DISCOVERY BOOKS

Edited by John Hampden and Freda Holmdahl

GREAT CANALS

No. 14

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GREAT CANALS

by

T. C. BRIDGES

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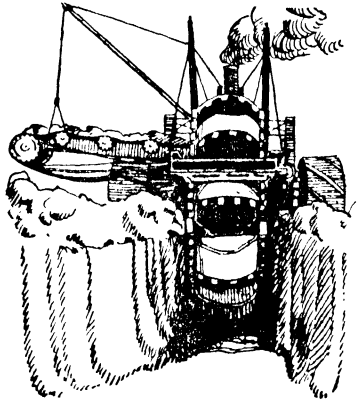


ILLUSTRATIONS

The map showing the network of English canals has been drawn up with the courteous assistance of the Grand Union Canal Co.

GREAT CANALS

CHAPTER I

THE FIRST CANALS—FRANCE LEADS THE WAY—THE FATHER OF ENGLISH CANALS

THE word "canal" at once brings up a picture of a stretch of smooth water with a towpath bordered by a hedge and a quiet old horse plodding along at three miles an hour, towing a long narrow barge deeply laden with coal or bricks or some other form of heavy merchandise. A man stands in the stern with a pipe in his mouth and one arm on the tiller; long ripples stretch out behind the slowly moving barge. It is all extremely quiet and peaceful.

A canal can, however, present a very different picture. Take, for instance, the Plymouth leat which brings water for the city from little streams high on Dartmoor. It comes racing swiftly over a sandy bed, clear as crystal, full of small trout, here and there tumbling down a tor side in foaming falls. Yet it is nothing but a canal, an artificial waterway.

Of a very different type are the great ship canals, the Manchester, for instance, or the broad channel

connecting Bruges with the sea. In these you may watch great cargo steamers, still white with brine from the sea waves, steaming up into the heart of the country; and, here again, is something completely different from the ordinary canal of one's dreams. Then there are the drainage canals, of which many miles exist in our own Fen country, in the marshy lands of Somerset, in Holland, and in that flat stretch of Portugal south-west from Lisbon. Often these run between high embankments and discharge their water through sluices into the sea.

The oldest form of canal is, of course, the irrigation canal, which was originally a runnel dug from a stream or river to water a garden or rice patch. There are to-day thousands of miles of these. In India great tracts that once were deserts are now watered by such canals, and bear rice crops. In Southern California are hundreds of square miles of orange groves and orchards which depend entirely on water brought by canals from distant mountains. Egypt, Persia, China, Japan, all have these useful channels.

The waterway for navigation purposes grew, no doubt, out of the irrigation canal, and may have originated, like so many useful inventions, in China. We know that China's Imperial Canal, more than a thousand miles in length and connecting forty-one different cities, was begun in the thirteenth century. This is the oldest canal in the world which possesses locks.

The earliest canals had no locks. They were like the Suez Canal of to-day, or the Corinth, cut through flat country. We have no idea of the name or history of the clever man who invented the lock, but it was he who made the modern canal possible.

The oldest of European canals is the Languedoc, known as the Canal du Midi, which was finished in 1681, and opened by the French king, Louis XIV. A most amazing piece of engineering, for it crosses the whole of France from the Bay of Biscay to the Mediterranean, and for one-sixth of its length is cut through mountainous country. It is thirty feet wide, about six feet deep, rises to over six hundred feet above sea-level, and has no fewer than one hundred locks. In 1881 Admiral Lord Clarence Paget took his steam yacht *Miranda* through this canal from one sea to the other. The *Miranda* was eighty-five feet long, eleven feet beam, and drew four feet eight inches of water.

To Pierre-Paul Riquet France owes this wonderful canal. Like most men of his type who are centuries ahead of their fellows, Riquet was jeered at, ill-paid, half starved, and died of a broken heart before his work was completed. It was Vauban, the great military engineer, who insisted that a memorial should be raised to him, and to-day a tall obelisk towers near the entrance to the canal. It is not unlike that which rises among the Buckinghamshire beech woods to the memory of the Duke of Bridgewater, father of English canals.

In England the first canals were made by the Romans, but the first of truly British canals was the channel joining the Trent with the Witham, made under Henry I. in 1134. After that we have a gap of centuries, during which little or nothing was done, either in the way of digging canals or improving existing waterways. It was in 1609 that the New River was begun. This, as most people know, is the channel which brings a large part of its water supply to London. It was finished in 1613.

In those days the Thames was a wide, shallow river bordered by marshes. At low tide it was actually fordable at Westminster. Even small boats could not go far up the river from London. In 1634 the channel was cleared and made navigable as far as Oxford. Then again came a long period during which the question of canals was talked about, yet nothing was done.

The need was there and was great. In fact, never was any country in sorer need of some form of transportation than England in the early eighteenth century. The roads, even the highroads, were so terribly bad that coaches took a fortnight to get from London to Edinburgh. People who lived in the village of Kensington could not reach London because of the sea of mud that lay between. Even on the way to St. James's Palace the King's coach was bogged.

In the country nearly all goods—even coal—were carried on the backs of pack horses, and to move five

hundredweight of coal a mile cost half a crown. One consequence was that food was terribly expensive. While labourers were paid only sixpence to ninepence a day, bread cost more than it does to-day. There might be plenty in one county and absolute famine in the next. Every thinking person deplored this state of things, yet nothing was done until the Duke of Bridgewater took the matter in hand.

Francis Egerton, third and last Duke of Bridgewater, was born in 1736. He was a weakly, feeble lad not only in body but also in mind. In fact he was looked upon as practically an idiot. Yet he grew up to become a great benefactor to his country. When he was twenty-three he fell in love with one of the beautiful Miss Gunnings. She and her two sisters were the most lovely women of their time, and had the world at their feet. She laughed at the poor, clumsy, plain-faced Duke, and he, in despair, left London and went back to his northern home, where he busied himself with developing the coal mines on his Lancashire property. The seams of coal were rich and near the surface; the difficulty was to get the coal to market. Manchester, already becoming a manufacturing town, was only ten miles away, but there was not even a decent road across the boggy land which lay between the pits and the city; and it actually cost more to carry the coal across those ten miles than it would cost at present to carry it from Liverpool to New York.

The Duke thought of the construction of a waterway, called in those days a "navigation," between his pits and Manchester. It is worth mentioning here that the word "navvy," now generally used for the men who construct new railways, is derived from "navigators," meaning the men who worked on the early canals.

The Duke had seen the Languedoc Canal, which we have already mentioned, and he realized that a waterway to Manchester would solve his problem. The difficulty was that the river Irwell interfered. The Irwell at that time was so shallow as to be impassable for any but quite small boats, and the canal would have to cross it. One river would have to run through or over another. The Duke knew nothing of engineering and had to find a man who did. He picked upon James Brindley, son of a Derbyshire farmer.

In those days there were no schools of engineering; no clever young graduates eager for a job, and at first sight Brindley seemed even less likely to be capable of the work than the Duke himself. James Brindley had served as apprentice to a millwright. Then he had started in business as a repairer of old machinery, and had made a name in the district for his clever contrivances in pottery works and silk factories. He could read, but writing was difficult to him. He drank more than was good for him, preferred bull-baiting to steady work, and neglected his family. Every one prophesied that he would come to a bad

end, yet the Duke chose wisely, for Brindley lived to become the " father of inland navigation."

He did all his work in his head, and when he had some specially difficult problem to solve it was his practice to go to bed and think it out. When the whole thing had slowly formed as a sort of picture in his head, up he would get and go straight back to work. He never put any figures down on paper, but he had a most amazing memory. The Duke paid him a pound a week, and for this absurdly small wage Brindley built the canal.

Brindley without doubt was a natural genius, and he had two very valuable qualities—great perseverance and a complete faith in his own judgment. His diary still remains to us. The spelling may amuse the reader, and the queer crabbed writing is very hard to read, yet the diary as a whole gives wonderful proof of the writer's dogged determination.

A duke is a personage, even to-day ; he was much more so in the eighteenth century. But Brindley had no respect for the Duke's judgment, and said so. To build this canal it was necessary to cross the river Irwell. The Duke explained his plan, which was to drop the canal to river level by a series of locks, then raise it again on the far side by similar means. Brindley would have none of it.

" We'll put her across on a bridge, Your Grace," he declared. Such a thing had never been done before in the whole history of engineering, and the Duke was

very doubtful as to whether such a scheme was possible. It is very much to his credit that he allowed Brindley to proceed. Others were not so polite. They roared with laughter or sneered openly, and prophesied that such a piece of work was out of the question. One river crossing another ! Who ever heard of the like ?

Remember, Brindley had none of the steel girders which would nowadays be used for such a feat of engineering ; there was none of the modern cement at his command. He had to work with bricks and mortar. Yet he built his aqueduct, and derision changed to admiration when barges began to pass and the structure showed no signs of collapse. It did not even leak. The pack horses were dispensed with, and the price of coal in Manchester fell to half the sum it had been before the canal was completed.

The success of the first canal was so great that the people of Liverpool at once began to clamour for an extension which would bring the coal into their city, so the Duke secured powers from Parliament and went ahead. Local landowners made much trouble, and the canal itself proved a far more difficult task than had been anticipated. Much of the ground was boggy, and in some places tunnels had to be cut. Before the first section was finished the Duke was very nearly ruined. In all he spent £220,000 before his canal reached Liverpool, yet he lived to see his project bring him a return of £80,000 a year and make him almost the richest man in England.

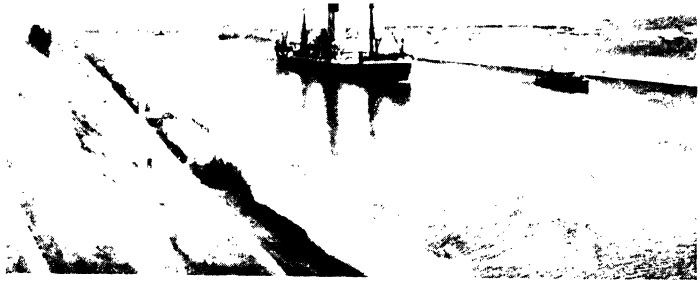


Photo: Mondiale.

The Suez Canal, giving an idea of the sandy desert through which this cut was made.

[Photo: Topical.

A canal barge passing along the aqueduct connecting the Trent and the Mersey Canals.

The Staffordshire potteries were the next to demand a waterway. Josiah Wedgwood, father of English pottery, was one of the first to realize the value of a canal which would bring coal to the door of his factory, and Brindley was engaged to survey a route for the new canal.

The difficulty was that the canal had to cross the Pennine Chain, which separates Staffordshire from Cheshire, and Brindley boldly decided in favour of a tunnel a mile and a half long. This was another new experiment in engineering, for no such tunnel had ever been cut in the British Isles or, for that matter, in Europe.

The difficulties were immense. True, the workers had gunpowder, but no other form of explosive, and, of course, pneumatic drills were still an invention of the far future. Again expert opinion was that it could not be done; but Brindley vowed it could, and, after eleven long years of dogged hard work, proved himself right. The tunnel, pioneer of many similar ones, still exists. It is simply a long culvert just wide enough for a single barge. There is no tow path, and barges are propelled by men who lie on their backs on the deck and push with their feet against the walls of the tunnel. They call it "legging."

The success of the new canal was immediate, and the cost of sending goods from Liverpool to Etruria, where Wedgwood's new works stood, fell from fifty shillings to twelve and sixpence per ton. Traffic

increased so rapidly that soon the two mouths of the tunnel were perpetually blocked by fleets of barges anxious to get through, and there were really serious fights among the bargemen in which more than one man was killed. The end of it was that the great Scottish engineer, Telford, was called in by the Company to construct a second tunnel, and this he completed within three years. The second tunnel is much larger than the first, and has room for a towing path alongside the water channel.

Meantime Brindley got busy with a canal connecting the Trent with the Severn, and it was this canal which put Birmingham on the map. In those days Birmingham was a village of ironworkers which had not even a carriage road. Letters were addressed to "Birmingham near Coleshill," the latter being the nearest place on the highroad.

Brindley's last work was the surveying of a route for a canal from Leeds to Liverpool, but although this was started in his lifetime, he died long before it was finished. The wars with France, as well as the difficulties of construction, delayed its completion, and it was not until 1816 that this canal was opened.

The success of the first canals started a canal craze. It began about 1790, and within the next ten years eighty-one Bills for new canals were passed through Parliament. Some, of course, were either foolish or fraudulent projects, but those that were genuine and well managed paid amazingly. We read of £100

shares paying their lucky owners £140 a year, and of £200 shares in another canal company selling for £4,600 each.

The seventeenth-century poet Waller, who must have been something of a prophet, wrote :

> " It is of more renown
> To make a river than to build a town."

And, by all accounts, the new canals did wonders for England. The carriage of goods between Manchester and Liverpool, which had been forty shillings a ton, fell to twelve shillings, and, later, to six shillings. In consequence, within ten years trade between the two cities quadrupled. After the Duke of Bridgewater's death his canal was sold to the Bridgewater Navigation Company for a sum of just under a million pounds, and, later, it was bought by the Manchester Ship Canal Company for £1,710,000.

Canals increased so rapidly all through England that by 1830 there were very nearly four thousand miles of them on which more than fourteen million pounds had been spent, but of these only 230 miles were fit to carry boats of ninety tons or over, while fully two thousand could not carry barges of more than thirty tons. The trouble was that there was no uniformity. Each company built the type of canal which suited its trade or its pocket. Width, depth, size of locks were widely different, and so was the system of tolls. The result was that barges were unable to move freely over the

whole system. Indeed many canals were not connected up with other systems. It was rather as if each railway company had built its lines with a different gauge, so that the trucks of one could not travel on any other.

Therefore, when railways came in canals went out. Some of them became absolutely derelict, and at present there are over four hundred miles of English canals which are quite out of use; given up to moorhens and other wild birds, and to anglers. A barge is never seen on them.

Of late years an attempt has been made to revive and reorganize British canals. Of this we shall have more to say in another chapter.

CHAPTER II

THE FIRST OF THE GREAT SHIP CANALS—THE SUEZ

At a date even before the Siege of Troy Egyptians, under Rameses II., were busy cutting a canal between the Mediterranean and the Red Sea. So at least tradition tells, and the story is that the ditch was actually completed so that the little craft of those early days could pass through it.

Many centuries later, in or about 450 B.C., Pharaoh Necho commenced a new canal which branched out of the Nile and traversed the desert to the Gulf of Suez. Then, so Herodotus writes, a soothsayer, whom the king consulted, declared that the canal, if completed, would be of benefit to the barbarians, and Pharaoh stopped the work. It was continued by Ptolemy II., who finished it, and was afterwards restored and improved by the Roman Emperor Trajan.

This must have been a real canal, for we are told that two galleys abreast could pass down it, and that it carried the riches of Egypt to the East and to the West. In the dark ages following the eclipse of the Western Roman Empire this canal went to ruin, and

was filled with blown sand, yet to this day traces remain. After that some fifteen centuries elapsed before the project of making a waterway across the Isthmus of Suez was revived. Napoleon saw the need, and French engineers took levels across the isthmus in 1799. They must have made a hash of their calculations, for they announced that the level of the Mediterranean was *thirty feet below* that of the Red Sea.

Napoleon's defeat in Egypt put a stop to the project, and it was not until 1847 that a fresh survey under M. Talabot and that great English engineer, Robert Stephenson, showed that the two seas had exactly the same mean level. M. Talabot, returning to France, published his plans for a ship canal, but it remained for another Frenchman, M. de Lesseps, to get things done.

De Lesseps was a personal friend of the Pacha, and presently turned up in Paris with a "concession"—that is, a document giving him the exclusive privilege of making this canal. De Lesseps would have welcomed British co-operation, but Stephenson was all against it. Not, mind you, against the canal itself. His objection was that, owing to the vast amount of mud poured out by the Nile, amounting to thirty million cubic yards yearly, the sea would be too shallow for ships to reach the northern mouth of the canal.

De Lesseps admitted this, but said he would run out piers, between which a dredged channel would allow large steamers to approach. The English retort was:

"Where are you going to get your stone? There isn't a quarry within scores of miles."

There was a great deal of squabbling, and years passed before anything was done, but at last, in 1855, a commission of engineers from France, England, Austria, Prussia, and Holland went out to Egypt and decided that the work could be done. A company was formed, and on April 25, 1859, the first cut was made.

The workers were Egyptians, and practically slaves. They were herded in camps in the desert. The water supply was miserable, and there was precious little sanitation of any kind. They died like flies. Mecca pilgrims soon after brought cholera into the camps, and then things became so awful that the Sultan of Turkey himself went to inspect. He was so horrified that he ordered the camps to be broken up and the men sent home.

So far the work had all been done by shovel and basket, and in ten months 18,000 men had shifted only about four million cubic yards of earth. Now the engineers, confronted with a labour famine, imported machinery and dredges and paid labour instead of slaves. Within one month as much work was done as in the first ten months. Even so it took a long time to finish the job, and it was not until 1869 that the canal was ready for use. The original estimate had been for eight million pounds, but actually the cost was twenty millions, to say nothing of several thousand lives.

The canal is just 100 miles long, and, as at first constructed, was 150 to 300 feet wide, with a depth of 26 feet and a width at the bottom of 72 feet. Dug almost entirely in sand, it was essential to give the sides a good slope, otherwise they would, of course, slide and break down. The hardest part of the work was in building the two great breakwaters at the northern end, which are each more than a mile long. All the stone had to be brought from quarries near the southern end of the canal.

Few ships of that day exceeded five thousand tons burden, and the canal was amply large enough to carry any vessels trading with the East. During the first year it was opened 486 vessels used it, but within five years the number had risen to 1,264. At that time a steamer took thirty-six hours to pass through, but after 1887, when electric light was installed all along the channel, the time was reduced to fifteen hours. Traffic continued to increase, until, in 1895, 3,434 ships with a gross tonnage of nearly twelve millions went through, paying in tolls more than three million pounds.

Ships were becoming bigger every year, and it became clear that the canal was no longer wide enough or deep enough for these new monsters. In 1901 the Suez Canal Company decided that the canal must be enlarged, and a sum of one million pounds was set aside to start the work.

It was a tremendous task, for, of course, the canal

could not be closed. The method adopted was to cut terraces in the banks one above the other, on which very narrow light railways were laid. Then huge dredgers forced their noses into the bank and chewed their way to the desired line. The excavated sand was either lifted into barges lying alongside the dredger, to be dumped where it was needed, or else forced through pipes on to the banks, building them up to the required slope.

Within three years a minimum depth of 28 feet was provided throughout the whole length of the canal, and twelve new points had been provided where ships could pass one another. Each of these crossing places is 3,000 feet long, and at each the bottom width of the canal is increased to 150 feet. Also the width of the whole canal had been increased by 50 feet.

Yet this was only the beginning, for year by year the size and tonnage of ships trading with the East was increasing so that plans had to be made for a fresh deepening to 34½ feet. To-day vessels of 20,000 tons can steam through the Suez Canal.

The increased width makes the canal much safer than formerly. It was quite common for vessels to get stranded in the canal and hang up the whole of the traffic, but to-day such an accident is very rare. The worst trouble that ever befell the canal authorities was when the *Chatham*, loaded with explosives, came to grief in collision and sank in mid-channel, tying up all navigation. The wreck had to be moved, and moved

quickly, and the only way of doing this was to blow her up. This, however, was a most dangerous piece of work, for she had aboard no less than one hundred tons of dynamite and a large quantity of detonators. It was suggested that divers should be used to remove the cargo; but there was no time. Steamers were constantly arriving in the canal from each end, and the delay would run into hundreds of thousands of pounds. Some experts declared that the explosion of such a mass of dynamite would wreck the whole canal; but the engineers in charge decided to risk it, and two large mines were made ready, each containing three hundred pounds of explosive and fitted with electric fuses.

One of these mines was placed by divers in the hold where the dynamite was stowed, the other amid the detonators, and cables were laid from the mines to the shore, where they were connected to wires running along the banks of the canal. The firing station was located three miles away, and after the circuits had been tested the mines were fired.

The explosion was a magnificent sight. A vast column of water rose to a height estimated at 1,500 feet, and the water of the canal rushed outwards over a circle a mile and a half in diameter, deluging the desert. As for the wreck itself, it was found in small pieces all over this area, and under the spot where the ship had been lying was a hole no less than seventy-three feet in depth.

The whole of this work was completed within a week;

but by that time no fewer than 109 vessels were waiting, fifty-three at the north end and fifty-six at the south. The Company passed them all through within four days—a very smart piece of work.

A few words as to how ships are passed through the canal may be interesting.

The canal is blocked out in divisions, and at the head office at Ismailia is a model showing the exact moving position of every ship in the waterway. Along the banks are stations, each furnished with a mast on which signals are hung, illuminated at night, and these show each vessel whether she may proceed into the next block or whether she must tie up and wait for a vessel coming in the opposite direction. Ships going the same way must on no account pass one another, but vessels of small tonnage going in opposite directions are permitted to pass. For the first seventeen years no shipping was permitted to move through the canal at night, but all ships are now provided with powerful searchlights and can travel in the dark hours, provided they do not exceed the permitted speed.

Nothing may be thrown overboard, and this prohibition applies more particularly to ashes and cinders; no guns may be fired and no steam whistles blown. Pilots are compulsory, yet the responsibility remains with the captain. If for any unforeseen cause a collision appears inevitable, all ships are instructed to run aground to avoid it. Finally, no floating ship is permitted to assist a grounded one.

Dredging goes on always, for every wind storm flings fresh masses of sand into the broad ditch. The banks have now been planted with shrubs and grasses, the roots of which bind the sand and prevent it from slipping. All day and all night traffic continues, and in these post-war years the number of vessels passing is between six and seven thousand yearly, with a tonnage of between thirty and forty millions, while the receipts are in the neighbourhood of nine millions yearly, of which nearly five millions go into the British Exchequer.

As we have said, the British nation had little to do with the origin of the Suez Canal, but, in the year 1875, the Khedive of Egypt, who had got into difficulties through extravagance, offered his shares for sale. Beaconsfield snapped them up, paying four millions for them. He had plenty of critics at the time, yet this has proved one of the best investments ever made, for it has been repaid more than tenfold in dividends, and it will continue to pay at the rate of one hundred per cent. or more for many years to come.

CHAPTER III

SIXTY MILLIONS SUNK IN MUD

THE Panama Canal, greatest of the world's canals, was, as we all know, completed by the United States of America, and the Canal Zone is to-day as American as Washington itself. Probably most of us are quite unaware of the fact that Britain once owned this part of the world, and might have done so to this day if James II. had taken the slightest interest in his country's oversea possessions, which, in point of fact, he never did.

In 1658 there was born at Skipmire, Dumfriesshire, a boy named William Paterson, who turned out to be one of the most remarkable men that his country has ever produced. William was the son of a small farmer, and we know little of his boyhood or education. His history begins when we find him a pedlar carrying a pack through England. He reached Bristol, lived there for a time, then sailed to America where he seems to have been a preacher in New England.

He went to sea again—some say as a buccaneer, which was a comparatively respectable occupation in those days. At any rate, he visited the West Indies, the Bahamas, and Central America, and there hatched

in his brain the famous Darien Scheme. This was to establish on the Darien Isthmus a settlement strongly fortified which, as he justly said, "would hold the key to the world's commerce." The ships of all nations were to be admitted to the harbour which would be constructed; free trade with all the world was to be maintained, and differences in religion and colour were to be annulled. It was a very wonderful idea, and could it have been carried out as Paterson intended, might have altered the whole course of world history.

Paterson came back to London, obtained an audience with King James II., but got no satisfaction from that monarch. He then went on to Berlin, to Hamburg, and to Rotterdam, in each place trying to interest important people, but all in vain.

Another man in Paterson's place might have been dismayed. Paterson merely made up his mind that, if others would not help, he would carry out his plan single-handed, and, returning to London, went into business. In 1690 he founded the Hampstead Water Company, and, a little later, the Bank of England, of which, in 1694, he was one of the first directors.

At this date the East India Company, which had a monopoly of trade in the East, was growing rich and powerful, and the money pouring into London was a matter of envy to the Scottish people. So when Paterson went to Edinburgh and propounded his Darien Scheme, he found plenty of people ready to back him. In May, 1695, he formed a Company with

a capital of £600,000, and obtained a special franchise from the Scottish Parliament. Shortly afterwards a strong expedition set sail for Darien.

Paterson was a better business man than colonist. The settlement, called New Edinburgh, was badly managed. The climate, of course, was deadly, and many colonists fell ill; then the Spaniards, furious at these heretic interlopers, attacked in force. The colonists fought bravely but, weakened by fever, had not a chance. The survivors capitulated to the Spaniards and were allowed to leave. But out of some two thousand there were fewer than five hundred survivors. The Company failed with a dead loss of £300,000.

Paterson had been with his colonists; he had fought and suffered with them, he returned home, ill and ruined, in the year 1699. But if his body was sick his spirit was still unbroken, and when, in 1701, William of Orange decided to carry war into the heart of Spanish America, he sent for Paterson, whose hopes again rose high. Then came the crowning disaster. King William died, and that was the end of the Darien Scheme.

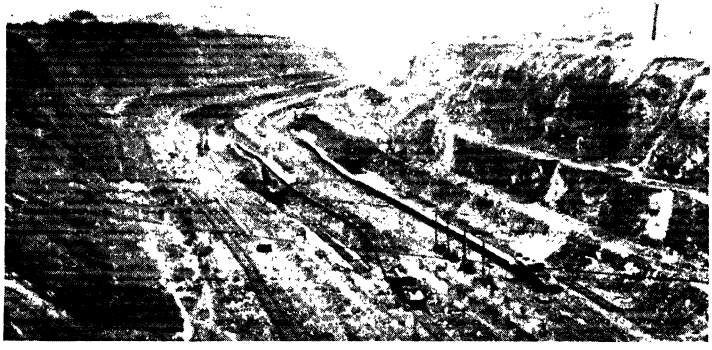
Paterson lived until 1719. He had much to do with the Union between Scotland and England, and was a member of the first United Parliament. In 1715 he was awarded, by special Act of Parliament, the sum of £18,000 as indemnity for his losses in the Darien Scheme.

This far-sighted man had realized the immense

value of a canal cutting the narrow isthmus and opening up the rich western coast of the two Americas to shipping; but he was not the first to do so. As long ago as the year 1550 a Portuguese sea captain, Antonio Galvao, had written a book on the subject, and had actually suggested three separate routes for such a canal, namely Panama, Nicaragua, and by Tehuantepec in Mexico.

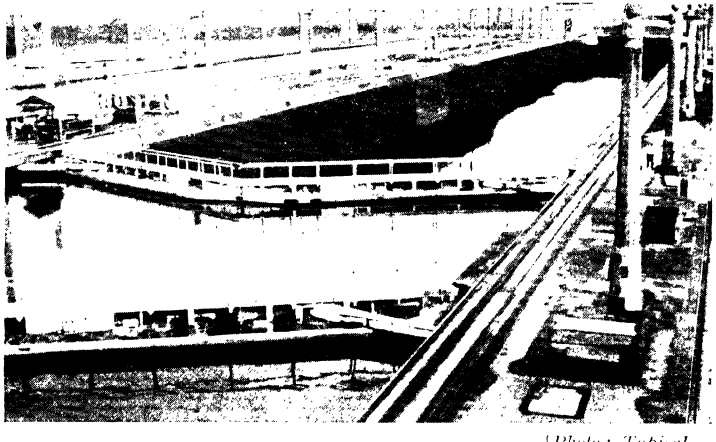
Later, Gomara, the Spanish historian, took up the idea of a canal, only to be severely snubbed by his Government, who considered that a through passage to China was of far less importance than the security afforded by the Isthmus as a barrier against the buccaneers who infested the Gulf of Mexico. Actually an edict was made forbidding any one, under pain of death, from seeking or making known any waterway between the oceans, across the Isthmus of Panama. It may be mentioned here that many of the early explorers firmly believed that there was some natural waterway between the seas, and spent much time in searching for it. This belief persisted well into the eighteenth century.

By degrees even the Spanish Government began to realize the value of a canal which would save the dangerous voyage around Cape Horn, and in 1771 sent out surveyors to report on the Tehuantepec route. Finding this to be impracticable they then made a survey of Lake Nicaragua and its approaches. Here the report was more favourable, but a fresh outbreak



[*Photo: Will F. Taylor.*

The Culebra Cut, Panama Canal. Making a channel through the hills for the Canal.



[*Photo: Topical.*

Gatun Locks, Panama Canal.

of war in Europe put an end to the project. In another chapter we tell the story of the vain attempts to cut the Nicaragua Canal.

It was not until 1849 that the project of a Panama Canal came up again. Gold had been found in California, the rush was on, and people were flocking there by thousands. Thousands, too, died on the way, for there were no roads across North America, and Indians were on the warpath. Shiploads of pioneers were carried round Cape Horn, while others were driven to force their way across the Isthmus of Panama. They went by ship from New York to the little town of Chagres, then up the swift, shallow Chagres River to the head of navigation some twenty miles inland, where they took the old Spanish road across the Divide known as the Culebra to Panama.

That road was a tragedy, for it was nothing but a mud swamp, and in wet weather men sank to over their knees, and mules to their bellies in the mire. Mosquitoes devoured the travellers, and malaria, yellow fever, and even cholera killed them by scores and hundreds. Panama, when they reached it, was full of gamblers, robbers, and cut-throats. The Spanish-American people hated the "Yanqui" invaders and preyed upon them.

The American Government had to do something, and in 1850 began to build a railway. It took five years, and it is said that for every sleeper laid a life was lost. Of eight hundred Chinese labourers im-

ported not a hundred survived, and about the same proportion of the Irish and negroes who were brought there for the work died. The cost was colossal. The line cost £30,000 per mile, or, in all, nearly a million and a half pounds, and the fare for that comparatively short distance was £5. Still, for some years the line paid large dividends, sometimes as much as twenty-four per cent.

Meantime the Union Pacific Company was pushing its line across the United States, and, in 1860, trains began to cross the continent. That killed the Panama line, which, so it was said, decayed until it became nothing but " two streaks of rust and a mortgage."

As steamers began to replace sailing ships for ocean travel the need for a canal became more and more evident, and one expedition after another was sent from the United States to survey all available routes. There was no doubt that the Panama one was the shortest, but Nicaragua had many advocates.

What is now the Canal Zone was originally part of the vice-royalty of Granada, and, after the Spanish domination was ended, became a province of the republic of Colombia, the larger part of whose territory lies in the continent of South America. All the negotiations as to concessions for a Panama Canal had to be transacted with the Government of Colombia, and Colombia very naturally tried to drive the best bargain possible. The first of these bargains was made with France.

De Lesseps had completed the Suez Canal, and its success made every one quite certain that it would be no harder to cut through the Isthmus of Panama, and that it would pay even better. In May, 1879, there was a Congress of Geographers in Paris, who came from various parts of the world, and these people voted that Panama was the place for the American canal, and that it should be cut at sea-level without any locks. A company was organized, and after some trouble a million shares of £20 each were sold.

De Lesseps, of course, was in charge, but he was now growing old; also he was blinded, by the success of Suez, to the very much greater difficulties in the way of the Panama cut. He planned airily for a sea-level canal 29½ feet deep, 72 feet wide at bottom, and 47 miles long. He reckoned he could complete it in eight years at a cost of £24,000,000, and he began by buying out the American railway for the enormous sum of £5,000,000.

He visited Panama and went over the ground. Engineers pointed out to him the difficulties of dealing with the Chagres River and its huge floods, and the tremendous amount of excavation required to cut through the backbone of the continent at the Culebra. De Lesseps merely smiled and declared it could be done, and would be done. On New Year's Day, 1880, his daughter cut the first sod, inaugurating the work which, as the Bishop of Panama said, was to "contribute to the union of two oceans for the good of humanity."

What de Lesseps had not reckoned on was the climate and the insects. Ticks and red bugs produced festering sores ; jiggers, a kind of flea, bored into men's feet and laid eggs under their toe nails ; the rancho, a sort of ringworm, drove workers mad, and that horrible worm, the gassano, killed many. But worst of all was the " vomito," a terrible form of yellow fever. In Florida, years ago, the writer knew an old Irishman named Tom Stanley, who had driven a dead-cart at Colon during the first attempt to build the canal. Day after day, he said, bodies were piled high upon his cart and dumped into great plague pits, where they were covered with lime. The Company admitted to fifty deaths a week, but Stanley said there were often fifty a day.

There was no proper sanitation ; the drinking water was dreadful ; the air swarmed with mosquitoes carrying the germs of malaria and yellow fever. If de Lesseps had had a hundred millions to spend he could never have cut the canal by the means he had adopted. In eight years the expenditure reached sixty million pounds, more than three times the cost of the Suez Canal, and not a quarter of the work was done.

In 1888 the Panama Canal Company went bankrupt, de Lessep himself was arrested, and he and other directors tried for embezzlement. It was a sad end to a great career.

It was even worse for the shareholders, of whom there were more than two hundred thousand. Many

of these were poor French peasants who, full of trust in de Lesseps, had invested all their savings. The French Government, struggling to save something out of the wreckage, appointed a commission of French and foreign engineers, who decided that a sea-level canal was out of the question, but that a lock canal could be made at a cost of about fifty million pounds. So in 1904 a new Panama Canal Company was organized, backed by the French Government, and Colombia received a fresh subsidy to extend the concession. Plans were got out, but before work began afresh news came that the United States had decided to build the Nicaragua Canal at a cost of one hundred and eighty million dollars.

Panic seized the French Company, and the value of the shares fell heavily. It was suggested that the best way out of the dilemma would be to sell the Panama Concession to the United States. There was a great deal of bargaining over the price. In the end the States paid down forty million dollars, which was to include the shares of the Panama Railway Company. Further, a strip of land was to be obtained from Colombia as a Canal Zone, and this was to be held for all time by the United States Government.

So it came about that the Panama Canal was begun and eventually completed by the United States. In our next chapter we will tell how the difficulties of climate, disease, and of the Chagres River floods were fought and conquered.

CHAPTER IV

THE BIG DITCH

In December 1902 an agreement was made between the United States and the Republic of Colombia, by which the former Power was to pay the latter the sum of ten million dollars in cash in purchase of the so-called Canal Zone, and a rental of a hundred thousand dollars a year. The Colombian Minister at Washington signed this treaty, but the Colombian Senate refused to ratify it.

Then the fat was in the fire. The States were furious, and declared that it was a "hold-up." They said that Colombia was simply delaying matters until the concession to the French Company expired, so that it might make a fresh bargain and get a great deal more money. But, as it turned out, Colombia would have been wiser to take what she could get, for, in the end, she got nothing. Suddenly United States warships appeared on both sides of the Isthmus, and Panama was recognized as an independent republic by the United States. A new treaty was drawn up between the new republic and the United States, and

in the end Colombia lost not only her ten million dollars but also a considerable stretch of her northern territory.

At once things began to move. President Theodore Roosevelt made General Davis civil governor of the Canal Zone, and appointed a committee of seven members to organize the cutting of what American papers called " The Big Ditch."

The outlook was not too good. What the American engineers found was seven miles of waterway cut into the Isthmus and some shallow depressions along the remaining forty miles, including a fairly deep notch in the famous Culebra Crest. Piles of rotting machinery lay buried in thick, tropical growth, houses and stores were falling to pieces and half devoured by insects, quantities of low-powered engines were so eaten by rust as to be completely useless, and—worse than all —there were thousands of graves. The whole country swarmed with mosquitoes, malaria was everywhere, and the towns were never free of yellow fever. It is to the credit of American engineers that they realized at once that their first battle must be against disease, and that there was no hope of completing the canal until the lives of the men employed were made safe.

The French had no means of fighting malaria, because in their day at Panama no one knew that it was caused, or rather carried, by the anopheles mosquito. The germ of yellow fever is carried by another kind of mosquito. The scientists mainly responsible

for this invaluable discovery were two Englishmen, Sir Patrick Manson and Sir Ronald Ross.

Colonel Gorgas was put at the head of the anti-mosquito battalion, and at once set to work to drain all stagnant pools, which are the breeding-place of mosquitoes, or—where this was not feasible—to cover the water with a scum of petroleum, which prevents the development of the mosquito larvæ. At the same time the walls and doors of all houses were protected by wire gauze, and all employees were regularly dosed with quinine.

By April 1905 Colonel Gorgas had an army of 4,100 men employed in the war against the mosquito. Panama at the time was a picturesque but extremely dirty town, along the streets of which open gutters flowed with filth. All this was done away with and the houses were fumigated with sulphur, much to the disgust of the native inhabitants. A new water supply and proper sanitation was installed, the drainage being put underground. Besides oiling the pools, the thick brushwood around Panama was cut down and the holes of the land crabs stopped up.

The results were amazing. While under de Lesseps no fewer than thirty-three per cent. of the white labourers went down with malaria, the sickness rate in 1907 fell to less than seven per cent. It kept falling, and to-day the Canal Zone is declared to be the healthiest place in tropical America, with a death-rate actually lower than that of New York. Another

valuable aid to health was the proper feeding of the men employed. At first a number of the coloured labourers died of pneumonia, but Colonel Gorgas and his assistants found that this was largely due to their poor standard of living. By altering and improving their rations the deaths from pneumonia fell to almost none.

In the history of medicine there has been nothing more remarkable than the work done in the Panama Canal Zone by Colonel Gorgas and Colonel Goethals. They have changed a death-trap into what is almost a health resort. In spite of the great heat, the torrential rains, and the rather stagnant air, white folk can live there all the year round in health and comfort.

Not until these tasks were finished did the real work begin. Then the engineering staff decided to see what they could do with the rebellious Chagres River. They decided to imprison it, to turn it into a lake, and they did this by using the earth dug from the canal to make a dam 100 feet high and of enormous thickness. This held back the crazy river, and made a lake which now covers 164 square miles of country. It is the largest artificial lake in the world. To-day it does not matter how many feet of flood water come roaring down from the hills. The great lake may rise a few feet, but its spillways rapidly get rid of the surplus water.

Soon fifteen thousand men were at work, plus a large quantity of up-to-date machinery. The men were of

many different races—natives, negroes, Creoles, Greeks, Italians, but all were carefully chosen. They were well paid, well fed, and well housed in proper barracks. By degrees the numbers were increased until at last no fewer than fifty thousand men were at work.

The country through which the Panama Canal is cut is by no means flat. Indeed it is very uneven, with a ridge in the centre quite four hundred feet high. It would have been out of the question to cut a ditch through the Isthmus at sea-level. The surface of Gatun Lake (formed by the imprisoned Chagres River) is actually eighty-five feet above the level of the Atlantic, and ships have to climb up to the lake through three mighty locks. Once in the lake, vessels can steam at full speed for a distance of twenty-four miles, the passengers enjoying the beautiful scenery before them. The vessel then enters the Culebra Cut, and steams through nine miles of this with high banks on either side. At Pedro Miguel other locks lower the ship to the small Miraflores lake, which is one and a half miles long. She then enters the Miraflores locks, which drop her another fifty-four feet to the level of the Pacific Ocean.

The most difficult part of the work was the Gaillard Cut, usually known as the Culebra Cut. To delve through hills for nine miles, cutting a channel with an average depth of 120 feet and a minimum width of 300 feet was a truly terrific task. In the centre, where the canal cuts the watershed, the depth of the

channel is actually 375 feet. In all over a hundred million tons of rock and earth had to be moved. For the purpose of the work the sides were cut into terraces, along which were built no fewer than 75 miles of railway. Every month during the construction of this vast ditch 400,000 lbs. of dynamite were used for blasting, and forty steam shovels were at work, each capable of shifting 10,000 tons a day. Most of the earth and rock removed from the Cut was taken out to sea and used to build a land-locked harbour on the Pacific side.

The great difficulty experienced by the engineers in making the Culebra Cut was from "slides." If the ground had been all solid rock, as is the case in the Corinth Canal, the work would have been simple, but between Colon and Panama much of the soil is soft clay. When the French Company tried to cut the Culebra one slide took down no less than forty-seven acres of hillside. That is the size of a small farm. Over twenty slides occurred while the Americans were at work, and in August 1912 there was a tremendous break near the town of Empire, which buried some £20,000 worth of machinery and—worse still—diverted the river Obispo, which flooded the canal. It was a mighty piece of work to divert the river, pump out the water, and clear the million odd tons of rubble which blocked the canal.

The earth in the great Cut is mostly a rich red, rather like that in South Devon, and is very soft. One

way of getting rid of it was to mix it with water, pump it away, and use it to fill up swamps near the town of Panama. Slides still occur, and dredgers are constantly at work in the Cut. In 1915, just after the canal was opened to traffic, ten million cubic yards slipped down, completely blocking the canal, and it took more than six months to clear away this immense amount of material.

Still another difficulty which confronts the engineers is that in some parts of the Cut the bottom squeezes up owing to the great pressure. Then, too, the canal is in the earthquake zone, and on several occasions quakes have brought down slides. The whole of the Culebra Cut has to be watched night and day, but the organization is so splendidly efficient that there is rarely any delay in getting ships through.

The locks are marvels of ingenuity. There are six double locks, three pairs in flight at Gatun, one pair at Pedro Miguel, and two pairs at Miraflores. They are built of solid concrete, and their size may be appreciated when we say that the British battle cruiser *Hood*, the largest warship in the world, has passed through the canal. Incidentally the toll she had to pay was £4,400! Each lock is 1,000 feet long and 110 feet wide. The gates of these locks are colossal. You could drive a motor car along the top of any one of them, for each is 7 feet thick, 65 feet long, and they vary from 47 to 82 feet in height. They are made of solid steel, and their weight varies from three to six

hundred tons apiece. In all 57,000 tons of steel were used in building these gates.

One of the first films in colour ever shown in London was of the building of the Panama Canal. It was shown at the Scala Theatre about 1913, and Londoners were able to watch men at work on the Gatun locks, heating rivets in little portable furnaces and dropping them to the riveters far below.

All the locks are worked by electricity, and more than four hundred motors are installed for moving the giant gates. Four and a half million cubic yards of concrete were worked into the walls of these locks, which are built to endure for centuries. The wall of masonry at the Gatun Dam is also faced with concrete. This is almost as high as Big Ben, as long as from the Tower to Westminster, and as broad at its base as twice the width of the Thames at Westminster.

The beauty of duplicate locks is that ships going east and west can pass one another in the locks. Talking of east and west, if you glance at a map of Central America you will notice an odd point. The canal does not run east and west, but actually from north-west to south-east. This is due to the queer crook in the Isthmus of Panama.

Passing through the canal the traveller is always struck by the lighthouses which rise here and there amid the forest on the banks. The canal has many bends—twenty-two in all—but the curves are so well engineered that a ship a thousand feet long can get

round them. It is forty-nine miles long, which is only about half the length of the Suez Canal, but it cost four times as much. By 1921 the States had spent very nearly ninety million pounds sterling on it. But now it pays quite well, for some six thousand vessels pass through it yearly, paying tolls amounting to well over five million pounds a year. It has lessened the sea distance between New York and San Francisco by about eight thousand miles, and is, of course, of incalculable value to the American Navy.

By the autumn of 1913 the work was nearly done. Only one big barrier of earth remained and prevented the waters of the Gatun Lake from flooding the Culebra Cut. Under this mass of earth and rock, known as the Gamboa Dyke, no less than forty tons of dynamite was buried, and on October 10th this great mass of explosive was fired by President Wilson, standing four thousand miles away in the White House at Washington. Through ten States, through Mexico, through Nicaragua, and so down to Panama ran the wire which carried this spark.

The thousands of people who stood to watch the explosion felt the ground tremble beneath them, and saw a vast cloud of black smoke arise and spread like a huge umbrella against the blue. When this cloud dispersed water was seen racing muddily amid the debris into the Cut, until within a few moments it was a torrent.

So on the four hundredth anniversary of the day

when the Spanish explorer Balboa first viewed the Pacific from the Divide, the waters of the two oceans were first intermingled across the Isthmus, and on the following November 20th a small steamer passed from the Atlantic to the Pacific. She was the little *Louise*, a French vessel which had been sent out twenty-five years earlier, and which had conveyed de Lesseps to the spot where his daughter turned the first sod. It was a pretty compliment to the French nation who, if they had failed to finish the canal, had at any rate been the first nation to attempt its construction.

The canal was opened on August 15, 1914, and at present it takes about eight hours for a ship to pass through from one end to the other. The Canal Zone is a little world of its own, controlled directly from Washington, better governed than any State in the Union, and employing constantly no fewer than 8,500 persons.

CHAPTER V

THE CANAL THAT WAS NEVER CUT

NELSON, after successfully taking two thousand men to San Juan de Nicaragua in the year 1780, sent a dispatch to the British Admiralty in which he described the great lake as "the inland Gibraltar of Spanish America."

Lake Nicaragua is indeed a magnificent sheet of water, being 110 miles long by 40 miles wide and most of it of enormous depth. It has two things possessed by no other lake in the world, namely, an active volcano on an island in its centre and fresh-water sharks in its waters.

Long before the Panama Canal was dreamed of the Nicaragua Canal was plotted. Even in the very early days of the Spanish Conquest there were far-sighted men who were able to realize the immense value of a waterway across the Isthmus, and to whom it seemed that this great lake offered a Heaven-sent opportunity of opening such a way. Indeed, as a well-known American engineer said in 1900, the most remarkable thing about the Nicaragua Canal is that it is not yet in existence.

Those early explorers entered the mouth of the San

Juan River which drains the lake, and is in itself quite a big stream. Up it they paddled or poled their dugouts, at times being forced to tow up rapids. But they reached the lake, crossed it, and found themselves only a dozen miles from the Pacific. No wonder they believed that they had found the much desired waterway. What they did not realize was the fact that the surface of Lake Nicaragua is almost 122 feet above the level of the Atlantic, and that a system of gigantic locks would be necessary on both sides, more especially on the Pacific side, where the fall is ten feet to the mile.

As long ago as 1550 an enterprising Portuguese named Antonio Galvao proposed an inter-oceanic canal by way of Lake Nicaragua, and the same man went farther south and surveyed the route of the present Panama Canal. The project of the Nicaragua Canal was revived in the days of Philip II. of Spain, and it is said that he was quite prepared to start it. But Philip was a devout Catholic, and consulted the Archbishop of Madrid. His advice was to abandon the idea, and the reason he gave was that to pierce the continent would be to show a blasphemous contempt for the scheme of creation; inasmuch as, had God intended the two American continents to be insulated, He would have made them so from the beginning. That prelate would get a shock if he could visit Panama to-day!

The Spanish Empire in America slowly decayed, and was finally ended by the great insurrections of the early

years of the nineteenth century. It was the United States who revived the Nicaragua Canal Scheme. In 1825 that far-sighted statesman, Henry Clay, then Secretary of State, issued a Commission to inquire whether such a canal was practicable. He was strongly backed by the Nicaraguan minister at Washington, who suggested that the canal might be constructed as a joint enterprise between the two countries. Nicaragua, better governed in those days than it has been since, fully realized the immense value of such a canal to her commerce and general prosperity. The great naturalist, Humboldt, was equally interested and, after travelling over the route of the proposed canal, declared that it could be made.

Clay went out of office before anything was done, but ten years later President Jackson ordered a survey to be made, and this was done. The engineers reported that the San Juan River could be made navigable, but that the construction of the Pacific side of the canal would be very difficult and costly. The summit of the divide which lies between the great lake and the Pacific rises to 487 feet, and their opinion was that a tunnel of at least sixteen miles in length would have to be made.

Again the reports were pigeon-holed, but the scheme kept on coming up again and again. During the nineteenth century no fewer than sixteen surveying parties were sent south from the United States to report on the Nicaragua Canal route.

In 1838 Nicaragua, disgusted with these dilly-dally tactics, granted a concession to a Belgian company which professed to be willing to cut the canal. The company had the support of Prince Louis Napoleon, who himself wrote a pamphlet on the subject. At that date the Prince was a political prisoner in the fortress of Ham. He offered, if set free, to go in person to Nicaragua and conduct the undertaking. He had been invested with full powers by the Nicaraguan Government. The French Government refused to release him. Had they done so the whole course of history might have been changed, for this was the Prince who, later, became Emperor of the French, and under whom France suffered the disaster of defeat at the hands of Germany.

It was at this date that the Nicaraguan Government employed a certain Lieutenant Bailey to survey the route, and he did it very thoroughly and reckoned that the total length of the canal would be 190 miles. He did not conceal from his employers that it would be a colossal task. For a canal 50 feet wide and 30 feet deep he estimated that not less than 162 million cubic yards of earth would have to be moved, which, as he said, was as much as required for the construction of 2,000 miles of railway. Staggered by such figures the Belgian company cried off, and nothing more was done until the year 1852, when Colonel Childs of Philadelphia, who was employed by Vanderbilt, made a fresh survey, and proposed to avoid

cutting the ridge by taking the canal out of the north end of the lake where the small river Tipitapa runs out. Vanderbilt obtained a fresh concession from the Nicaraguan Government for an " America Atlantic and Pacific Ship Canal."

At that time Commodore Vanderbilt was the richest man in America, and he was tremendously keen on the canal. It was a gentleman named Walker who upset Vanderbilt's plans. Walker was the famous American filibuster, a little man with the heart of a lion, who set out with a few white men of his own sort to liberate the Central American republics from the " dictator " presidents who ruled them. He plunged Nicaragua into civil war, and by the time this commotion subsided the great American Civil War between the North and the South had broken out.

When this was over President Grant took up the canal scheme with enthusiasm. But the States were poor after four years' fighting, and Grant came over to England to try to raise the money. If English capitalists had put up the money Britain would now be partners in the Isthmus Canal, but they refused. In those days most of the heavy goods were still carried in sailing ships, and the English argument was that these certainly would not pay heavy dues of perhaps thirty shillings a ton to be towed through the Nicaragua Canal.

They were probably right. At any rate nothing more was done until 1880, when Mr. Menocal, a well-

known engineer, designed a waterway 72 feet wide at the bottom, 26 feet deep, and with eleven locks on the 53½ miles of artificial waterway. The cost he reckoned at about eight and a half million pounds, a very moderate estimate. The Atlantic terminus was to be Greytown, where they still point to a fence made of the old muzzle-loading rifles used by Walker's army. Three years later a Maritime Canal Company was incorporated in the United States, and in 1889 work actually began.

For two and a half years the Company carried on. Menocal deepened the harbour, built 1,000 feet of breakwater, erected wharves, storehouses, barracks, hospitals, and workshops, constructed 11 miles of railway, and cleared the dense jungle for a considerable distance inland. The Company also acquired exclusive rights of navigation over the San Juan River and Lake Nicaragua, and excavated a mile of canal 17 feet deep by 120 feet in width. Matters were going swimmingly and all looked forward to a prosperous end to the undertaking, but the ill-luck which had attended every attempt to cut the Nicaragua Canal was still working. Like a bolt from the blue came the financial panic of 1893, which was only a degree less severe than that of 1931. Money ran out, no more was forthcoming, the Company had to pack up and clear out, and now all that remains to be seen for three years of hard work is the City of America breakwater.

Even that was not the end of it, for in 1899 the

American Senate passed the Morgan Bill for the construction of the Nicaragua Canal, and provided 100 million dollars (£20,000,000) for that purpose. But when this measure went to Congress the Foreign Commerce Committee threw it out. These gentlemen had already made up their minds that the Panama was the best route.

They were probably right, and here are some of the reasons which decided them. We give the pros and cons in parallel colums :

Panama	*Nicaragua*
Two good harbours existing.	Two harbours to be made.
Good railway existing.	120 miles of railway to build.
Length 46 miles.	Length 176 miles.
Rainfall about 90 inches.	Rainfall up to 256 inches.
No active volcanoes within 200 miles.	Two volcanoes quite close.

Besides all this the cost of the Nicaragua Canal was reckoned at a third more than that of the Panama.

Well, the Panama has been made and the Nicaragua is definitely shelved. Still, it would have been delightful to steam across mysterious Lake Nicaragua, with its spouting volcano and lovely green islands. It is one of the most beautiful lakes in the world, but few of us are ever likely to see it.

CHAPTER VI

EUROPE'S GREATEST CANAL

THERE are spots on the Earth's map where narrow necks of land cut off one sea from another, and where it must have been plain from earliest times that a canal would save immensely both in time and money. The two most obvious spots are, of course, the isthmuses of Suez and Panama, both of which have now been cut. Another is the neck of Denmark, and this the more obvious because the wide mouth of the great Elbe River makes a natural channel for nearly a third of the distance. Hamburg, Germany's greatest port, stands on tidal water, but is nearly as far inland as London. From her position she has free access to the North Sea, but the whole mass of Denmark separates her from the Baltic, and her ships have had to sail more than four hundred miles round the dangerous coast of Jutland before reaching that inland sea with all its vast trade.

Nearly five hundred years ago a small waterway was cut connecting the ancient city of Lubeck on the Baltic with the river Elbe, and, later, the Eyder Canal was constructed. But these are both small,

and only fit for barges. In the year 1885 no fewer than 35,000 vessels passed round the north of Denmark, and the traffic was steadily increasing. Among them were German war vessels. The whole of Germany's growing mercantile marine, as well as her naval authorities, demanded a ship canal between the Elbe and the Baltic.

It was a considerable undertaking, for the cut was to be 72 feet wide at the bottom and 29 deep—that is, large enough to carry any warships which Germany possessed at that date, and almost any cargo steamers. The length of the canal was surveyed at 61 miles, and it was decided to cut it at sea-level with only two locks, one at each mouth. In the Baltic there is very little tide, but in the mouth of the Elbe the rise and fall is no less than 27½ feet at spring tides, and without a sea lock there would be danger of flooding. While the country through which this canal is cut is fairly flat there is one point, some 18 miles inland from the Elbe, where the land rises to 70 feet above sea-level, and for some miles the depth of the cutting from the surface to the bottom of the canal is nearly 100 feet.

Hamburg naturally wished the canal to open from that city, but this suggestion was vetoed by the German Government, and it was decided that the mouth should be at Brunsbuttel, only fifteen miles up the Elbe from the North Sea. Here there is always deep water, but Hamburg itself is dependent on the

tides, and at times, when the east wind is strong over an ebb, the harbour at Hamburg dries dangerously. The eastern outlet of the canal was to be at Haltenau, just outside Kiel, which was and is one of the principal German dockyards.

The canal, as originally planned, was put in hand in 1887 and completed in 1895. It is one of the few, if not the only great canal, which was constructed to an agreed time-table, which was opened promptly on the date originally fixed, and which cost precisely the sum originally estimated. This was eight million pounds, two-thirds of which was defrayed by the German Empire as a whole, and one-third by Prussia.

The amount of material excavated was about 105,000,000 cubic yards, and the cost per yard was the lowest on record. It amounted to only one and sixpence a yard, as compared with four shillings for the Suez, five for the Manchester Ship Canal, and twenty-five for the Panama. When completed, the canal saved two and a half days' passage around the Danish peninsula.

The Kaiser Wilhelm Canal, as it was named, was opened on June 20, 1895, by the Kaiser himself. He and his sons, in the Imperial yacht, *Hohenzollern*, followed by some twenty-three other vessels, entered the Brunsbuttel lock at four in the morning, went right through the canal, and reached the Baltic end shortly after midday, where he was received with crashing salutes from the warships in Kiel harbour.

The moving spirit behind the construction of the Kiel Canal was the Kaiser. He was always keen to make Germany a great naval power, and all his spare time was spent at sea. When at any naval port it was his habit to sleep aboard a battleship and to share the midday dinner in the ward-room with the officers. Besides his huge royal yacht, the *Hohenzollern*, he had a special torpedo boat, the *Sleigner*, in which he made frequent trips in the Baltic. He made a point of attending launches of the big German liners that were built before the war to compete with Cunard and White Star vessels, and at one of these launches he had the narrowest escape of his life.

That was in 1912 when the Hamburg–America wonder ship *Imperator* was being launched. The great ship was gliding down into the water, when an immense steel chain hanging over the side became caught in the side of the dock. The weight of the ship snapped it as if it had been thread, and a section weighing at least three hundred pounds whirled through the air and passed right over the platform occupied by the Kaiser, missing his head by no more than a couple of feet. It was pouring with rain at the time, the crowd was a sea of umbrellas, and very few except those close to the Emperor himself realized the closeness of his escape.

On another occasion the Kaiser, with about a hundred chosen companions, went cruising in the North Sea in the liner *Kaiser Wilhelm II.*, and it was noticed at the time how much more genial he was

than when on shore, and how for once he laid aside his usual stiff dignity.

It was the Kaiser who, when the new German dreadnoughts were built, insisted upon widening and deepening the Kiel Canal. The original locks were each 492 feet in length, 82 feet wide, and 32 feet deep. Until the building of such liners as the *Imperator* and warships of the *Dreadnought* type there were no ships with a beam of 82 feet, but the coming of these new giant vessels made it essential to reconstruct the Kiel Canal, making it large enough to take them.

The decision was taken suddenly and rather secretly in the autumn of 1908, and the German Government voted eleven million pounds for the work. Oddly enough, it was an accident to a Belgian ship which hastened the decision. She was the *Palomares* of thirteen hundred tons, and while rounding one of the sharper curves in the canal she hit the masonry of the bank, head on, and sank in such a position that her hull lay right across the canal, completely blocking it. It was ten days before the wreck could be blown up, and by that time nearly a hundred ships were hung up at one end or the other.

The reconstruction was begun early in 1909, and, according to plan, was to be completed in 1915. At that time the danger of war between France and Germany was already realized, but it was freely prophesied that Germany would not make any move until the Kiel Canal reconstruction was completed.

The work, however, was pressed on with feverish speed and completed by June 1914. Owing to the rate at which it was pushed forward it cost a million pounds more than was anticipated.

Four thousand men were employed at first, but this number was afterwards increased to fourteen thousand. The canal was divided into twenty-two different sections and the men lived in barracks built along the banks. There was much more to do than merely widening and deepening the canal, for the locks had to be entirely rebuilt, and, at the same time, the road and railway bridges across it replaced by new ones. That in itself was no small task, for there are two road bridges, five rail bridges, and sixteen wire-rope ferries. The bridges had to be built high enough for big ships to pass under them, and each railway bridge towers at least a hundred and fifty feet above the surface of the canal.

The new locks are the largest in the world—larger even than the famous ones at Panama. Each is 1,150 feet in length, 148 wide, and 46 deep. Many curves were straightened out and eleven new sidings were built. Some of these are no less than 4,000 feet in length, so that a fleet can lie in them, if need be.

The whole canal is lighted by powerful electric lamps placed every 800 feet along the banks. In fact, every foot of water is illuminated so that ships can steam as fast by night as by day.

The bottom width of the canal was exactly doubled, being increased from 72 to 144 feet, the width at water-level from 220 to 334 feet, and the depth from 29 to no less than 40 feet.

As before, the Kaiser performed the opening ceremony of the new canal. A special platform was built for him high above the bridge of the Imperial yacht, and there he stood in solitary splendour at the salute while the *Hohenzollern's* sharp bow cut the strand of black, white, and red ribbon hung across the opening. A salute of thirty-three guns roared from the assembled German and British fleets.

CHAPTER VII

THE MANCHESTER SHIP CANAL

MANCHESTER to-day is the fourth port in the kingdom. Considering that the city lies some thirty-five miles inland and never had a navigable river, the achievement is a startling one. To-day this inland city has more than four hundred acres of docks, and ships of 15,000 tons' burden lie in her heart.

It is at least two hundred years since the people of Manchester began to have ambitions to obtain access to the sea, but as late as 1750 there was not even a carriage road between Liverpool and Manchester. The river Irwell, shallow and winding, was the only route to the coast, not only for merchandise but even for passenger traffic. The river was managed by the Mersey and Irwell Navigation Company, which had put in some locks but does not seem to have managed the business very cleverly.

In our first chapter we have described how the Duke of Bridgewater successfully built a canal from his coal pits to Manchester. He presently absorbed the Mersey and Irwell Company, and carried on his small waterway

to Liverpool. The two together became the Bridgewater Navigation Company, which was purchased by the Ship Canal Company in 1885.

The success of the Suez Canal stimulated the people of Manchester to press for a ship canal, and in 1877 a London engineer, Hamilton Fulton, prepared not only plans but a model in relief, which was exhibited at the Royal Exchange in Manchester. Fulton's idea was for a tidal waterway, but this was abandoned for a canal with locks, as designed by Leader Williams, the man who eventually carried out the work and was knighted as a reward.

The Bill for the new canal passed the House of Commons in July 1883, but was thrown out by the Lords, and a second Bill passed the Lords but was thrown out by the Commons. Yet Manchester refused to be discouraged, and at last, in 1885, the Bill passed through both Houses and work was begun in the autumn of 1887, Lord Egerton cutting the first sod at the site of the Eastham Lock.

The capital of the Company was fixed at six millions, but this sum, as it turned out, was not nearly sufficient, the more so because misfortune seemed to dog the work from the beginning. There was a very heavy rainfall in 1888, causing a flood which did thousands of pounds' worth of damage to the works ; then the cost of labour increased, upsetting all calculations. Money ran short, but the Manchester Corporation came to the rescue with a loan of three millions. Even this was

not enough, and two millions more were lent by the city.

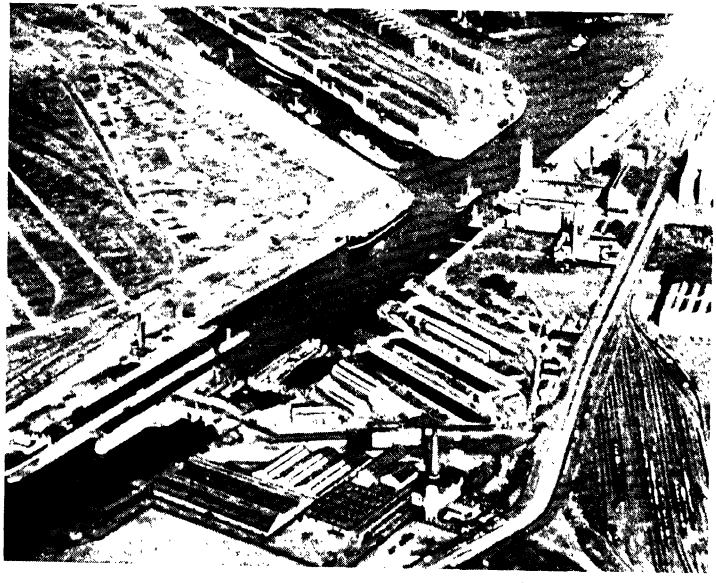
It is rather wonderful to read how complete was the faith of the Manchester folk in the eventual success of this tremendous project. Rates went up, and, in spite of the size and wealth of the city, it sometimes seemed as if disaster loomed ahead. Yet no one complained, more and more money was provided, and the result was triumph. Profit on the Corporation's loan to-day amounts to about £200,000 a year, providing a substantial sum for the relief of rates, and Manchester has every reason to be grateful to the far-sighted promoters of the great waterway which brings goods cheaply to the huge population of the city and the surrounding country.

Speaking of population, that of Greater London is 8,000,000, of Greater Manchester only 1,000,000; yet, if you take a circle sixty miles in diameter, with Manchester as its centre, you find that this circle holds 12,200,000 people, which is only half a million less than a similar circle round London, with Charing Cross as its centre. Within a radius of eighty miles of Manchester the population is 16,250,000; within a similar radius of London it is only 14,360,000.

To return to the canal, it was begun in 1887 and completed ready for opening in 1894. It is 30 feet deep as far as Stanlow, and 28 feet from that point on to Manchester. Its width at the bottom is 120 feet, and it is supplied with water from the rivers Irwell and

[Photo: Topical.

Congestion in the Kiel Canal caused through a collision. One of the real difficulties of canal shipping.



[Photo: Aerofilms.

Manchester Ship Canal Docks from the Air.

Mersey. The river Gowy runs under the canal in a huge syphon, and the river Weaver runs into the canal ten miles above its western end.

The level of the water in the Manchester docks is 58 feet 6 inches above the average high-water level at the mouth of the canal, and the levels in the various sections of the canal are maintained by huge locks. There are five locking systems and each is double, the larger lock being 600 feet by 65 and the smaller 350 feet by 45. Each lock has sluice gates to get rid of surplus water in time of flood, and also a pumping system which safeguards the upper levels from becoming too low for navigation in time of drought.

Several fixed high-level bridges cross the canal, but most of the roads cross by swing bridges. The old Bridgewater Canal crosses at Barton by a swing aqueduct, which is, in its way, as remarkable a piece of work as was Brindley's original aqueduct. It is indeed a master stroke of engineering. This modern aqueduct is a long narrow steel box pivoted on a little artificial island built in the centre of the Ship Canal. Waterproof iron doors work in slots at either end of the trough and can be easily lowered. When the bridge is to be opened to allow a ship to pass, the doors are closed and the swinging section with its trough of water moves into a position in line with the Ship Canal. When it is swung back the gates are opened, and the trough becomes again a continuous section of the Bridgewater Canal. The aqueduct is 235 feet long,

about 24 feet wide, and the trough carries 6 feet of water. Including the 800 tons of water which it holds, the whole thing weighs 1,450 tons. It is operated by hydraulic machinery in a control tower, and, in spite of its vast weight, can be swung to and fro with the greatest of ease. There is room for a ship to pass on either side of the island.

Starting from the eastern end, the first seven and a half miles of the Ship Canal follows the course of the river Irwell, which has been deepened and widened. For four miles from the spot where the Mersey and Irwell meet, the canal is a canalized section of the Mersey. The remaining twenty-four miles is all fresh cutting. The total quantity of earth moved was more than forty-four million cubic yards, and many kinds of soil were found, including blue loam, gravel, sand, black sludge, and even quicksand. But all this is underlaid with sandstone, and practically the whole bottom of the canal is rock.

The Ship Canal is always busy. Between four and five thousand vessels use it yearly, with a combined burden of more than six million tons. Raw cotton now comes straight from America or Africa to the heart of Manchester. So do oil, wheat, copper, lard, tea, chemicals, timber, and all sorts of raw or manufactured materials. The trade of the port of Manchester is valued at about a hundred million sterling a year.

Manchester sends quantities of goods by water from

her docks to Birmingham through smaller canals. The distance is 108 miles. These goods are transferred direct overside from the ships into barges. Hundreds of tons of fuel oil travel weekly in this way. The barges are towed by 40-h.p. Diesel tugs, of which the Company owns a number. Each of these tugs can tow four sixty-ton barges, and one result is that the time taken for the journey has been cut down from six to four days. While the motor boats are, of course, capable of a much greater speed, it is impossible to exceed three miles an hour on account of the damage that would be done by the wash to the banks of a narrow canal.

CHAPTER VIII

SPLITTING SCOTLAND

EARLY in the seventeenth century Coinneach Odhar, a Highland seer who, like so many of his countrymen, had the gift of second sight, said to his friends, " The time will come, and is not very far off, when full-rigged ships will be seen sailing east and west by Muirton and Tomnahurich." These are places in what is called The Great Glen, through which has since been cut the Caledonian Canal. This canal was planned as early as the days of Queen Anne. In 1725 an English officer, Captain Burt, travelled north to look at the glen, and declared that making a canal was out of the question. He said the expense would be colossal, and that, even if it were cut, the winds blowing down from the mountains that bounded it would destroy any vessels using it.

The gallant Captain could not have had much experience of the country, or he would have known that boats and vessels up to forty tons had used Loch Ness for many years without coming to any serious harm. He might also have recognized the fact that nowhere else in the world has Nature done so much

towards making everything ready for a canal. Of the total length of sixty-eight miles no less than thirty-eight miles are lochs. Loch Ness is twenty-four miles long, Loch Oich four miles, and Loch Lochy ten miles in length.

The canal was started to relieve distress after the great French wars at the beginning of the nineteenth century, and in 1822 the first small craft passed through it. But the work was so badly done that in 1838 the Government found itself faced with two alternatives—either to let the whole thing slide or to practically reconstruct it. They chose the latter course, and in May 1847 the canal was opened for vessels drawing seventeen feet of water. It had and has at least twenty-eight locks, and the level of Loch Lochy had to be raised by no less than ten feet. The height of the canal at Fort William is one hundred feet above sea-level.

To-day the canal is still in excellent order, and still pays expenses of upkeep. When the Great War came there was universal regret that it had not been built on a larger scale, for even if our destroyers could have used it its value would have been enormous. If it had been a ship canal our navy could have concentrated without risking the dangerous Pentland Firth passage.

After the war Government engineers carefully surveyed the Caledonian Canal, and came to the conclusion that it would cost ten millions to modernize it

and make it fit to carry large modern ships. There was much talk but nothing was done, and to-day the canal is used mainly by small tourist steamers. The appearance of the Loch Ness monster did a good deal in increasing this traffic, and during the summer of 1934 the canal steamers were packed with visitors from the south, anxious to get a glimpse of this mysterious creature.

Naturally the people of Inverness are keen to have the Caledonian converted into a big ship canal, but there is a rival route for a canal across Scotland. That is between the Firths of Forth and Clyde. The distance between the heads of these two great inlets is only thirty miles, and this may be called the neck of our island, for it is the narrowest strip of land dividing east from west. Another advantage of this route is that the highest point of land between the two firths is only 156 feet.

A canal does join the firths. It was begun in 1777 and finished in 1790. It is ten feet deep, and holds a record among the world's canals in that the earliest British steamer plied on its waters. This was the little *Charlotte Dundas*, built and engined by that genius, Symington, in the year 1790. Though of course very slow, she worked well, and was used to tow barges along the canal. But Symington was before his time. The owners declared that the steamer made a swell which damaged the canal banks, and the unfortunate Symington had to withdraw his boat, and

later died in poverty. It is worth mentioning that Robert Fulton, the American inventor who achieved great fame by building the *Clermont*, saw the *Charlotte Dundas* at work, and most certainly got some of his ideas from her. In 1812 a steamer built after his model ran on the Clyde.

In 1832 small steamers laden with coal began to run upon the Forth and Clyde Canal, which, at that time, paid twenty-eight per cent. in dividends on its shares. But the little canal has thirty-nine locks, and is quite inadequate for modern traffic, while it is generally agreed that a great modern waterway along its course would have tremendous possibilities. This is one of the richest parts of our island from the point of view of minerals. Thousands of millions of tons of coal lie beneath it, and there are also layers of shale rich in mineral oil.

A mid-Scottish canal would be of enormous value to the sea-borne trade of the country. At present Leith, the port of Edinburgh, is five hundred miles by sea from Glasgow by the northern passage. By the new canal the distance would be cut down to sixty-five miles. London would be a hundred miles nearer Glasgow and very much nearer to Belfast. Liverpool, Hull, Aberdeen, and Dundee would all be greatly benefited by the construction of this ship canal. The canal would be a boon also to Continental lines. Steamers from German, Dutch, and Baltic ports bound to and from America would use it. There does not

seem to be any doubt as to the amount of traffic it would acquire, or that it would pay good interest on its cost. There is also the point that, in time of war, if the misfortune of another war does come again upon Europe, it would be of untold value to Great Britain. For instance, if our fleet were in the North Sea and a sudden attack were made upon the North of Ireland, the North Sea fleet would have four hundred miles less to steam than by the passage round the North of Scotland. Then, too, it should be remembered that the Clyde is the centre of the greatest shipbuilding works in the kingdom. Disabled warships from the North Sea could be towed through the canal for repairs.

This great canal would be cut at sea-level, and its only locks would be one at each entrance. Allowing twenty minutes to negotiate each lock, Scotland could be crossed within five hours. The deepest cutting would be at Cannisburn, 160 feet, but this work would be child's play compared with the cutting of the Culebra Divide on the Panama Canal. The depth of the new canal would be thirty-six feet, and it would be broad enough to admit the largest of modern liners. As for the construction, that is all plain sailing, for the ground is old sea bed—sand, gravel, and boulder clay, with very little rock. The work could be completed within nine years.

From surveys made since the war it is reckoned that the cost would be twenty-five million pounds, and the lowest estimate of the shipping that would use it

yearly is well over eight million tons. That figure does not take into account Atlantic traffic from Northern Europe, which might easily make the takings half as large again.

It is an interesting point to remember that Defoe, famous author of *Robinson Crusoe*, visited Glasgow in the days of Queen Anne, and wrote that there was an easy passage from the Forth to the Clyde, and that a canal across Scotland would be a sound proposition.

There is still a third spot where our island could be cut in two, and for many years past there has been a scheme afoot to construct a ship canal between the Tyne and the Solway. But this would be a much heavier and more costly task than to link the Clyde and the Forth. In the first place the distance is much greater, being sixty-six miles, and in the second the land rises to such a height that it would be necessary to make a tunnel of about nine and a half miles in length under the town of Haltwhistle. The cost is reckoned at about fifty-six million pounds.

A tunnel large enough to allow modern ships to pass seems, on the face of it, a perfectly preposterous undertaking, but in point of fact it is nothing of the kind, for it has already been done.

The idea of using the Rhone and its canal to link the great Mediterranean port of Marseilles with the interior of France was mooted fifty years ago, so that heavy barges of 1,200 tons' burden could carry raw materials imported by sea to the factories inland. On

the map it looks as if the Rhone offered Marseilles a fine waterway into Central Europe, but the fact is that the mouths of the Rhone are so choked with the immense amount of mud brought down by the river that they are impassable for anything larger than a fishing boat. As for dredging them, the cost puts this out of the question.

It was clear from the beginning that a canal would have to be made to reach the Rhone at Arles; but the mountain ridge which skirts the coast of the Riviera and lies between the city and the large lake known as the Etang de Berre, was a real difficulty. Engineers said that there was nothing for it but a tunnel, a tunnel of four and a half miles in length.

There are at least a dozen tunnels of more than four and a half miles long elsewhere; there are four which are more than twice that length, and one, the Simplon, which is three times as long, but nowhere else in the world is there a four-mile tunnel of such height and width as the one at Rove. It is 72 feet wide and 47 feet in height, whereas the largest railway tunnel, which runs under Bergen Hill in New York State, is only 30 feet by 23 feet. In spite of the greatness of the undertaking the work was put in hand in 1911, at an estimated cost of four million pounds, and two thousand men were employed. The war interrupted the work, and actually the tunnel was not completed until 1925. It is as straight as a ruled line. There is not a foot difference anywhere in height or breadth,

and on a bright day, sitting in a boat at the Marseilles end, the passenger can actually see a faint glimmer of sunlight in a half-moon shape at the far end.

The difficulties experienced by the engineers were far greater than anticipated. In the middle of the tunnel the rock gave way to loose earth full of water, and an underground stream pouring out in a vast spout tore down the walls of the tunnel and carried away machinery and cement casing as if it had been so much paper. Fresh approach works had to be constructed and a channel made for the underground river before work could be continued.

In the end the cost of the canal was twenty-five million pounds, yet, in spite of this heavy outlay, the Marseilles Canal is already beginning to pay. It not only opens up central France to sea-borne goods, but allows them to reach Switzerland via Geneva, and Germany by way of Mulhouse. Its success should encourage Great Britain to go ahead with the Mid-Scottish Canal.

CHAPTER IX

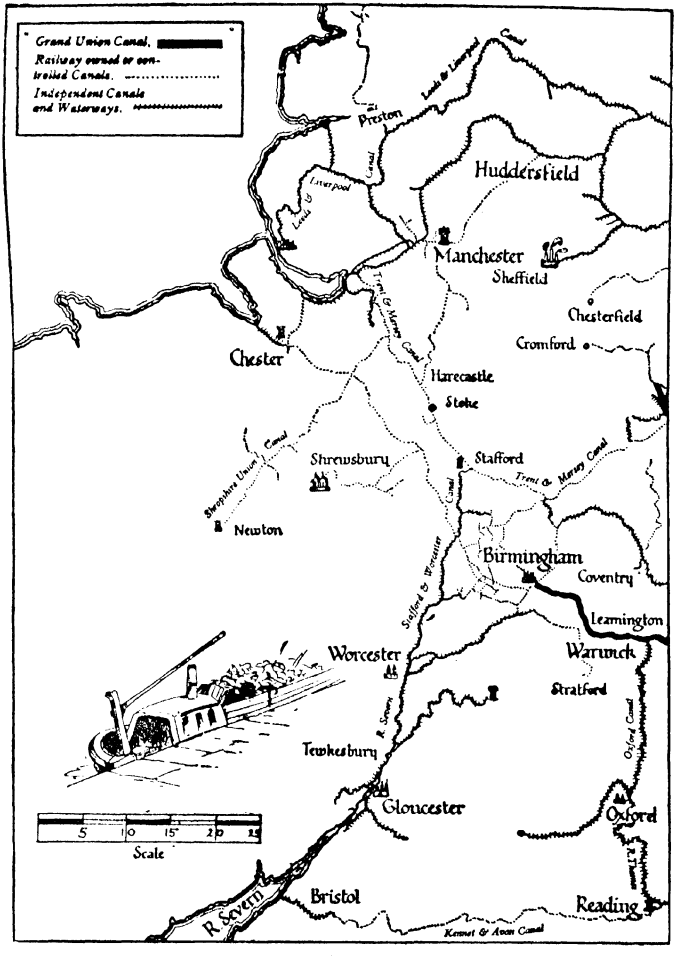
OUR NEGLECTED CANALS

WITHOUT boasting we can say that British railways are the best and safest in the world. Equally without fear of contradiction, we have to confess that our canal system, once the best, is now the worst. The unpleasant truth is that the railways are mainly responsible for the ruin of the canals.

The golden age of British canals dates from 1761, when the Worsley–Manchester Canal was opened, and lasted up to about 1840, when railways began to expand. The railway companies looked upon canals as dangerous competitors, and the canal owners, thinking that their profits would go to the quicker railways, took fright and were only too ready to sell to the railways, and get out with as little loss as possible. The railways were equally ready to buy. As a result a dozen canals fell into the hands of the Great Western, six to the Great Northern, fourteen to the London and North-Western, and seven to the Manchester, Sheffield, and Lincolnshire. By 1855 our canal system was in ruins, and, with a few brilliant exceptions, has remained so.

Of course, the early railway directors who bought in the canals so as to prevent competition acted foolishly. In other countries, such as France, Belgium, and Germany, canals are used as feeders to the railways, and it has been found that there is plenty of room for both forms of transport. Canals can carry heavy goods such as coal, bricks, gravel, sand, pig-iron, and manure much more cheaply than railways. Here are figures to prove it. On a flat road a horse can pull two tons at three miles an hour; on a flat railway it can pull fifteen tons, but on a canal it can pull from sixty to a hundred tons. Therefore the cost of propulsion on water, whether it be horse traction, motor, or steam traction, is only a fraction of the cost by road or rail.

Our canals are still in existence though some are derelict, but very few people are aware how complete is the system. Actually you can get almost anywhere in England by water—for instance, from London to Bristol, or from London to towns in Lancashire or Yorkshire. You can travel by boat or canoe from the Thames to the Severn, from the Severn to the Ouse, from the Ouse to the Trent, the Humber, or the Mersey. During the past few years enterprising young people have been discovering this fact, and have been spending delightful holidays by canoe on our inland waterways. The Canadian canoe is the ideal craft for a trip of this sort, because it can be so easily lifted over locks.


Grand Union Canal.
Railway owned or controlled Canals.
Independent Canals and Waterways.
Preston
Leeds & Liverpool Canal
Huddersfield
Manchester
Sheffield
Chesterfield
Cromford
Chester
Harecastle
Stoke
Trent & Mersey Canal
Shrewsbury
Shropshire Union Canal
Newton
Stafford
Trent & Mersey Canal
Birmingham
Coventry
Leamington
Warwick
Stratford
Worcester
Stafford & Worcester Canal
R. Severn
Tewkesbury
Gloucester
Oxford
Oxford Canal
Bristol
R. Severn
Reading
Kennet & Avon Canal
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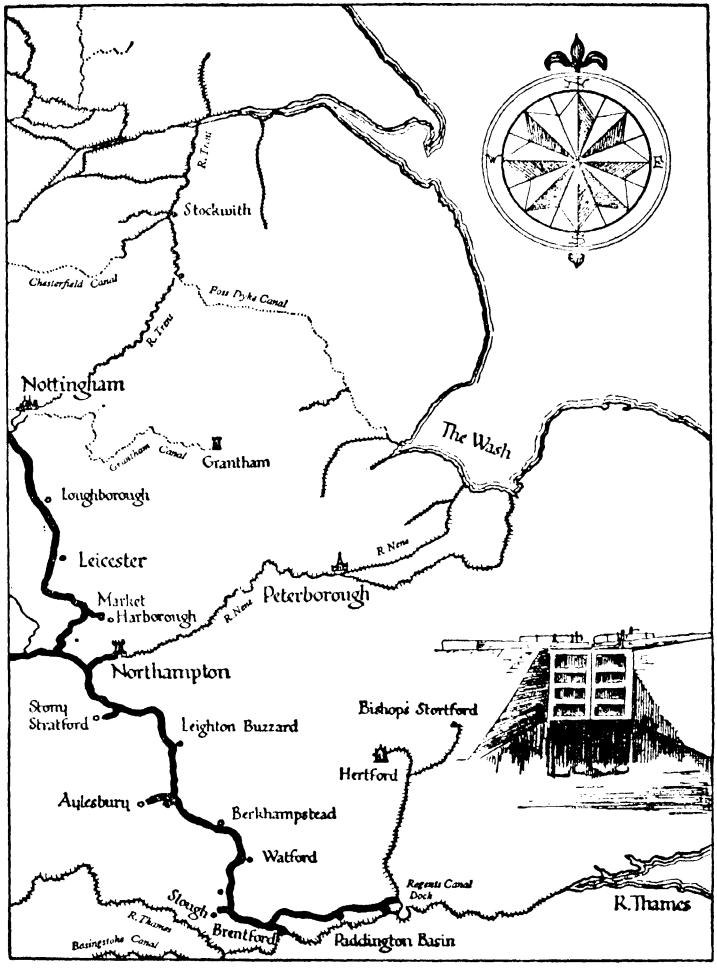
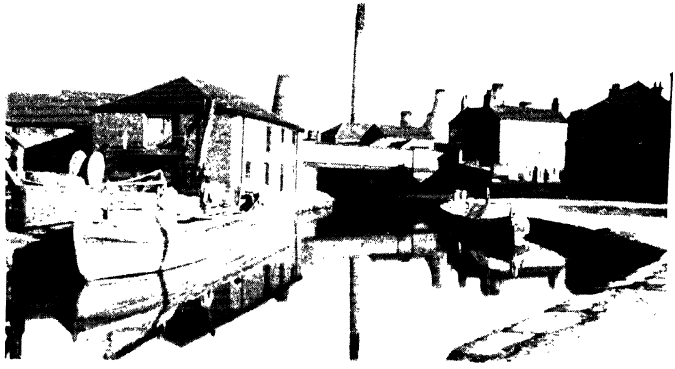
Scale


Stockwith
R. Trent
Chesterfield Canal
Fosse Dyke Canal
R. Trent
Nottingham
Grantham Canal
Grantham
The Wash
Loughborough
Leicester
R. Nene
Market Harborough
R. Nene
Peterborough
Northampton
Stony Stratford
Leighton Buzzard
Bishop's Stortford
Hertford
Aylesbury
Berkhampstead
Watford
Regents Canal Dock
R. Thames
Slough
R. Thames
Brentford
Paddington Basin
Basingstoke Canal

In the early years of the present century our canals still carried forty million tons of merchandise yearly, but in 1933 this tonnage had fallen to about eleven and a half millions, and it is interesting to notice that of this amount only a million and a quarter was carried by the canals owned by railways. Instead of profit the railways make a dead loss on their canals, with the result that they would be glad to give them away in order to save the expense of maintaining them, as by law they are compelled to do. Actually there are something like a thousand miles of canals in this country, constructed at a cost of millions of pounds, which can be had for the asking. The gifts would include all accessories such as pumping stations, locks, tunnels, lifts, and inclines, to say nothing of much excellent fishing. Some of these canals run through lovely country, and give unrivalled opportunities for boating, picnic parties, and even bathing.

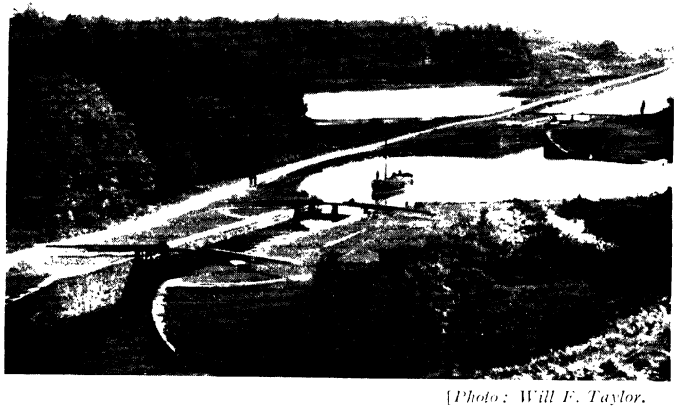
In 1906 a Royal Commission was appointed to look into the decay of British canals, and was followed by the appointment of a Committee on Inland Waterways, with Mr. Neville Chamberlain as President. Their report shows that there are two chief difficulties in the way of restoring inland water trade in this country.

1. The canals are too small and too shallow. They average only four to five feet in depth, with locks about seventy feet long and eight feet wide. There are also too many locks. The Rochdale



[*Photo: Will F. Taylor.*

In the Staffordshire Pottery District.



[*Photo: Will F. Taylor.*

The Crinan Canal, Argyll.

Canal, for instance, has ninety-two locks in thirty-three miles, while between Birmingham and Worcester there are no fewer than fifty-eight locks.

2. The canals have too many different owners. Even individual canals are not owned by one company throughout their entire length, but are split up into sections under different ownership. As an example, a boat travelling from London to Liverpool passes over the waters of nine different companies. Also, the owners are not, as a rule, carriers; they are merely toll-takers, so that on few canals is there any regular service.

British railways suffered for years from being divided up under scores of different companies. Since they have been amalgamated into four great groups they are doing better. The Committee advise that our canals should be divided into seven groups, and that canals should be deepened and widened so as to be able to take barges up to one hundred tons instead of the small barges now in use.

Government reports are dull reading, but we have had to mention this one, because, though its recommendations have not yet been carried out, it has turned popular attention to our canals and helped to start the revival which is now beginning.

This revival began as long ago as 1917. Those of us old enough to remember the Great War remember also the coal famine in London. The railways were so busy they simply could not spare trucks to carry coal.

The collieries turned to the canals, and in April 1917 the first coal-laden barges arrived in London from Staffordshire, a distance of 160 miles. These barges were motor driven, and carried fifty tons of coal at a cost of three shillings and sixpence a ton for transport as compared with seven and sixpence a ton by rail. This traffic was hindered by lack of barges. It was said at the time that nearly half the barges in use fifty years earlier had been left to decay.

This coal came by the Grand Union Canal, and this is the Company which has headed the revival of our canals. It has amalgamated the Regent Canal, the Grand Junction, the Warwick and Birmingham, the Warwick and Napton, the Leicester and Loughborough Navigation, and the Erewash Canal, and now controls 280 miles of waterway. The Company has spent a million pounds in deepening and widening its canals, building new locks, and strengthening and cementing the banks, so that they can withstand the wash of faster vessels. The work was begun in May 1931 and completed in 1934. In October of that year the Duke of York performed the opening ceremony at the new series of locks on the Warwick section. There are now fifty-one new locks of a large modern type replacing the fifty-two old ones which, most of them, were made in the eighteenth century. The result is that now barges of 12 feet 6 inches beam can be navigated from London to Birmingham in place of the old " monkey " boats which were only 7 feet in width.

The barges which the Company are building are of a type new to English canals. They are made in pairs. One of the pair has a Diesel motor engine, and not only carries a load but pulls its fellow. Each pair has a carrying capacity of fifty-five tons, and costs a little over £1,000. They are faster than the old horse-drawn barges, though the speed of any canal boat is strictly limited because of the wash which damages the banks. These modern boats have also much more comfortable living accommodation than the old ones. They have electric light, and can work at night, which was, of course, impossible for the older type of barge. About a hundred and fifty men will find steady employment with these new barges.

The Grand Union Canal joins the Thames at Limehouse, where, if you ever pay the place a visit, you will find a large dock with a number of barges lying in it. Outside may be seen cargo steamers from almost every port in Europe. The canal goes right through east London, passing under the high ground of Islington by a tunnel a mile in length. There is no tow path through the tunnel, and barges are towed through by a tug which runs once an hour, pulling a whole string of barges. This tunnel was made more than a century ago, but is still in perfect condition.

On the north side of the tunnel the canal crosses the railway lines by a series of bridges, and the men in charge look down on a tangle of lines and sidings. Then comes the stretch through Regent's Park, and

presently the barge passes under the Edgware Road by another short tunnel and reaches Paddington Basin, which is the junction for all London's barge traffic. North from London it is one long climb up to Tring in Hertfordshire, and at Tring are three large reservoirs used to fill the canal.

One of the first things to be considered in the construction of a canal is the water supply. And that supply has to be close to the highest land which the canal crosses. If water fails the canal is useless, and it is a fact that during the dry summers of 1933 and 1934 some of our English canals were little better than dry ditches. There was hardly water enough to float a canoe let alone a barge !

CHAPTER X

BARGE FOLK

And the craft they live in

Of all the world's workers there are none so isolated as the people of the canals. They have been called "The People by Themselves," and it is not a bad description. Not *lonely*, mind you, but isolated. All day they are moving up and down the water lanes; at night they may meet friends at a canal-side public house, but their friends are barge-men like themselves. You notice we say *barge-men*, not *bargees*. The people of the barges never use the word, so why should we?

They live, sleep, and eat aboard their long narrow boats, and even these are not commonly called barges. Most of them are "monkey boats." The monkey boat is roughly seventy feet long, with a beam or width of seven feet, and, since it is built for carrying cargo, the living quarters are very small. As a witness said in giving evidence before the Royal Commission on Labour some years ago, "A narrow-boat cabin has only 250 cubic feet of space for living, sickness, sleep-

ing, cooking, washing, and dying, and all other incidents of family life."

Two hundred and fifty cubic feet is barely room for one person. The barge cabin is actually smaller than the average third-class railway compartment, and how a man, his wife, and three or four children contrive to live in it is a mystery. You may say, of course, that they live outside on the deck. So they do as much as possible, but what about winter weather and snow and rain and fog and cold winds? We have heard of a case of five children as well as their father and mother living in such a cabin. One child slept across the top of the bed, another across the bottom, two under the bed, and the fifth on the table.

You watch one of these narrow boats moving slowly along the canal on a summer day, the old horse plodding along the tow path with one of the children leading it; you see the skipper, pipe in mouth, leaning against the tiller and his wife sitting on the cabin top, and you think to yourself that this is a pleasant, gipsy-like sort of life. Have a chat with the man, if you can catch him in the evening, and you will soon learn that his work is very far from being easy. Life on the "cut," as the boat people call the canal, is full of hardship, and has more than a dash of danger.

In the first place the work is not constant; a job is finished and a man may have to wait days for the next. And while he waits he gets no pay. Indeed, most of his life is waiting. He waits for jobs, for weather, for

his turn below the loading chute, and his turn at lock gates or tunnels. He has to be up and doing very early in the morning, and he can rarely count on any definite time for tying up for the night. He is exposed to every sort of weather, and it is weather that brings him his three chief dangers, all of which begin with " f." They are fog, frost, and flood.

He hates the fog most of all. When there is a bad fog the barge-man lies up if it is anyway possible. A tow path is a narrow thing at best, and when he cannot see a yard ahead he or his horse or both may find themselves over the edge of the slippery bank and struggling in six feet of icy water. The number of deaths from drowning among the barge people is very large, but the newspapers rarely mention such accidents. Then, too, in a fog there is always the risk of collision, especially if one barge is motor-driven and the other horse-driven.

Flood is bad. You would be surprised to know how frequently tow paths are flooded. If the weather is clear the man or woman mounts the horse and rides along, splashing slowly through a foot or so of water; but when a gate has to be opened the rider must dismount and wade knee-deep in the chilly water.

Sharp frosts put an end to active work on the canals. Everything comes to a standstill when the sluggish cut freezes up. An inch of ice is quite enough to prevent boats from moving. If the frost lasts long money runs out, and the barge folk soon begin to go

hungry. In the big frost of 1895 there was terrible distress, and soup kitchens were opened in London and elsewhere for the people of the canals.

The canal population has its classes just like every other form of labour. At the head is the man who owns his boat, or perhaps a pair of boats, and works independently; next is the man who hires his boat, paying a weekly rental, picking up work as he can; thirdly come men employed by one of the companies who own boats, and who work either for a fixed wage or a percentage of the takings. Some have their own horses, some hire them, some have them provided by the company.

There is an old saying about "swearing like a bargee," and it is true that the average barge-man has a fair command of strong language. Yet as a rule he is a very philosophical sort of fellow, and certainly does not swear unless worked up. And one thing must be said for him and for his wife. They are the cleanest, tidiest people imaginable. Perhaps it is because their living quarters are so tiny that they feel the necessity for perfect order, but, be that as it may, these wee cabins fairly shine. The stove glows like a patent-leather boot, there are bright curtains, and every spare bit of wall is hung with pictures. The same thing is evident in the boat itself. Hatches and roof-decks are constantly swabbed, and the mop is used, too, to clean the boots of those who step aboard after a spell on the muddy tow path. The horse is

well groomed, and the brass on his harness shines in the sun.

A love of bright colour is shown in the way the boats are painted. From the gunwales to the tiller everything is covered with painted designs. Even the cupboard in the cabin is similarly decorated.

The women deserve a word to themselves, for they are as capable as the men. Most of them have been brought up on the water, and the wife knows as much about handling the boat as the husband. Besides being able to steer she can drive as well, and is generally a good cook into the bargain.

Thirty years ago ninety per cent. of the canal population of our country were illiterate. They could neither read nor write. Small wonder, for how was a child to get schooling when it was in London one week, Birmingham the next, and perhaps Manchester the third? A great change has come about, and now there are special schools for the children of the barges at Paddington and Brentford, while the Grand Union Canal Company has fitted up a large barge as a school, which is staffed by the Middlesex County Council Education Committee.

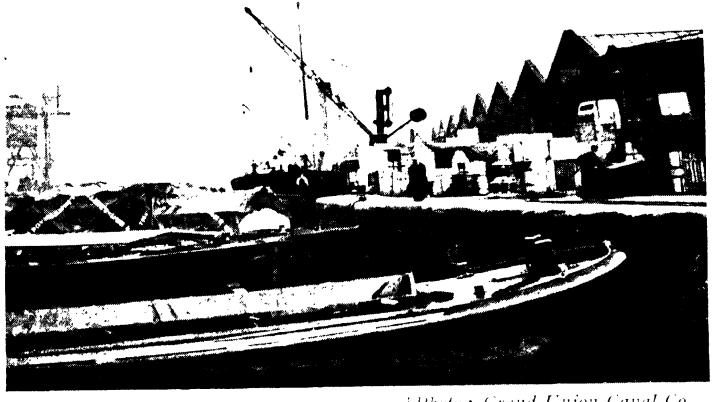
The outside world calls everything that floats upon a canal a barge, but the true barge is the great broad-beamed, brown-sailed craft which you see on the Thames or off the coasts, often so heavily loaded that water actually washes across the deck. Canal craft are boats which are roughly divided into two kinds,

one with an open hold for imperishable cargo, the other—commonly called the "cloth boat"—roofed with planks and canvas for carrying more valuable or more perishable stuffs.

The ordinary monkey boat is, as we have said, about seventy feet in length. It draws eight to eleven inches of water when empty, which draught increases roughly one inch to the ton as the boat is loaded. The Dutch taught us centuries ago that boats without keels are best for canals, and that the best shape for bow and stern is that of the end of the bowl of an ordinary spoon, and most of our canal boats are built on these lines. At the same time you will find varying types of boats on canals in different parts of the country.

On the Leeds and Liverpool Canal they have what are called "short" boats which are only 62 feet long, that being the maximum length for some of the locks. But these short boats are twice as wide as the monkey boats, their beam being 14 feet 3 inches. Fen lighters are only 42 feet long and about 9 feet wide, while Mersey flats have a length of 70 feet and a width of nearly 15 feet. Fen lighters are seen only on the Bedford Level and its tributaries, and usually travel in strings of five, the stern post of one being tightly coupled to the bow of the next by what is called a "seizing chain."

Swansea Canal boats are double-ended, and the rudder can be changed from one end to the other as



[*Photo: Grand Union Canal Co.*

A busy scene in Regent's Canal Dock, London.

[*Photo: Topical.*

Father Christmas visits the Barge Folk.

required, while Tyne wherries will carry as much as a hundred tons of coal and are usually towed by a tug.

Perhaps the oddest of all canal boats are the so-called " Tom Puddings " used on the Aire and Calder Navigation. These are nothing but oblong iron boxes, each 20 feet long, 15 feet wide, and 8 feet deep. They are used for coal, and can carry thirty-five tons on a draught of 6 feet 6 inches. Nineteen form a train, which is towed by a steam tug. Since boats of this shape would offer a very heavy resistance to the water and tow badly, a short wedge-shaped boat called " Dummy Bows " is attached to the fore end of the train. This carries no cargo and its use is only for cleaving the water.

All our canal boats are small when compared with those used abroad. In Holland and Germany canal boats carry up to three hundred tons of cargo, yet require no larger crew than our much smaller craft. For another thing, it costs less to build one three-hundred-ton boat than three boats of seventy tons' burden, so size proves an economy.

The best canal boats yet constructed in England are certainly the new type of the Grand Union Canal Company, which, as we have said, are in pairs, the front one being provided with a motor engine and towing the second, which is called a " butty." These boats are iron-sided, with bottoms of elm wood. The engine of the motor boat is 18 h.p., and is designed to give a steady speed of five miles an hour.

What must rejoice the occupants of these new boats is the immensely improved cabin accommodation. In the "butty" there are three folding bunks and a folding table. There is plenty of room for stowage of clothes and blankets and the like, while the cabin itself is fully twice the size of the old ones.

CHAPTER XI

CANALS OF THE FUTURE

Paris may be a seaport and Florida an island

JACQUES LEBAUDY was an enterprising young Frenchman, whose great ambition was to become a king. He had a nice little fortune of three million pounds, so he hired an army of five hundred old soldiers, bought sixteen thousand rifles and machine guns, and sailed for Cape Juby on the north-west coast of Africa. This was in the year 1903.

Arrived at the edge of the Sahara Desert he ran up his flag—blue with three golden balls, and proclaimed himself emperor of the Sahara. He started to build a capital called Troja, but the Moors, who had at first received him well, became annoyed and attacked him. At the same time the Spanish authorities seized his yacht, the *Frasquita*. Lebaudy retired, and was heard of no more until 1915, when he came into the papers again as having escaped from a lunatic asylum at Amityville in New York State. His excuse was that the cooking did not suit him !

You may ask what this story has to do with canals.

The fact is that Lebaudy had the idea of cutting a great canal through the boundary range between the Atlantic and the Sahara and creating an inland sea. He argued—and quite sensibly—that a large body of water in the desert would cause evaporation and make rain, and so change the climate.

Actually his scheme was impossible, because all that side of the Sahara lies above sea-level. There is, however, another area inland from the Gulf of Gabes, behind Tunis, which does lie below the level of the Mediterranean, and which could be turned into an inland sea. But whether it would pay to let in the sea is a question much discussed and not yet decided.

The deepest hole in the world is that occupied by the Dead Sea. It is actually as much below sea-level as the Malvern Hills are above it, that is 1,400 feet. There has been much talk of cutting a canal across Palestine to take sea water across to the Dead Sea and use the great fall for electric power. Such a plan might, however, interfere with the important potash works which have been started on the shores of the Dead Sea.

That irrigation does change climate has been proved in America. Of late years rainfall has increased over all the arid country which was once called The Great American Desert. Mr. E. B. Dunn, an authority on climatic changes, points out that nineteen million acres of once desert land from Montana to Texas has been watered by irrigation canals during the past thirty or

forty years. This land is now covered with trees and crops, from which moisture is drawn up, causing areas of low pressure and, consequently, storms. The same thing has been noticed—though to a lesser extent—in the irrigated lands of India.

We have spoken in an earlier chapter of the Canal du Midi in France. A plan is afoot for building along its course a large ship canal running from Bordeaux to Narbonne. It would be a tremendous waterway, the largest in the world, with a breadth of 65 yards at the bottom and a depth of 40 feet. It would be 400 kilometres in length, but would have only 14 locks as compared with 148 on the present canal. Such a canal would carry almost any ship afloat, and it is said that they could traverse it in twenty-four hours at a speed of fourteen knots per hour.

But the cost would be colossal. It is estimated at a hundred million pounds. Also it would take at least ten years to construct. It is reckoned that it would cost a million and a half yearly to keep it in order, and the big question is whether it would pay. Still it seems likely that, sooner or later, the "Canal of the Two Seas"—as the French call it—may be cut.

Paris is to some extent a seaport, for barges and small craft come up the Seine to the French capital. But the Seine is liable to very heavy floods, during which navigation is impossible, and at such times the warehouses at Havre and Rouen become choked with goods. For years past there has been a project afoot

to connect Paris with Rouen by means of a ship canal, which would render Paris immune from disastrous floods and make her a great seaport. The canal would follow the course of the Seine for most of its distance, but several cuts would be made where the river makes big bends. At present the depth of the Seine is only ten feet six inches. The new channel would be at least twenty feet deep, enabling vessels of 4,500 tons to reach the city. The cost is estimated at about eleven millions.

Barges can pass from the Baltic to the Black Sea, and, indeed, on to the Caspian. This system of canals was planned by Peter the Great, but only completed about the year 1860. The Ladoga Canal unites the Neva River with the great Volga. Central Russia is mostly a vast plain, so that canal making is a comparatively simple matter. For many years past every Russian Government has been keen upon a ship canal between the Baltic and the Black Sea, and it is easy to see why this is the case. At present the Russian fleet is cut in two, and if the two parts wish to join up they have the tremendous voyage all through the Mediterranean, the Straits of Gibraltar, the Atlantic, North Sea, and Baltic.

The barges used on Russian canals are very different from those seen on English waters. They are longer but very narrow, and they draw only twenty to thirty inches of water. Instead of a rudder each is provided with a long steering oar roughly hewn out of a tree

trunk. An English barge has a pump, but the Russian barge-man uses a scoop fastened to a crossbar. And leak they do, for they are very roughly built.

South American Indians bring cargoes down the Amazon on rafts which float with the current. When the cargo reaches its destination and is unloaded, the Indians simply turn the raft loose to float or break up. The Russian canal navigator works on similar lines. He will start from the Volga with the floods of spring in a barge that has cost no more than thirty or forty pounds to build, deliver his cargo at Leningrad in the autumn, then sell his barge to be broken for firewood, and go back afoot or, if he can afford it, by train.

Plans were made many years ago for this Baltic-Black Sea canal by the Belgian engineer M. Defosse. The idea was to use the river Dneiper, which runs into the Black Sea. This canal, if it is made, will be by far the longest ship canal in the world, for its length will be 960 miles. On the other hand, the cost will be much less, mile for mile, than any of the big ship canals which are already in use. It is thought that the whole thing could be carried through for forty millions, for labour is cheap in Russia.

There is an enormous coastal trade between Boston, New York, and other great ports on the Atlantic coast of North America, and the southern ports such as Galveston in Texas and New Orleans. All the traffic has to go round the toe of the long peninsula of Florida, a State which is as big as England and Wales.

At the time of writing there is a move on foot to construct a canal through North Florida from the Atlantic to the Gulf. It will cut the round trip from New York to New Orleans by at least 783 miles. The Bill for its construction has been signed by President Roosevelt.

The survey has been made, and the canal will run by the St. John's River, which is enormously broad and deep, across to the beautiful Ocklawaha River, then by the Withlacoochee River to the Gulf of Mexico. It is reckoned that 30,000 men could complete the job in four years. The canal will be 135 miles long and 33 feet in depth. Florida soil is mostly sand, and the country is very flat. The highest point of land between the two seas is only one hundred feet above sea-level, so the job will be an easy one, and there will be only two locks. The cost will be £23,000,000. Oil, cotton, and minerals will be brought cheaply from South to North, and warships as well as vessels of commerce will be saved the long voyage round by Key West and the dangerous passage through the Straits of Florida. Dangerous because the Straits are full of shallows and reefs, and also lie in the cyclone belt. There is, however, one serious objection to this Florida canal. The soil being all sand, it is asserted that the salt water will soak into it and destroy vegetation for some distance on either side.

Another American ship canal which is planned, and which is almost certain to be made before very long, will cut the Isthmus of Chigneto which connects the

Canadian province of New Brunswick with the peninsula of Nova Scotia, famous for its apples. Nova Scotia, lying just south of the mouth of the great St. Lawrence, is nearly three hundred miles long, and its coasts are notorious for their reefs and rocks. This canal, which would be only twenty miles long and easy to make, would save hundreds of miles to ships going south from Montreal, and the wonder is that it was not cut long ago.

THE END

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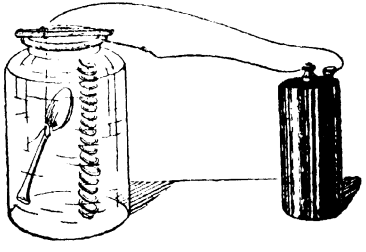

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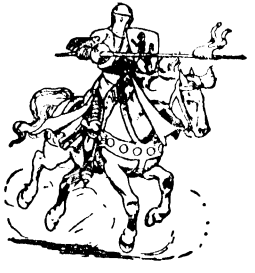

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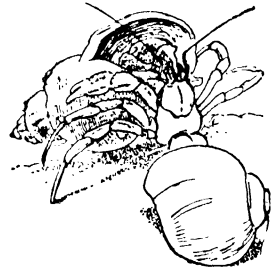

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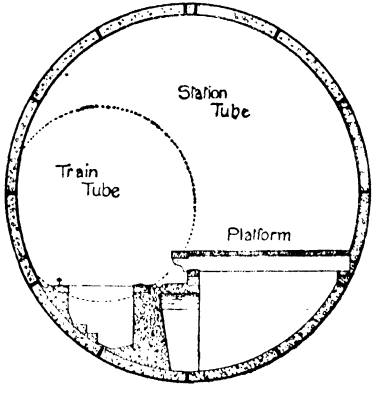

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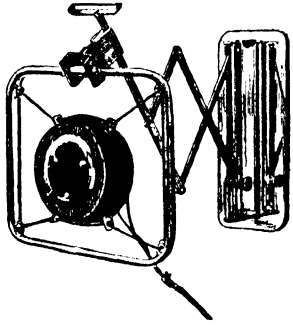

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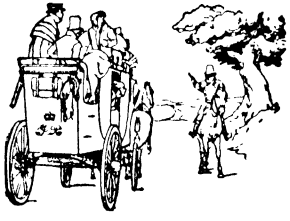

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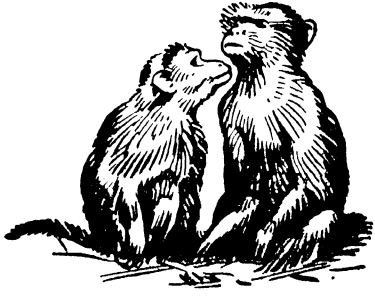

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