) per barrel in a special fund to be explained below.

The extra facilities were no longer required by the U.S. Government, Imperial Oil would have the right to try to negotiate for their purchase within a six-month period at a price to be agreed upon. If this option were exercised, the amount accumulated at $0.75 per barrel in the special fund mentioned above would be applied against the purchase price. Any amount in the special fund not used in exercise of the option would become payable to Imperial Oil Limited.

Imperial Oil immediately took charge of the operation, leasing necessary drilling equipment, finding and organizing personnel and arranging for transportation. River transport, then the only way to get most of the heavy equipment to the drilling sites, opened on June 15th and ceased in September. The equipment required, therefore, had not only to be found, but delivered within a few weeks to the mill-head over 300 miles north of Edmonton.

Some idea of the speed with which this project was carried out may be gained from the fact that within two months of the original discussions in Washington, Imperial had begun drilling on the first of the new wells and drilling operations were never held up because of lack of material on the ground. In addition to the ordinary supply and transport difficulties in obtaining drilling equipment of all kinds and locating suitable personnel in Canada and the U.S., under wartime conditions, this personnel and equipment had to be transported for thousands of miles by the U.S. Army into the Arctic wilderness, using railroads, trucking, river craft and even portage.

Drilling operations in the Fort Norman area have been carried out continuously since July 1942 by Imperial Oil Limited in spite of Arctic winter conditions. This is the first time such operations have been conducted through the rigors of a North Canadian winter. Winter temperatures in this region reach 70°F below zero and have presented extraordinary difficulties. Sixteen wells were drilled by the end of 1942, sufficient to supply the full original production of crude desired by the U.S. Army. By August 1st, 1943, 25 wells, including two exploratory outside the Norman Wells area, had been completed, 20 of which may be classed as commercial producers. This has been achieved in what to many oil men appears an incredibly short period of time. Although production from this field has been satisfactory, not all of the wells drilled have been producers.

Actual drilling of the wells has provided additional data on the probable oil reserve existing at Fort Norman. At first considered to consist of only a few million barrels, it now appears that this field may exceed 5,000,000,000 barrels. This adds field, while large, is not exceptional when considered in terms of major U.S. oil fields. It is about the size of the average major oil field in the United States. Not all of this oil is accessible, since much of the oil-bearing structure lies under the bed of the Mackenzie River. Ordinary drilling equipment and well fixtures would be destroyed here by the river's ice movement. Special drilling and production techniques are being tried to increase the possible recovery.

After it became apparent that production in the Fort Norman area would reach the quantities first desired, the U.S. Army wished additional production. To establish the possibility of such greater production in this area, exploration activities were enlarged, and additional exploratory work has now been under way for some time to enable selection of drilling sites on perspective oil structures.

The sources of consumption normally tributary to the Fort Norman area, for purposes other than military, are quite limited. There has been no market beyond the stated normal amount produced in peacetime by Imperial Oil Limited. Increase in this market depends upon future development of the Northwest area of this continent.
Asphalt makes an ideal surface for air field runways. More than 10 million square yards of asphalt runways were laid in one year for the British Commonwealth Air Training Plan in Canada.

Asphalt is composed of the highest boiling petroleum hydrocarbons. Although the chemical properties of these hydrocarbons are unknown, they can be separated into three groups known as "olive constituents," "resins," and "asphaltene." The olive constituents have the appearance of a heavy lubricating oil. The asphaltenes are exceedingly small black or brown hydrocarbon particles suspended in the olive constituents and resins. The latter are believed to be tarry-like substances intermediate in properties between the olive constituents and the asphalts. The hardness and the softening point of an asphalt depend on the amount of resins and asphaltenes it contains. The smaller the content of olive constituents, the harder the asphalt and the higher its softening point.

Asphalts vary in consistency (degree of fluidity or hardness) from a semifluid to a brittle solid. A solid asphalt may be converted into a liquid by heating, and back into a solid by cooling, without any change in its composition. The properties of asphalts depend on the amount and properties of the olive constituents, resins and asphaltenes present. These properties include:

Chemical Inertia: Asphalts do not react with acids or alkalis. The chemical inertness of asphalt is such that it makes it suitable for battery boxes.

Water Resistance: The ability of asphalts to repel water is one of their most important characteristics. A relatively small amount of asphalt incorporated with substances such as wood, paper, concrete etc. make them waterproof.

Adhesiveness: Ranking in importance with their waterproofing characteristics is the ability of asphalts to act as a cement. As a cement they bind the aggregate (stone, sand, etc.) used in road construction. Asphalt is also commonly used as a cement and as a waterproofing medium in the preparation and laying of roofing materials.

Incubation: Since asphalts do not conduct electricity they are incorporated into compounds used for insulating electric wires and cables. Asphalts are also poor conductors of heat. It was shown in England that the insulating properties of a one-inch layer of asphalt would prevent the intense heat of a thermite incendiary bomb from harming combustible materials beneath it.

Resilience: Certain grades of asphalts are slightly elastic and have some rubber-like in that they can strain without breaking. Many years after exposure to the elements, asphalt will recover their shape after crushing the effect of a blow.
For practical purposes, asphalts are not graded according to the above characteristics, but are graded according to the following properties:

**Softening Point:** Asphalts gradually soften when heated, and do not melt at definite temperature, as do solid compounds of a crystalline nature. Consequently, the softening point of an asphalt is defined as the temperature at which it softens when tested according to an arbitrarily defined test procedure. The softening points of asphaltic materials varies from about 70°F.

**Penetration (Hardness):** The hardness of an asphalt is measured by the distance a standard needle will penetrate into an asphalt at a specified temperature in five seconds. The less the penetration the harder the asphalt. This test, of course, cannot be applied to liquid asphalts.

**Viscosity:** The viscosity of liquid asphalts is a measure of their ability to flow at the temperature at which the viscosity test is made. The viscosity is determined in much the same manner as for lubricating oils. Viscosity is used to measure the consistency of bitumens, whereas penetration and softening point are employed to measure the consistence of semi-solid and solid asphalts.

**Ductility:** The ductility test determines the ability of an asphalt to be stretched out into long thin threads without being pulled apart. This is measured by the distance to which a briquette of the asphalt will elongate before breaking when the ends of the briquette are pulled apart at a specified rate and temperature.

**Susceptibility to temperature change:** The susceptibility of an asphalt is a measure of the degree of softening at a specific temperature. For instance, an asphalt which softens at 70°F is more susceptible to temperature changes than an asphalt which softens at 100°F.

**Manufacture of Asphalts from Crude**

As described in the *Imperial Oil Review*, Fall, 1943, crude petroleum is first distilled in a bubble tower, which produces red cake as a bottom product or residue. This is the starting material in the manufacture of asphalts from crude. If the red cake residue contains lubricating oil fractions which are to be recovered, it is heated and passed into a second bubble tower which is maintained under very low pressure or vacuum. Here the lubricating oils are recovered from the heavy bottom product which is an asphalt. This heavy residue may be a heavy liquid, or may have a softening point of 100°F, or higher.

The consistency of this heavy asphaltic residue may be too low for many asphalt uses. Consequently it is further processed by "reduction" and "oxidation" to raise the softening point as desired. As the softening point is increased, the asphalt of course becomes harder as indicated by its penetration at room temperature.

Certain reduced crude contain exceptionally large amounts of asphalt. Reduced crude from such crudes contain little if any suitable lubricating oils, and consequently there is no use to a vacuum bubble tower for their recovery. Instead, the asphalt is separated from the lower boiling point fractions of the reduced crude in shell stills, or in a first roll furnace and flash drum unit. The latter is the more modern continuous method. Reduced crude or the asphaltic bottom product from vacuum distillation tower producing lubricating oils from reduced crude, is passed through the coils in a furnace where it is heated to the desired temperature. The higher the temperature the more oily constituents flash from the asphalt when the steam discharges into the flash drum. The flash drum is an evacuated vessel where the vapourised oil part company with the unvapourised asphalt that collects at the bottom of the drum. Steam injected into the bottom helps to strip off the asphalt. This method is described later since it is also used in the manufacture of asphalts from eroded residues.

Shell stills are used to produce reduced asphalt by batch operation. A batch of reduced crude is charged to a shell still and heat is applied by fires underneath. The still is brought up to a temperature of approximately 500°F. Steam is blown into the still to aid in stripping oils from the asphalt. The steam, injected into the bottom of the still, stirs the asphalt, thus preventing overheating near the bottom plates. The chief purpose of the steam, however, is to vaporise the asphalt to strip off all the still the oil vapours that accumulate in the space above the liquid. This method of processing reduced crude is called "fire and steam reduction". The longer the operation is carried out, the higher is the softening point of the asphalt remaining in the still. In this process it is possible with some reduced crude to produce asphalt with a softening point of 225°F, by the use of higher temperatures and continued use of the stripping steam. However, since the higher softening point is obtained by removing oily constituents, the volume of asphalt remaining in the still decreases with increased softening point.

By oxidation it is possible to increase the softening point of an asphalt to any desired degree without materially reducing the volume of the asphalt. Consequently, frequent refining practice is to reduce the asphalt until it has a softening point of about 75°F-100°F, and then subject it to the oxidation process to produce grades with higher softening points.

On the other hand, the characteristics of a finished asphalt product can be altered markedly by varying the proportion of reduction and oxidation used in its manufacture. Therefore, the amount of reducing versus oxidation is governed largely by the property required in the finished product.

**Oxidation**

In the oxidation process oxygen of the air is combined with some of the components of asphalt. The oxygen combines with some of the hydrocarbon atoms of the asphalt molecules to form water, which is removed as steam. The removal of hydrocarbons is believed to convert oily constituents to resins and asphaltenes. As this way the softening point is increased by increasing the proportion of resins and asphaltenes in the asphalt and not by stripping off oxygen. Consequently there is need to use a scrubber stack where a water spray enhances any oil components. These are recovered.

In the process described above both reduction and oxidation take place in the same unit. Where it is desired to increase the softening point of the bottom product of a vacuum bubble tower, the material may be pumped to a shell still and oxidized as described above. Also, instead of using a shell still, oxidation may be carried out by means of a Pipe Coil Furnace and Oxidizer, which is a tank some 10' in diameter and 35' high. In this process asphalt usually about 75°F softening point is pumped through the Pipe Coil Furnace where it is oxidized at approximately 475°F. The heated asphalt then passes into one of several Oxidizers. When an Oxidizer is charged the flow of asphalt is cut off at the bottom of the tank an arranged of perforated pipes called a "spider". As in the shell still, steam is intro-
PRODUCTION OF ASPHALTS

THE FLOW DIAGRAM—The flow diagram shows, in much simplified form, a typical asphalt plant. Many smaller parts such as containers, pumps, screens, preheaters, etc., have been omitted. In particular, thevalves, lines of installation and steam heating coils necessary to keep the asphalt in a liquid state for handling have been shown.

Many types of solid and liquid asphalts are produced in our asphalt plants. These asphalts originate in both crude petroleum and cracked residues. The latter is the heavy residue formed in the manufacture of cracked gasoline.

All asphalts are composed of three types of hydrocarbons, called “oily constituents,” “waxes” and “asphaltene.” The oily constituents are heavy, lubricating oily, the asphaltenes are exceedingly small black solids suspended in the oil constituents. The resins are believed to be hard, tacky-like substances, intermediate in properties between the oily constituents and the asphaltenes. The hardness and the softening point of an asphalt depend on the amount of oily constituents present. The smaller the content of oily constituents, the harder is the asphalt and the higher its softening point.

MANUFACTURE OF ASPHALTS FROM CRACKED RESIDUES—Cracked residues have the appearance of a heavy black oil. Asphalt is produced from cracked residues by a distillation process known as “oxidation.” The cracked residue is passed through a Flash Coil Furnace wherein it is heated to a temperature of 700° F., at which point it is sent into a Flash Drum which is essentially a large vertical vessel fitted with a flat bottom and a conical top. The distillate, or vapor, is removed continuously under a very low pressure or vacuum and into the bottom of which steam is injected. The desired quantity of oil constituents flash into vapor and are removed overhead from the Flash Drum to be condensed into a heavy gas oil. The material left at the bottom of the Flash Drum, when cooled, is a solid with a melting point of approximately 110°F., known as liquid asphalt base. This is usually mixed with a solvent of the gas oil, kerosene, or gasoline type to form some of the grades of liquid asphalts.

MANUFACTURE OF ASPHALTS FROM REDUCED CRUDE—Reduced crude is the usual starting point in the manufacture of asphalt from crude oil. As was the case for cracked residues in reduced crude is denatured or “reduced” until sufficient of the gas oils and lubricating oils are removed to leave a residual product with the properties of an asphalt. This usually has a softening point of 150°F., or less and may be used in certain types of paving. Many asphalts require materials with higher softening points. Higher softening points may be obtained by “oxidizing” the asphalt obtained from crude.

OXIDATION—The oily constituents in an asphalt, the lower is its softening point. Oxidation increases the softening point of an asphalt by converting the oily constituents to wax, and the waxes to asphaltenes. This is done by a process in which hydrogen atoms of the asphalt molecules are caused to combine with oxygen of air to form water.

In the oxidation process, asphalts with softening points of 75°F. to 100°F. are pumped through a pipe coil where they are heated to approximately 475°F. The heated asphalt passes through the Oxidizer, which is a inert steel tank. On the Oxidizer is charged, the flow of asphalt is diverted to another Oxidizer. It is then blown in at the bottom of the first Oxidizer. The operation is carefully controlled to maintain a temperature set at 500°F. Steam is introduced at the top as a safety measure. When oxidation has been sufficiently continued to produce the desired softening point, the batch of asphalt is pumped to storage or shipped directly. The heavy asphalt cools and solidifies. The asphalt base is then mixed with a solvent of the gas oil, kerosene, or gasoline type to form some of the grades of liquid asphalts.

MANUFACTURE OF LIQUID ASPHALTS—Liquid asphalts form a series of products that may be subdivided into two main groups: (1) those containing relatively non-volatile liquids such as naturally occurring oil constituents or added gas oil, and (2) those containing added volatile liquids of the kerosene or gasoline type. The first take a long time to “cure,” or set to a solid and are known as Slow Curing or S.C. asphalts. The second is subdivided into Medium Curing (M.C.) asphalts and Rapid Curing (R.C.) asphalts. M.C. asphalts are mixed with an “cut-back” with kerosene or a similar material. R.C. asphalts are cut-back with gasoline or a similar volatile solvent.

Cut-back asphalts are made by mixing the desired solid asphalt (called the base) with the proper amount of the proper solvent or cut-back. This is done by passing the base and cut-back at about 300°F. through a mechanical mixer and then it into a mixing tank, where the mixture is further mixed by drawing liquid from the top of the horizontal tank and pumping it into the bottom through a perforated pipe. The liquid asphalt is shipped from the mixing tank in tank cars or tank trucks.
duced at the top as a safety measure. The operations carried out in the Oxidizer are the same as in the shell still.

Frequently an Oxidizer is equipped with a cooling coil which permits better control of the oxidizing temperature. Cooled oil is circulated by a pump through a coil of pipe immersed in the asphalt. The oil leaves the coil after picking up heat to enter a cooler where it gives up the heat. The cooled oil is then recycled to the Oxidizer.

**MANUFACTURE OF ASPHALTS FROM CRACKED RESIDUE**

Cracked Residue has the appearance of a heavy black oil. They are made by the cracking operation whereby fractions of crude petroleum are converted by high temperatures into a material very similar to the theoretical crude petroleum. In fact the total product from a cracking coil is commonly called "synthetic crude petroleum." Consequently the heavy cracked material remaining after cracked gasoline and cracked fuel oils are removed is very similar to the asphalt in natural crude. The properties of the asphalt in the synthetic crude, while in general the same as asphalt from natural crude, differ sufficiently to make it particularly useful for certain asphalt products such as liquid asphalts for low cost road construction.

The first step in the manufacture of asphalts from cracked residue is to heat the tar in a pipe coil furnace. It is then discharged into the side of an evaporated flash drum. This is essentially an empty drum or small tower some 16 feet in diameter and 25 feet high. Here the low pressure aided by steam, injected into the bottom of the drum strips sufficient of the oily constituents from the tar to produce an asphalt of any desired viscosity, from a liquid to a hard solid. This operation is known as "vacuum and steam reduction." This reduction operation may be stopped at various stages to provide residues of the different consistencies required for dust layer, blenders for the construction of low cost roads, bases for the production of cut-back asphalts, etc. These residues are not subjected to oxidation as far as the manufacture of asphalts for road construction are concerned. They may be cracked, however, to produce special asphalts such as emulsifying binder, which is used to emulsify powdered coal into briquettes for fuel.

**MANUFACTURE OF LIQUID ASPHALTS**

Liquid asphalts are those that are liquid or almost liquid at ordinary temperatures. They can thus be mixed with other materials such as aggregate with little if any heat. After standing for some time many of the liquid asphalts will change to a solid or "cure" thus cementing together the material with which it has been mixed.

One type of liquid asphalt, however, known as Slow Curing or S.C. asphalts increase in consistency or cure very slowly, without setting to a hard solid. Such asphalts, when used in the construction of low-cost roads, require a "graded aggregate". The stability of this type of pavement depends on the grading of the aggregate rather than on the cementing properties of the asphalt. Graded aggregate is that in which the spaces between the larger stones are filled with the next smaller stones and so on until the smallest sized particles are dust.

S.C. asphalts are made in five grades numbered from 1 to 5, ranging in fluidity from a heavy syrup to practically a solid. The various fluidities result from the amount of oil in the asphalt. S.C. asphalts are made by:

1. Controlling the amount of oily constituents flashed or distilled during steam or vacuum and steam reduction of cracking coil tar or asphalt from crude.

2. Adding gas oil in the desired amounts to solid asphalts obtained from crude or cracked residues. The addition of a petroleum solvent such as gas oil, kerosene or naphtha forms a liquid "cut-back" asphalt.

Since gas oil evaporates very slowly, asphalts cut-back with this material take a long time to cure. Other liquid asphalts will cure to a solid asphalt in a relatively short time. These are known as Medium Curing (M.C.) and Rapid Curing (R.C.) liquid asphalts. These are made by adding a volatile petroleum product such as kerosene or naphtha (gasoline) to solid asphalts from crude or cracked residues. Asphalts from cracked residue known as road base oil or liquid asphalt base is commonly used in the making of liquid cut-back asphalts. After these liquid asphalts are mixed with aggregate or other material, the solvent evaporates, leaving a solid asphalt. Since the asphalt is a solid, with definite cementing properties, the need for a graded aggregate to form a stable road is not so great.

M.C. liquid asphalts are made by cutting back with kerosene or a similar petroleum product. R.C. liquid asphalts are made by cutting back with more volatile naphtha or cracked gasoline.

The cut-back solvent is added to an asphalt base by pumping both the desired base and the cut-back through a mechanical mixer such as a turbo-mixer. The cut-back and base at about 170°F. are stirred together by the rotating vales of the mixer and then discharged into a horizontal tank used for further mixing and storage of the particular grade of liquid asphalt being made. Mixing takes place in the tank by pumping liquid from the top of the tank and returning it to the bottom through a perforated pipe that extends the length of the tank. This is called "circulating on the tank". When thoroughly mixed as indicated by control tests the liquid asphalt is pumped from the mixing tank to tank car or tank truck.

**BRITTON OSLER PASSES**

BRITTON OSLER, K.C., one of Canada's eminent authorities on corporation law and senior partner in the firm of Osler, Hoskin and Harcourt, passed away on December 11 last.

During his distinguished law career Mr. Osler had gained an international reputation. Counsel for Imperial Oil Limited for nearly 30 years, he also served as counsel and director of several enterprises, including the International Nickel Co. of Canada, Ltd., the Bowden Co. Ltd., and the Texan Gulf Sulphur Co.

Mr. Osler was born in Toronto on July 5, 1874, son of the late Mr. Justice Peter Samsung Osler, of the Court of Appeal for Ontario, and the late Mrs. Henrietta Smith Osler. He received his education at Upper Canada College, Royal Military College and Dugdale Hall. After reading law with Moret, Aylesworth, Barwick and Wright in Toronto, he was called to the Bar of Ontario in 1897, and 15 years later was created a King's Counsel.

In 1937, he joined the firm of his uncle, B. B. Osler, K.C. —McCartney, Osler, Hoskin and Creelman—and became a member the following year. His entire career was spent with this firm.

Surviving Mr. Osler are his wife and three sons, Major Britton Michael Osler, R.C.A., overseas, and Major John Gwyn Osler, R.C.A., and Major Campbell Revere Osler, R.C.A., both with the Central Mediterranean forces, and a daughter, Miss Henrietta Osler, at home.

To the family of the late Britton Osler, his friends and associates at Imperial Oil Limited extend sincere sympathy.
WOMEN ON THE OIL FRONT

WITH more than 1,500 Imperial Oil employees in the Services, women have taken over many of their duties in the Refineries and the Laboratories. Here the camera catches some of them at their work.

In the mechanical shop, Sarnia, women are engaged in war work, welding. (Right) Miss Marion Hall operates a trimming machine.

Converting lithographed cans from civilian to army use, Miss Constance Jay and Mrs. Dorothy Kettle, Sarnia, spray the cans with a neutral coloured paint.

At Dartmouth, N.S., Miss Paul Linton and her sister, Miss Dorothy Linton, are employed in the refinery storehouse.

Many women are employed in the laboratories. Joyce Chong (left) is engaged in testing lubricating oils at Sarnia. At Inco, B.C., Miss Marion Robson (right), B.A., in Chemistry, does advanced testing and research work.

Left to right: Mrs. Helen Kerr, Mrs. Jean Sheean, and Mrs. Doris Kettle (lll), label and pack bottles of specialty oils at Sarnia.

Miss Shirley Mercier, Sarnia, checks out barrels of aviation oil which have been loaded into a freight car.

In the drum plant of Sarnia, Mrs. Doris Towler and Mrs. Alice Stevenson are inserting tags in drum heads.

Left: Miss Violet Allerenshaw and Miss Joan Carpenter.
MISS EILEEN KNIGHT
NOW SERVING OVERSEAS

The young lady whose picture appears to the left is Lance-Corporal Eileen Knight, the first Imperial Oil girl in uniform to be sent overseas. Formerly with the Comptometer Department of the Treasurer's Office at Sarnia, Miss Knight joined the Canadian Women's Army Corps in December of 1941, and reached England in the early Spring of 1943. She is now stationed in London.

The photograph shows her unit being inspected by Princess Mary (Eileen at extreme right), whilst the smaller picture is a reproduction of Eileen as a "cover girl" on the English magazine "Woman's Own."

Eileen has two brothers in the R.C.A.F., both of whom were employed formerly at the Sarnia Refinery. Grant is still in Canada, but John is overseas and he and Eileen have had good fortune to meet on several occasions. A younger sister recently joined the staff of the Sarnia office.

SARNIA REFINERY ELECTS LADY DELEGATE

The first woman in the history of Imperial Oil refineries to be elected a delegate to a Joint Industrial Council is Miss Lillian Northrup, who is pictured below. Miss Northrup, who represented more than 160 women employees of the Sarnia Refinery of Imperial Oil Limited, was elected a delegate on September 1st of last year.

Sarnia Refinery's lady delegate was born in Sarnia, and attended public school and high school there. On graduating from high school she took a Government course in welding and joined Imperial Oil Limited on January 22, 1945, as a welder in the drum plant. Her father, Mr. F. W. Northrup, is chief welder at the Number 3 Plant of the Sarnia Refinery.

OIL FOR THE FUTURE

(Continued from page 3)

Depending on the particular process of hydrogenation, the gas can be recovered from as little as one-half ton of coal. Canada's pre-war coal output was around 18 million tons per annum which would represent quite a substantial amount of gasoline. Still more reassuring is an estimate, from Government sources, that Canada has reserves of 1,284 million tons of coal of every shade and variety, her resources only being exceeded by those of the U.S.A. and China.

As long as men can drill holes and get free-flowing petroleum in sufficient quantity, no matter in what part of the globe, economic considerations will demand its continued use, but it is comforting to reflect that should Nature's bounty show signs of exhaustion, we will not be caught short. If and when these things shall be, it need occasion no surprise if Canada is able to supply her entire needs of petroleum, which she lacks by a wide margin to do-day.
Oil IS Ammunition
...Use it Wisely!

“In one day we had 367 planes leave an airport on the Atlantic for the other side and each required 1,000 gallons of gasoline.

... On the Pacific Coast others are taking off for Russia, all requiring 100-octane gasoline.

... Not a plane has been grounded in Canada, not a ship tied up at the dock, not a machine tool held up, for lack of petroleum supply.”

—from a speech by the Canadian Oil Controller at the 30th Annual Meeting of the Canadian Automobile Association.

BOMBERS FOR BRITAIN. Lining one of the giant runways of the great Goose Bay air base in Labrador, Flying Fortresses prepare to hop off for Britain. NATIONAL FILM BOARD PHOTO.