HARRY McNICOL

FAMOUS INVENTORS

ARKWRIGHT - WEDGWOOD

EDISON - MARCONI

RICHARD ARKWRIGHT

I

ON a bright spring afternoon in the year 1767 a thick-set man of about thirty-five rode into the village of Heywood in Lancashire. On his rather coarse face was a serious expression as he looked towards the cottage doors, where women and girls sat working at their spinning wheels. Through the open doors and windows came the noise of looms as the weavers sent their shuttles backwards and forwards, weaving together cotton and linen thread into 'fustian'. In those days it was still impossible to make pure cotton cloth from English thread, as the spinning wheel could not make yarn strong enough to stand the strain of the clumsy looms.

The traveller brought his horse to a stand by a small cottage, at the door of which sat a young girl. She was bareheaded, and her rich, chestnut hair hung in two heavy braids over her shoulders.

'I'll give you a shilling for your hair, my girl,' the horseman called to her in broad, Lancashire speech.

The girl stopped her wheel and, blushing, was about to run into the cottage when an older woman appeared at the door.

'What is it, Sarah Jane?' she inquired, looking at the man suspiciously.

'Arkwright's my name, ma'am; the barber of Bolton. I pay a good price for hair to make into wigs. I'll give the lass a shilling for hers and take it off so neatly that she won't know the difference.'

'Come in,' the woman invited, and the barber climbed down from his fat mare and followed her into the cottage.

The living-room was half filled with a loom, at which sat the girl's father. He turned as the newcomer entered: 'Why, it's Master Arkwright! Sit down, lad. I'm very pleased to see you! It's the barber from Bolton I was telling you about, Mary,' he added, turning to his wife.

'How do, Jack!' Arkwright responded heartily, seating himself on the corner of the table. 'How's trade these days? Are you busy?'

'If it isn't one thing it's the other. There was a time when we weavers had to work ourselves to the bone to make enough to keep alive. Now the traveller from Manchester can't give us enough varn to keep the looms going for a whole week at a time.'

'But the loom works faster these days and you ought to be making twice as many yards of cloth,' put in the barber.

'Yes, but we're paid less for what we do. A couple of years ago Mr. Acroyd, my employer, came with his traveller and told me to fix a fly-shuttle to the old loom. He said I'd weave twice as fast. But he paid me only half the price I'd been getting for each piece. The work's not so hard now; but the spinners can't keep up with us weavers.'

'You want to invent a spinning frame that would work about a dozen spindles.'

'And what would my old woman and the lass do for a living—and all the other lasses as well? Yarn would be so cheap that the travellers would only take the cotton wool to the spinners who had the new frames.'

'They say a man in Blackburn, a fellow called Hargreaves, has made a spinning frame to work eight spindles.'

'Yes! And what's happened to him?' the weaver demanded angrily. 'The weavers and spinners smashed his devil's machine

and burnt his house for him. We want no inventors in this part of the country. Why don't they leave honest men to earn an honest living?'

As Arkwright rode along the road to Bolton, his thoughts were far from the bundles of hair in his saddle bags and the wigs they would make. Yes, there was a fortune for the man who could make a spinning frame. Since the joiner of Bury had speeded up weaving by inventing the fly-shuttle, it took four spinners working at wheels to keep pace with one weaver.

For five years he had travelled the roads in search of hair, and it was always the same story: weavers were idle for want of yarn. And Hargreaves of Blackburn had invented a spinning frame! His own thoughts had been running on such an invention for many months. Had he missed his opportunity, he wondered?

In those days most of the cotton used in England came from countries at the eastern end of the Mediterranean Sea, where the fluffy, white tops of the cotton plants were picked and made into large bundles. Since the cotton wool was very tangled, the craftsmen in England had first to straighten it out. This was called carding, and was done by laying the cotton wool on what looked like a large hair-brush with steel bristles, which was fastened by its back to the table. Then another 'hair-brush' was drawn across this so that the steel teeth combed out the cotton wool.

The next thing to do was to make the cotton wool into a continuous rope. This was called roving. Then came the spinning. You will be able to understand how this was done if you find a piece of string and take out your fountain pen. Tie a loop at one end of the piece of string and catch this under the clip of your pen.

Now hold the pen in front of you in your right hand and the string in your left, so that pen and string are in a straight line. Roll the pen round between your fingers, and you will find that it twists the string.

After doing this for some time, move your left hand so that the string is at right angles to the pen, which you are still rolling between your fingers. The pen will now wind the twisted string round itself.

Spinning is just like that. The pen is the spindle and the string is the yarn, or thread. The spinning wheel consists of a large wheel mounted on a stand, with a belt running round it to the wooden spindle. The spindle is a piece of wood about the same size and shape as a pen. It has a hook on it like a pen clip. The spinner fastens the end of the roving, or cotton wool rope, to this hook. Then she turns the large wheel with her right hand, causing the spindle to revolve very quickly. At the same time she draws out the cotton rope with her left hand until it is very thin. When the spindle has twisted this sufficiently, the spinner moves her hand round, so that the thread is wound up round the spindle. This is done again and again.

There were two drawbacks: the thread so made was weak and thin; and it took four spinners to keep up with one weaver, when the thread was made into cloth on the loom. The loom was a large frame with hundreds of threads running side by side. When the weaver pressed a pedal down, the even threads rose up and the odd ones sank down, and he passed a shuttle between them. This shuttle was shaped like a torpedo, and inside it was a bobbin of thread, which was paid out through a hole in the side of the shuttle.

JOSIAH WEDGWOOD

I

'JOSIAH, come here!' called the burly man from the door of the workshop.

The boy at the bench apparently did not hear, in spite of the loudness of the call. He dipped his brush in the pot of enamel and, with the greatest care, proceeded to apply the colour to the article he was decorating.

'Confound the boy!' muttered the man who had called. Folding his arms he strode across the room. With a frown he stood for a moment looking down at the young craftsman, who was so intent on his task that he had not noticed the approach of the other.

'Josiah!' the man bellowed, almost in his ear.

The startled boy jumped, and his brush smeared the blue enamel in a streak across the design he was painting. He turned, clenching his fists with rage, then, seeing who had disturbed him, checked himself.

'Why did you do that? You've ruined it,' he cried hotly.

'Didn't you hear me call you? Must I come running to find my apprentices every time I want them?'

'But ——'

'Be quiet! You seem to think that, because you are my young brother, you can take what liberties you like. But remember this, Master Josiah Wedgwood; you are my apprentice, and I am your master. You are not a master potter yet, and never will be, if you waste your time like this. What have you been playing

with, anyway?' He picked up the tiny piece of earthenware from the bench. 'A snuff box, eh!'

In spite of his annoyance, Master Thomas Wedgwood had to admit to himself the beauty of the dainty little box, with its sprays of flowers in blue and green. He was a skilful potter himself and he realized that his youngest brother was much cleverer at this kind of work than many men.

'I can't keep the business going if my workmen spend their time making these toys,' he said more quietly. 'I've let you do decorating work because your leg hurts you when you work at the wheel; but I expect you to do as you are told.'

'But I've ——'

'Don't answer me! Go and help Jack to put those saggers in the kiln.'

With a sigh Josiah Wedgwood limped out of the workshop.

II

Young Josiah Wedgwood was learning to be a potter, like all the rest of his family, and his father and grandfather before him. In fact for over a hundred years before 1730, when he was born, the Wedgwood family had earned their living by making pots in Staffordshire.

Let us see how pottery is made. Everyone uses the terms 'china', 'earthenware', 'porcelain' and 'pot'; but it is not everyone who knows the difference in their meanings. The word 'pot', means any of them; it is like a Latin word for drinking-cup. There are two kinds of pot—earthenware, and porcelain (or china, as it is sometimes called, for the white clay from which it is made was found first in China). Porcelain, then, is a special kind of pottery made from the white china-clay, or kaolin. Earthenware, on the other hand, is made from commoner clays.

It is quite easy to tell one from the other, for, if you hold porcelain to the light, you can see the light shining through it. Only very thin and fine earthenware would let light pass, and then only a little.

No one knows who was the first person to make articles of clay. Clay pots many thousands of years old have been dug up. Before that time it was only possible to carry liquids in sea-shells, gourds and skins. Then perhaps some observant person noticed that, after a rainfall, a footprint in clay soil held water. He then realized that clay could be very useful, and decided to try coating the inside of a basket with it. Imagine his delight to find that the basket would now carry liquid!

But one day this experimenter was careless, and left the basket too near his fire. It caught fire. By the time he noticed what had happened, all the basket work had been burnt away, and the clay lining had baked hard. That, perhaps, is how the first clay vessel was made, and how the first hot drink became possible!

We see, then, that to make clay vessels it is necessary first of all to shape them, and then to burn them in order to make the clay hard. How was this done when Josiah Wedgwood was learning to be a potter? Almost exactly as it is done today.

The county of Staffordshire contains many different kinds of clay, so that it has become famous as a pot-making district. The clay was first dug out of the ground and then left to stand in heaps for a long time. Then it was ground up with water between mill stones, the different kinds of clay being mixed together, according to the potter's recipe for the kind of earthenware he was making.

The clay and water mixture, which is called 'slip', came out of the mill looking

like cream, and it was put through fine sieves to remove any particles of earth or stone. For a long while the thick, creamy liquid was left to stand in an open tank, so that the water would evaporate from it. When it had become thick enough to be worked like plasticine in the hands, lumps of it were cut out of the tank and the potter took them to his wheel.

The potter's wheel is a very old machine indeed, for we read of it in the Bible. It is a low, wooden stand, with a round plate on top, which revolves like a gramophone turn-table. The potter works it from underneath with his left foot.

The potter now takes a ball of clay large enough for the pot he intends to shape, and throws it on to the wheel, so that it sticks firmly. Then, placing his hands on each side of the clay, and turning the wheel with his foot, he cleverly shapes his material as he wants. Then he pushes his thumbs into the round clay at the top and works it hollow. Before long, as if by magic, the skilful potter has fashioned the uninteresting lump of clay into a beautifully shaped cup, or bowl, or jug.

Making pottery on the potter's wheel is called 'throwing', and a thrower is a very skilful workman. But there is another method of shaping articles out of clay—'moulding'. A plaster mould is made and the clay is pressed into it. This is a quicker and less difficult way, and it must be used to make things like handles; but all the most beautiful pottery is thrown.

When the piece of pottery is taken off the wheel, it is put aside to dry, after which designs may be painted on it with special colours that will stand great heat; it is then ready to be fired. This is done in a large oven, or 'kiln'. The pieces of pottery are placed in earthenware tubs called 'saggers', so that the flames cannot

VI

Earthenware had now improved so much that the potters no longer found the clays of Staffordshire good enough for their purpose, and finer clays were brought from the south of England. Since trains were not yet invented and the roads were too bad to allow carts to travel far, these clays were brought by sea as far as Chester and then carried to the Potteries on the backs of horses. This was, of course, very slow and expensive.

But Wedgwood heard that a nobleman called the Duke of Bridgewater had employed a clever engineer, James Brindley, to build him a canal from his coal mines at Worsley to Manchester. This canal had been so successful that the Duke was thinking of building another one right across England to join the rivers Mersey and Trent. When Wedgwood heard of this, he went to see the Duke and persuaded him to make the canal pass through the Staffordshire Potteries. And so the clay could be brought cheaply and the pots could be sent away to be sold. Wedgwood also did a great deal to improve the roads round the Potteries.

For the greater part of his life Wedgwood's leg troubled him till at last he decided to have it cut off. But although he was lame, he was never idle. When he was not reading or experimenting, he was stumping round his factory, and if he found a workman making a piece of pottery which was not perfect, he would throw it to the ground and cry: 'This won't do for Josiah Wedgwood!' The workmen never objected, for they knew that he himself was a better workman than any of them.

In 1795 the great Josiah died, leaving over half a million pounds, besides his factories, which are working busily to this day.

And why do we consider him one of the greatest Englishmen? He gave people cheap, useful, and beautiful china, which was sold all over the world. He changed the Staffordshire Potteries from a group of small, untidy towns into one of the busiest and richest parts of the country. And he made many very beautiful things, which will always help to make people happier.

THOMAS ALVA EDISON

I

'THAT youngster of yours has grown since I saw him last, Sam,' said Captain Alva Bradley, as he filled his long clay pipe. The two men sat on the veranda of Samuel Edison's little house in the village of Milan, in Ohio, near the great American Lake Huron.

Sam watched his youngest son, a tousle-headed lad of about six, who had been sitting at the other end of the porch looking at a book, get to his feet and run off in the direction of the street. Then he replied to his companion's remark.

'Yes, Al, he's grown in the last year. And he's getting a smart lad. Talk about asking questions! It's always "why? why? why?" His mother never tires of answering him; but I soon give up.'

'I've heard about him on the lake,' the other said. 'I was talking to a barge man the other week. I told him I knew Milan, and he said: "Then you'll know that youngster, Al Edison?" "Know him!" I said; "Isn't he named after me? What's he been doing?" "He was trying to walk the logs on the river like the lumber jacks, and roaring their songs at the top of his

voice," said the barge man. "Suddenly he took a header into the river and I just managed to get a boat-hook and pull him out."'

Sam Edison laughed. 'I never saw his equal for inquiring about things.' He was proud of young Al and pleased to get the chance to tell of his doings. 'I expect he's gone up to the farm to bother them with his questions.

'The other week he went to the grain store and climbed to the top to watch the wheat pouring in. He leant over too far and fell in. If one of the men hadn't seen him and pulled him out he'd have been killed.'

The captain laughed and re-lit his pipe.

'Then there was the time when I found him up at the farm,' went on Sam Edison. 'He was coming out of the barn. And you should have seen the seat of his pants! I asked him what he'd been doin'. "Sittin' on eggs to hatch out chickens," he said. Then he asked why he shouldn't be able to do it, since the goose could!'

'I bet you couldn't answer that one, Sam!' the captain chuckled.

'Then there was the time he wanted to know how a bees' nest back in the hedge there worked. He looked in and nothing happened, so he began prodding with a stick. Just then a goat came and butted him into that bees' nest, and the bees didn't like it a bit. You should have seen his face and hands when he came running home!'

'That lad will go a long way,' the other prophesied. 'It's good for him to find out things, as long as he does no harm.'

'He never does any harm—except to himself and his clothes.' As he finished speaking, Sam Edison wrinkled up his nose and sniffed. 'Do you smell anything? Like burning?' he inquired, getting to his feet.

'There's smoke over there,' the captain said, and the two men went into the street.

'Seems to come from the direction of the farm. Why, there's young Al, running as if there was a mad bull after him.'

And so he was: but the 'mad bull' was a very angry farmer.

'Set my barn on fire, would you?' he was roaring.

Sam Edison went into the house and then came out again with a very switchy cane. 'Why did you do it?' he asked in a terrible voice.

'I wanted to see what would happen,' answered his son.

'Come with me, and I'll show you.' Sam Edison took him by the hand and led him down the street.

And that is how the world's greatest inventor was publicly spanked at the age of six in the market place of Milan, Ohio, in the year 1853.

II

The next year the Edison family moved to a town called Port Huron. Their new house was a large one, and, to young Al's delight, had a cellar. He at once took possession of this, deciding to make it his workshop. Al's father hired a little Dutch boy called Michael Oates to help with odd jobs about the place, and Michael and Al soon became fast friends.

Al now decided to make some money. He borrowed his father's horse and cart and, helped by Michael, loaded it up with fruit and vegetables grown in the grounds round the house, and sold these from door to door. This was not just a craze that lasted for a few days, for in a year they made £150.

But Al was interested most of all in chemistry. He managed to get hold of some books on this subject and, at the age of ten, decided to have a laboratory of

type of magic lantern, or projector, as it is called. Thus we owe the cinema to Thomas Alva Edison as well. In 1912 he combined the phonograph and the cinematograph to make the first talking-picture.

No man has ever worked harder than Edison. Often he was in his laboratory for twenty hours a day, and sometimes he worked there for days on end, only lying down on a bench now and then to snatch a short sleep. He was so enthusiastic about his work that his helpers—'the boys', he always called them—were ready to work just as hard as he.

He died in 1931 at the age of eighty-four, and, until a few months before his death, worked as hard as ever. That is the story of how a newspaper-boy who refused to go to school became one of the most famous men in the world.

GUGLIELMO MARCONI

I

IN the summer of 1894 two men sat in an hotel in the Alps. They had had a long, tiring day in the mountains, and the elder dozed in his chair. The other, a young fellow of twenty, of medium height, with blue eyes and fair hair, was reading a scientific paper, which he had found among the magazines and newspapers provided by the hotel for the entertainment of its guests.

The elder man at last stirred himself and looked at his watch. 'I'll go up to bed now, Guglielmo. It's after ten, and we want to make an early start in the morning,' he said, rising.

But Guglielmo Marconi appeared not to hear him.

'What are you reading?' his half-brother, Luigi, inquired, looking over his shoulder. 'Electricity again! What a man!'

The younger Marconi looked up with a smile. 'I'll follow you later. I must finish this article,' he said, and returned to his reading.

The article that Guglielmo found so interesting was about an experiment, carried out by a scientist called Heinrich Hertz, who had died the year before. Hertz had discovered that, if he made an electric spark jump across a gap between two pieces of metal in an instrument at one end of his laboratory, another spark would jump between two other pieces of metal, placed very close together, in an instrument at the other end of the room; although there was no wire connecting the two instruments.

That certainly looks like magic. But scientists can explain it. They believe that everywhere—in the air, beyond the air, among the sun, moon, and stars, in the earth, in everything—there is what they call 'ether'. Even the scientists do not know what ether is. Light consists of very small wave-movements in this ether—like the movement of ripples in a pond when a stone is thrown into it, but far, far smaller.

Hertz said that his electric spark caused waves in the ether, and that these travelled to the other instrument and caused it to spark also, and that, like waves of light, they travelled at 186,000 miles a second. That is over seven times round the world in a second!

Now these ideas were not quite new to the young Marconi, for he had always been fascinated by electricity and had read many books on science. In fact

science was his hobby, and when he was not fishing or riding he was almost certain to be in the laboratory, which he made for himself on the third floor of his home near Bologna, in Italy.

It was very late before Guglielmo followed his brother up to bed, for an extraordinary idea had come to him. If a spark could cause ether waves to travel to another machine across a room and make that machine spark, why could not a bigger spark make waves travel a longer distance and cause another spark, say, a mile away? And, by using long and short sparks, why could not this be used to send messages by Morse Code? Indeed, why should not messages be sent this way over great distances, using the ether instead of wires?

The elder man found his young brother poor company during the rest of that holiday, for Guglielmo was so interested in his idea that he could not take his thoughts off it.

II

At last they arrived home at their father's mansion outside Bologna, and young Marconi hurried to his laboratory to start his experiments. Assisted by his brother Alfonso, who, although nine years his senior, was not ashamed to work under this brilliant young scientist, he struggled for months testing his idea. At last, to their joy, they got the instrument at the other end of the room to give its answering spark.

Marconi now decided to show his father that there really was something in this idea of his, for Signor Marconi, who had made a large fortune in business, had not a great deal of faith in his youngest son's science.

At last the apparatus was ready, and Guglielmo invited his father and mother to come to the laboratory.

Signor Marconi entered, his good-humoured face beaming. 'What is this new toy you have made, my boy?' he asked.

'Listen!' the young inventor said, and he pressed a switch.

Faintly, in the lower part of the big house, an electric bell rang.

'Well?' his father inquired.

'There are no wires running to that bell. Don't you see what it means, Father? Messages can be sent through space without wires to carry them.'

But Signor Marconi was not convinced. 'Let me take one of your machines down to the lawn. Then, if you can send me a signal, I'll believe you,' he said.

Marconi took him at his word. A little later he was back in the lab., his hand on the morse key. Through the window he could see his father at the receiver. The young man's heart thumped as he tapped ··· the test signal, S, which telegraphists use. He could tell by the expression on his father's face that the message had got through.

That evening Signora Marconi talked to her husband, and on the following day Guglielmo was overjoyed to receive from his father 5,000 lire—about £ 250—to help with his experiments.

The hard work continued for months. Then one day Alfonso stood by a wireless receiver over a mile away. He was within sight of the laboratory window, and he held in his hand a flag. Guglielmo pressed the morse key, the sparks crackled on the instrument by his side—and Alfonso waved the flag. The message had gone over!

Then Alfonso moved the receiver so