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With the Editor

Greenwich and the Prime Meridian

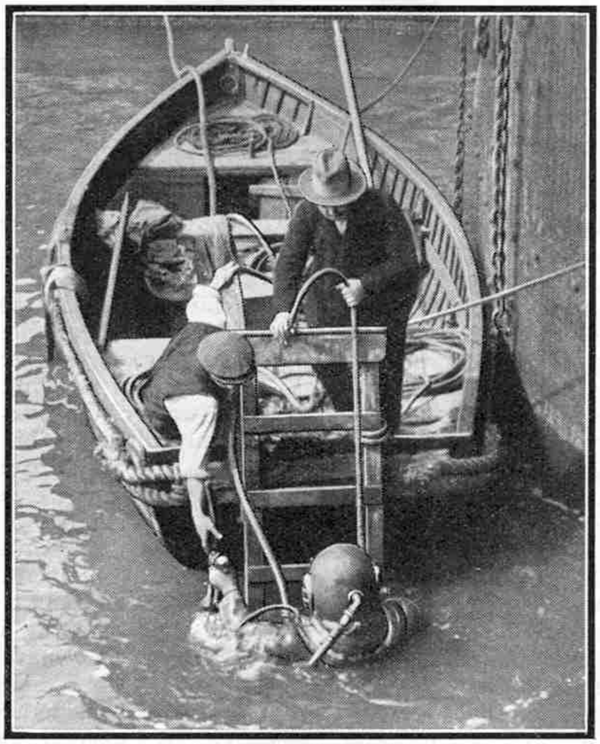
One of the greatest defects of early charts was the absence of a fixed prime or first meridian of longitude. In the 16th and 17th centuries all sorts of places were taken by different chart makers as the first meridian, and even as late as 1870 more than a dozen meridians were in use, including Greenwich, Paris, Cadiz, Naples, Stockholm, Lisbon, Copenhagen, Rio de Janeiro and Washington. This was a thoroughly unsatisfactory arrangement, and one that caused a great deal of trouble to seamen.

Various suggestions for a universal meridian were made, among the places proposed for the purpose being Jerusalem and the Great Pyramid. In October 1883 a conference was held at Rome to discuss the matter, and it was decided, after much deliberation, to recommend that the meridian of Greenwich should be adopted, on the ground that this meridian was the one in widest use. There was a sting in the tail of the resolution, however, for it was proposed that, if the Greenwich meridian were universally accepted, Great Britain in return should adopt the Metric System. Nothing came of the proposal, as many of the Governments could not be persuaded to abandon their own national meridian.

The urgency of the matter caused the holding of another conference in the following year, this time at Washington. On this occasion the United States delegates proposed "the adoption of the meridian passing through the transit instrument at the Observatory of Greenwich as the initial meridian for longitude," and pressed their proposal with such energy that it was adopted. At the same time the suggestion to count the longitude continuously from 0 degrees to 360 degrees was turned down, and it was decided that it should be reckoned east and west of Greenwich up to 180 degrees.

The Royal Astronomical Observatory at Greenwich was founded by King Charles II in 1675, with the object of "Rectifying of the Tables of the Motions of the Heavens and the Places of the Fixed Stars, in order to find out the so much desired Longitude at Sea." Its original purpose thus was to assist navigation. In 1838 a Magnetic and Meteorological Department was added, and since 1873 photographic records of the Sun's surface have been regularly taken.

In 1887 an International Conference meeting at Paris decided to construct a photographic chart of the whole heavens, recording the stars down to the 14th magnitude, the number of which was estimated to be about 20,000,000. A second catalogue was to be formed of stars down to the 11th magnitude, estimated at about 1,250,000. This work was divided up between 18 great observatories, and to Greenwich was allotted the task of dealing with all the stars within 26 degrees of the Pole Star. The greatest task of Greenwich Observatory, however, is to act as what might be described as the time centre of the world.



A diver at work in the Mersey, where he is caulking a leak in the gate of the Langton Graving Dock. Photograph by G. A. Collins, Liverpool.

The MacRobertson Air Races

The MacRobertson air races from England to Australia that are to be flown this month are without doubt among the most important aerial events that have yet been organised. Machines from all over the world have been entered, and they will be manned by the best of the world's pilots. The machines that will take part in these races are, of necessity, fast, but they will not be in any sense freak types, such as those used in the contests for the Schneider Trophy, which were quite unsuitable for anything but racing. The capacity of the machines for long-sustained flying will be tested to the utmost, and no machine that is not of the highest possible reliability will have any chance of success.

The results of the races should supply a great deal of extremely useful information in regard to the possibilities of fast flights over long distances. At present on long flights passengers are landed towards the end of the day, so that they may spend the night at an aerodrome hotel. This practice has a serious effect on the total time occupied by the journey, and the only alternative is the provision of machines with accommodation for passengers to sleep comfortably in the machine. Aeroplanes of this type are already being designed, and at least one machine already built, the Fokker F.XXXVI described on page 780 of this issue, is fitted with sleeping accommodation.

Before night flying can be extended to commercial passenger lines, however, it will be necessary to erect beacons at reasonable intervals along the whole length of the route. Such beacons are already in extensive use for night flying across the American Continent, and although the difficulties involved in lighting such a route as that from England to Australia are much greater than those over a continuous land surface, the obstacles do not appear to be insuperable. Until adequate guidance for night flying can be provided, there seems no alternative but to carry mails at the utmost possible speed, while passengers travel in slower but more comfortable air liners, with their flights arranged so that each night can be spent on the ground.

At the time of going to press, there are about 15 British entrants for the race and only one of these has entered an aeroplane made by foreign constructors. Probably the best-known of the British entrants are Mr. and Mrs. Mollison, who are flying the new De Havilland "Comet." This machine is one of the most interesting British aeroplanes in the event for, with the exception of the seaplanes built for the Schneider Trophy contests, it is the fastest British civil aeroplane that has ever been produced. In spite of its high speed, the machine, which is of the low wing type, is one of the lowest-powered machines entered in the race. Three "Comets" are entered and work has been proceeding night and day to get them ready.

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6D.

HUGE HYDRAULIC PRESS
(see page 762)

Modern Hydraulic Apparatus

An Interesting French Press

TO-DAY hydraulic machinery is to be found in almost every shipyard and engineering works, where it is used when heavy loads have to be moved, or when great power is required for forging or shaping metal. The prodigious force that can be exerted by a hydraulic cylinder can only be appreciated fully when the machine is seen actually at work; and yet the control of such a machine is so simple that a boy could easily manage it.

The principle of the hydraulic press is employed in a great variety of machines and appliances, one of its most familiar applications being in hydraulic lifts for passengers or goods. In addition to forging and stamping presses there are presses for packing, bending and re-forming tubes and metal rods, all worked by water at high pressure. There are also giant combination steam and hydraulic presses capable of exerting pressures up to 12,000 tons, which stand nearly 50 ft. high and weigh 800 tons or more. The cylinders of these great presses are sometimes as much as 40 in. in diameter, with a ram stroke of 10 ft. or even longer. On the lower end of the ram is fixed a mass of metal shaped like an inverted "T," which takes the pressure of the ram on each end of its cross bar. The water pressure used for operating the ram is approximately 2½ to 3 tons per sq. in. when the press is in action.

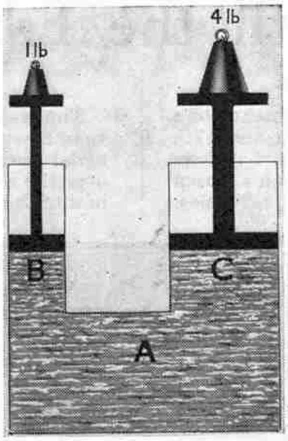


Fig. 1

A small press of a rather different type is illustrated on our cover this month and also on the opposite page. It was built by Les Ateliers et Chantiers de la Loire, France, for an important railway works, and is used principally in the manufacture of boiler casings, locomotive footplates, railway wagon and locomotive chassis and coach parts. This machine consists essentially of three main hydraulic cylinders, and a double action auxiliary cylinder, which is placed on the upper part of the press.

The water passes to the cylinders from a valve distributor block that is shown in the illustration. The distributor is fitted with six hand levers attached to valves, by the operation of which the water can be sent into any one or all of the different cylinders of the press. The two levers shown on the right distribute the water to the auxiliary upper cylinder, while the two middle levers operate the central cylinder. The two levers on the left control the two outer cylinders, which are double acting and raise or lower the press plate. These levers can also be used to operate three small extractor jacks that are situated in the centres of the three main cylinders. The purpose of these is to extract pressings from the dies in which they remain after the pistons are withdrawn.

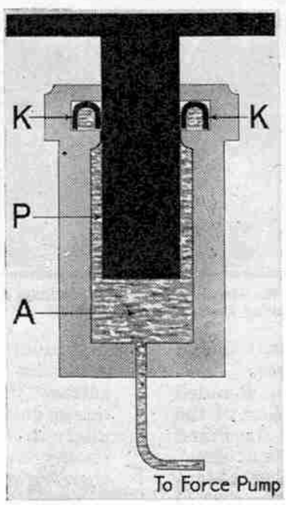


Fig. 2

Different designs of tools are required for the production of the various parts, and they consist of two or more pieces. In the machine illustrated here a tool known as a matrice is assembled on the bed of the press, which is movable, and another tool is fixed to an upper plate which, during the work, remains stationary. The metal to be worked is placed on the matrice. The hydraulic piston is then set in motion and so presses the metal to the desired shape. When the pressing is completed the piston is withdrawn, and the pressed part remains in the matrice, from which it is extracted by the action of the extractor jacks.

The possibility of using water as a source of power had not received much serious attention before 1795, when the famous English engineer Joseph Bramah turned his attention to the matter. He built a press that was operated by water, and as soon as the success of this became known other engineers directed their activities in the same direction, and before long water power was used to work all kinds of machines.

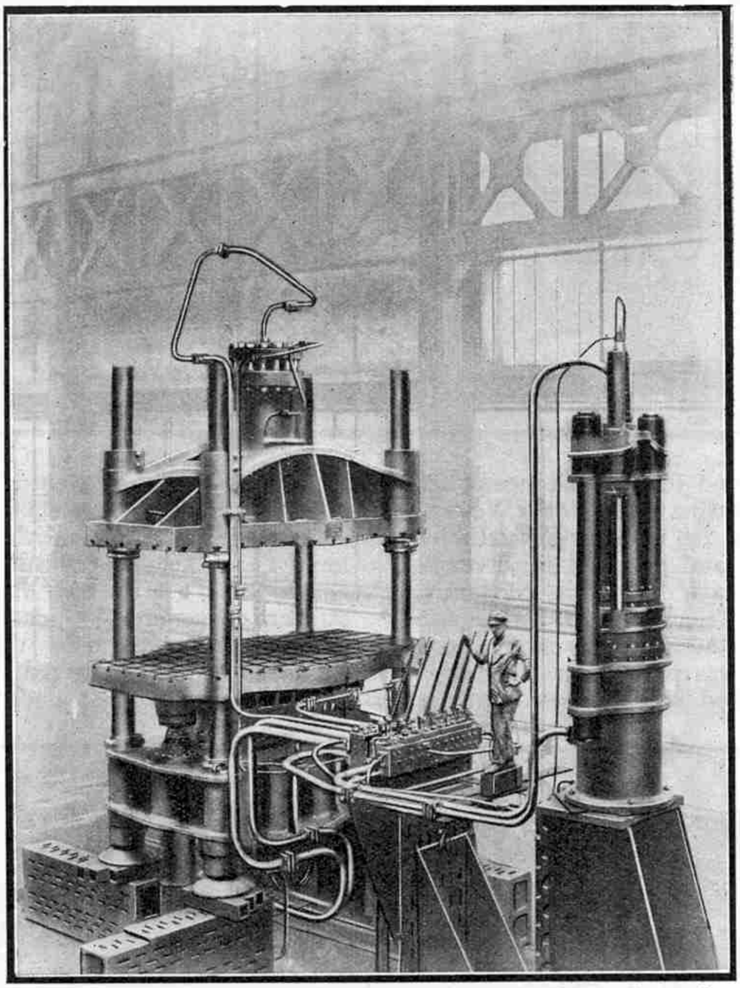
Joseph Bramah was born in 1748 at the village of Stainborough, near Barnsley, in Yorkshire, where his father rented a small farm. He was the eldest of five children, and he commenced work on the farm at a very early age. His favourite boyhood hobby was that of making musical instruments. His few tools were rough ones made for him out of old violins and razor blades by his great friend the village blacksmith, but in spite of this handicap he turned out some excellent work, including a violin cut out of a solid block of wood.

It is quite likely that Bramah would have remained a ploughman all his life but for an accident that occurred when he was about 16, resulting in an injury to his right ankle that made him permanently unfit for farm work. He was confined to the house for a considerable period, which he spent in carving various articles out of wood. His ability for this class of work was obvious to everybody, and when he was able to get about once more he was apprenticed to the village carpenter, under whose tuition he soon became an expert workman. At the termination of his apprenticeship he realised that there was little prospect for him in his own locality, and he therefore tramped to London to try his fortune in the great city. He soon found work with a cabinet maker, and remained with him for some time before setting up in business on his own account.

Bramah's first invention was connected with household water apparatus, and was sufficiently successful to place him on a sound footing. It is interesting to learn that at this time he sent for the blacksmith of his native village to take charge of the blacksmiths' department in his rapidly growing business.

The principle underlying the action of the hydraulic press had been set out by Pascal, the famous French mathematician (1623-62), as follows. If a vessel is full of water, closed on all sides, has two openings, the one a hundred times as large as the other, and if each be supplied with a piston that fits it exactly, then a man pushing the small piston will exert a force that will equilibrate that of 100 men pushing the large piston, and will overcome that of 99.

This important principle may be illustrated simply by reference to Fig. 1. The water vessel A has two cylindrical necks each fitted with a piston. The bore of cylinder B is one inch and that of cylinder C two inches. The area of piston C is therefore four times that of piston B, and if a weight of 1 lb. be placed on piston B it will balance a weight of 4 lb. on piston C. Bramah's hydraulic press consisted essentially of a large and massive cylinder (A, Fig. 2) in which worked a closely-fitting solid plunger P. A force pump of very small bore communicated with the bottom of the cylinder and by means of this pump small quantities of water were forced at high pressure beneath the plunger, thus gradually forcing it upward. In this apparatus the cylinder A represents the large cylinder C in Fig. 1, and the force pump takes the place of the small cylinder B.



A multiple-cylinder hydraulic press installed at a large railway workshop. The machine was built by Les Ateliers et Chantiers de la Loire, France, to whom we are indebted for our photograph.

It was not until after many difficulties had been overcome that the use of water power became a practical reality. One of the main obstacles that had to be surmounted arose from the tremendous pressure exerted by the pump, which forced the water between the solid piston and the side of the cylinder in which it worked in such quantities as to render the machine very inefficient. Bramah was completely baffled by this difficulty. He tried all kinds of devices without success, and at one time it seemed that his invention was doomed to failure. The problem was to secure a joint sufficiently free to let the piston slide up through it, and at the same time so water-tight as to withstand the tremendous internal force of the pump. In this dilemma Bramah's foreman, Henry Maudslay, came to the rescue. The solution came to him in a flash of genius, and the result was his famous self-tightening collar.

A collar of sound leather of U-section, K, Fig. 2, was fitted, convex side upward, into a recess turned in the neck of the cylinder at the place formerly occupied by the stuffing-box. When the high-pressure water was turned on it forced apart the edges of the collar and thus caused the leather to apply itself to the surface of the rising plunger with a degree of tightness proportionate to the pressure of the water. As soon as the pressure was relaxed and the water released, the collar collapsed, thus allowing the plunger to sink gently down to be ready for the next stroke.

In the steam-hydraulic system, which is now employed in large forging presses, operating power is obtained by means of an intensifier consisting of a steam cylinder that works in conjunction with a hydraulic cylinder, the steam piston having a positive connection with the hydraulic ram. A steam pressure of say 150 lb. per sq. in., acting on the large area of the steam piston, multiplies the pressure on the small area of the hydraulic ram. This gives a pressure in the hydraulic cylinder of the intensifier, and also, as they are directly connected in the main cylinder of the press, of say $2\frac{1}{2}$ tons per sq. in. A "prefiller," or vessel containing water under an air pressure of say 60 lb. per sq. in., also forms part of the installation, its function being to keep the system full of water so as to exclude air, and to bring the press-head down on to the work prior to the exertion of the intensified power.

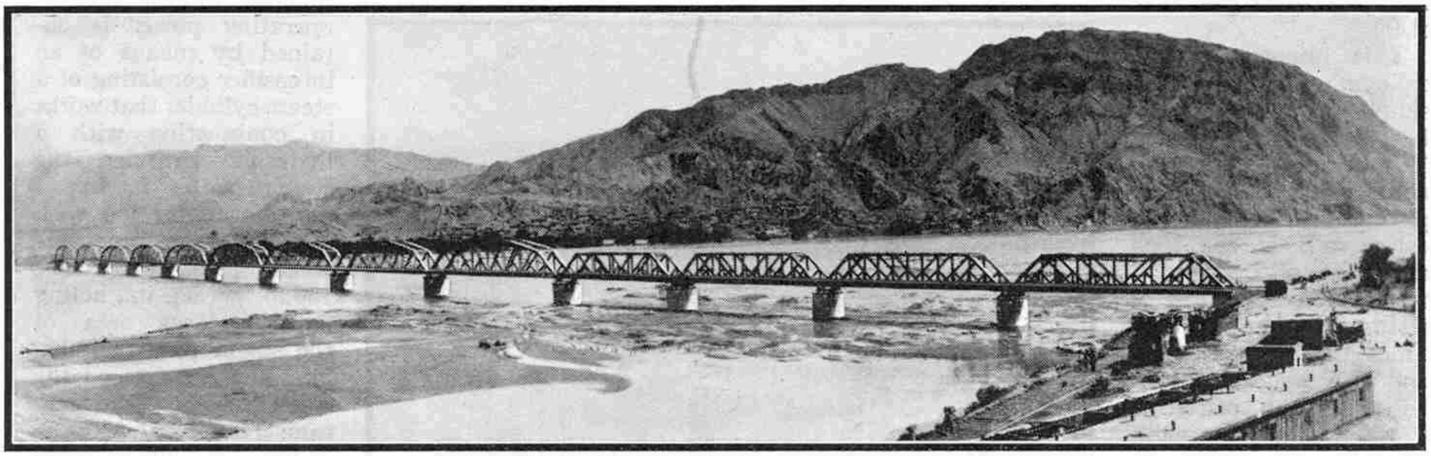
Except in special cases the steam-hydraulic press is now invariably used for heavy forging work, as it is simple in operation and more economical in power, and capable of a faster working speed than any other system.

Presses with a power of over 2,000 tons are made of special duplex-cylinder construction, the features of which are the provision of two cylinders, the absence of rigid connection between the rams and the crosshead, and the provision of a central guide cylinder for the crosshead stalk. These details enable the presses to bear without injury the heavy side strains set up when the work is not directly under the centre of the press, a condition that is unavoidable in some classes of work, and which becomes a serious factor in presses of large size. Machines of this type are now installed in most of the principal steelworks throughout the world.

The hydraulic principle is one of the most efficient means of applying force known to engineers, and its use has made possible the production in an economic manner of many articles that would otherwise be very costly to manufacture.

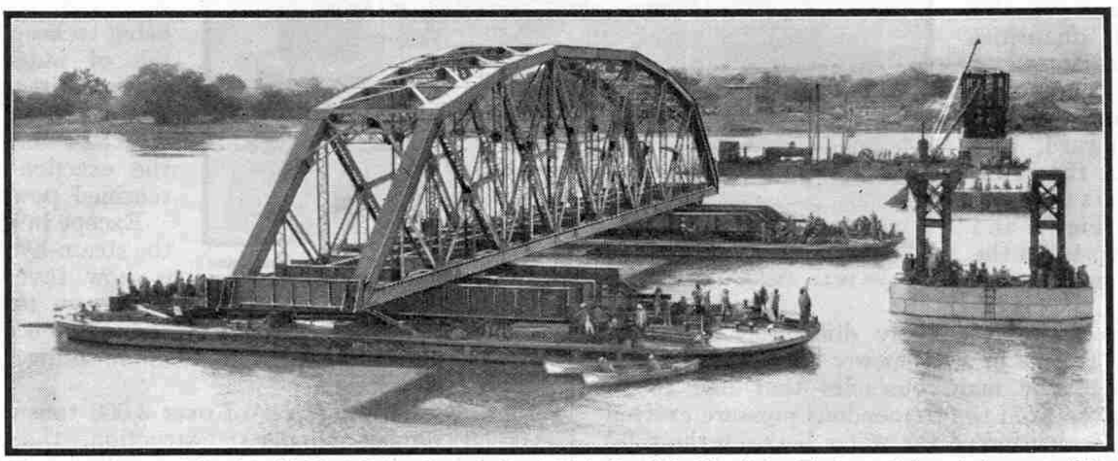
Building a 13-Span Railway Bridge

Interesting Indian Engineering Feat



BETWEEN Mahmud Kot and Jand, a distance of 230 miles, the Multan-Peshawar line of the North Western State Railway, India, runs parallel with the River Indus. At Daud Khel, 45 miles from Jand, a branch line diverges and crosses the river to Kalabagh on the way to Bannu, a town near the Afghanistan frontier. Until three years ago rolling stock was conveyed across the river on a ferry steamer, the deck of which was provided with railway track; but this tedious method was dispensed with in August 1931 when a fine truss girder bridge was completed and put into service.

The construction of the bridge was carried out by the Bridge Department of the North Western State Railway, under the supervision of Mr. W. T. Everall, O.B.E., M.I.C.E., Deputy Chief Engineer of that department, and the work was begun in January 1928. The bridge was designed to have nine truss spans each of 263 ft., giving a total length of 2,367 ft. During the high-river season the Indus at Kalabagh is nearly three-quarters of a mile wide, and therefore a curved embankment 700 ft. long and in line with the shore was erected at the Daud Khel end of the bridge so as to narrow the river at that point to the length of the bridge. The face of this embankment, and also of the abutment of the shore pier at the Kalabagh end of the bridge, was protected by a facing of stone.

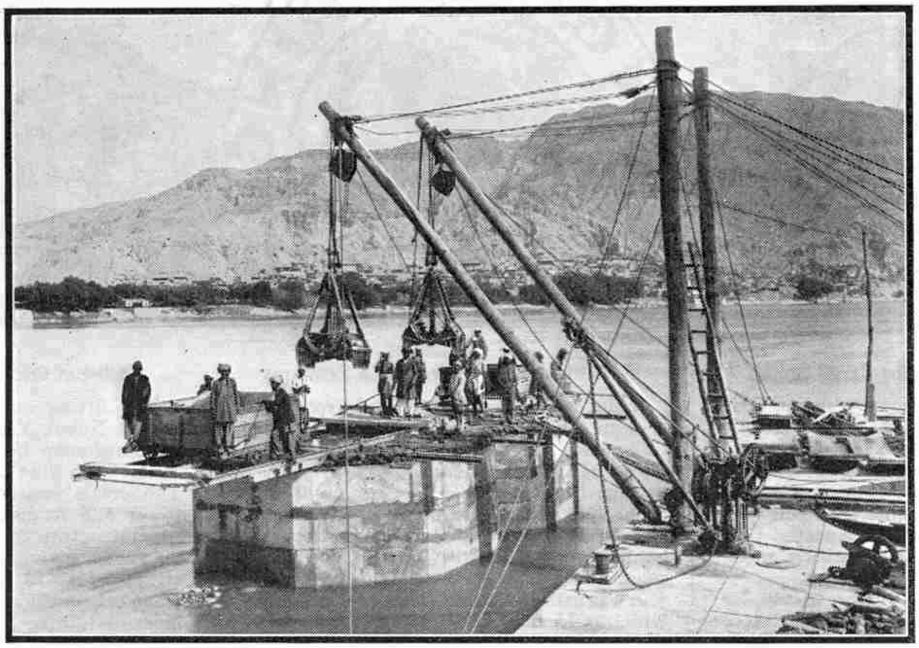


The upper photograph is of the Kalabagh Bridge from the Daud Khel side of the River Indus. The lower photograph shows one of the completed spans being conveyed on pontoons to its allotted place in the bridge. The illustrations to this article are reproduced by courtesy of the Editor of "The Railway Engineer."

The deep-water channel of the river is at the Kalabagh side, where it attains a depth of nearly 20 ft. at low water level. There the river bed consists of a stratum of boulders embedded in coarse sand, but elsewhere in the river this stratum is overlaid by thich layers of finer materials. The pier foundations therefore were sunk deep into the firmer earth so as to be unaffected by any scouring away of the lighter materials. The foundations consisted of structures called wells, which resembled open caissons and were sunk into position by dredging the ground enclosed by them. Each well was shaped like two octagons joined together at one of their sides, and had two vertical shafts, one passing through the centre of each octagon, up which the dredged material was withdrawn. The dredged earth was removed by the grabs of two steam-operated derricks working from an adjacent 250-ton barge and deposited in two tipping wagons on the well-top; when full these wagons were emptied over the downstream side of the well.

The deep-water wells were sunk as far as possible by this method of open dredging, and pneumatic power was then employed to force them down to the required depth. When the various wells had been sunk to their full depth their shafts were filled with sand and sealed at the top with concrete, and the other parts of the structures were filled up with a layer of sand to close up the cutting edges, and over this with a thick layer of concrete.

The nine spans of the bridge were believed to provide ample clearance for the passage of the river during the flood season, their dimensions being based upon the highest recorded flood discharge, 800,000 cusecs., which occurred during the high-river season of 1878. During the monsoon period in August 1929, however, the river rose to a new record high level, and a flood estimated at the enormous total of 1,200,000 cusecs. swept over the unfinished bridge. The flood was 50 per cent. greater than the bridge had been designed to cope with, and several of the wells were forced out of alignment. Two wells, nearly in midstream, fared the worst, one being tilted 12 ft. out of the vertical, while the other was struck by a 200-ton barge that broke loose from its shore moorings. The swiftly-flowing river swept the barge against the well, which was knocked askew, and enveloped by the wreckage of the barge.

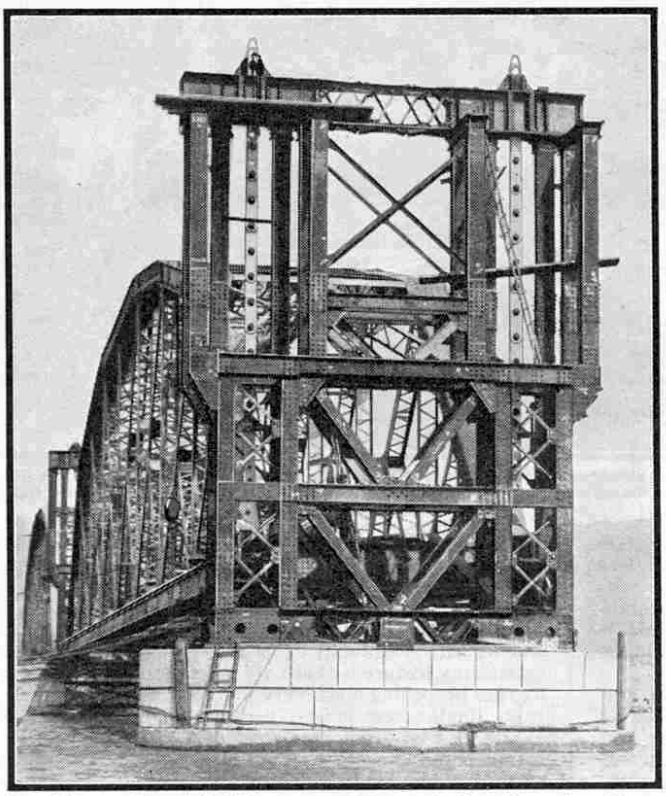


Grabs removing dredged earth during the sinking of one of the piers.

This flood made necessary a revision of the calculations on which the size of the bridge had been based. It was obvious that greater facilities would have to be provided for the passage of flood water, and this was done by abandoning the curved protection bank, and extending the bridge to the full width of the river by means of four additional truss spans. Three of these spans are 175 ft. 4 in. long, and the fourth or shoreward span is 169 ft. 10 in. long.

While the sinking of the wells for the new piers was being carried out the task of clearing the enveloped well in mid-stream was begun, and this work took 3½ months to complete. The righting of the tilted wells also required much time and patience. The river bed on the downstream side of each of these wells was dredged, and pneumatic plant, operating from the well top, excavated material from the dredging shafts. Long girders that projected over the downstream side of the well were secured to the top of the structure. The projecting portion of the girders was loaded with rails, and two crates each loaded with 100 tons of pig iron were lowered against and secured to the downstream side of the well to supplement the weight of the girders and rails. These measures were successful in restoring the wells to an upright position.

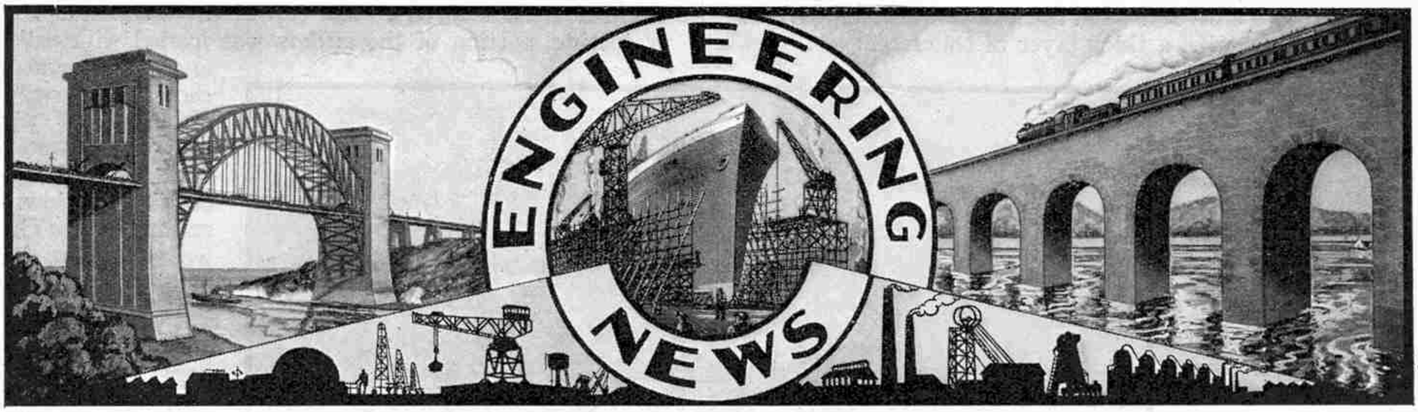
The assembling and riveting of the spans was carried out at the erection yard at the Daud Khel side of the river. Each span, when completed, was moved forward over a roller track laid on a specially erected staging to the river, where two pontoons were waiting to receive it. The riverward end of the span was lowered by means of powerful mechanical jacks on to one of the pontoons, which was kept steady by steel ropes attached to special anchorages upstream and downstream and to some of the piers. The pontoon was then slowly moved out into the river, drawing the span with it until the other end of this was in a position to be lowered by jacks on to the second pontoon. When this was effected the pontoons conveyed the span to its allotted place in the bridge.



One of the trestles and its lifting gear erected on a pier in readiness for raising a completed span into position.

The next task was to lift the span on to its piers, and this was done with the aid of vertical structures called trestles, one of which was erected on each pier. Mechanical jacks raised and transferred the span from its resting place on the pontoons to the base of the trestles. Special lifting gear was then attached to the trestles, and by means of this and mechanical jacks the span was raised. Cast steel bearings were fitted into position and the span was lowered on to them, after which the permanent connections were made.

Work on the bridge scheme was restricted to nine months of the year, operations being suspended during the high river season. In spite of this restriction, however, the bridge was completed nine months ahead of schedule.



New Diesel Engines for Cargo Ships

Two new cargo motor ships, the "*Durham*" and the "*Dorset*," that are being built for the Federal Steam Navigation Co. Ltd., will be provided with propulsion machinery consisting of two sets of a new type of Sulzer Diesel engine that will give a total of 11,000 b.h.p. It is expected that these engines will give the vessels a speed of 16 knots.

The new engines are of the 8-cylinder type and have a normal output of 5,500 b.h.p. at 126 r.p.m. Improvements have been made in connection with the cooling, and the system of fuel injection also has been altered, the period of injection being kept constant and the stroke of the pump varied by altering the time at which it begins to inject the fuel. By doing this the timing is retarded when the engine is running with a light load and at a low speed, a very desirable feature for a marine engine that is required to run as economically as possible. Simplifications have been made also in the manœuvring control, the engines being actually operated by means of levers on the navigating bridge.

Electric Boilers in Canada

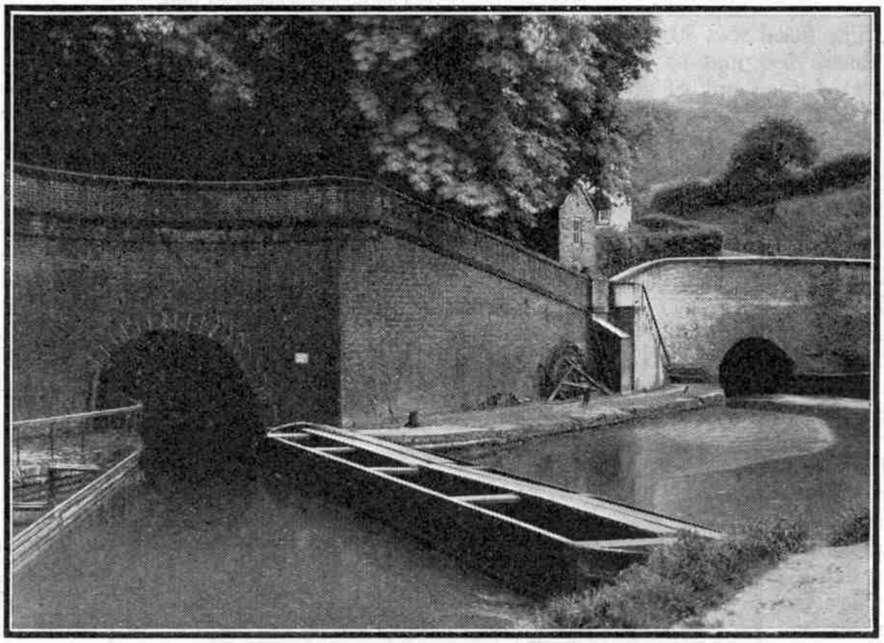
Canadian central electric stations in May of this year developed 1,829,681,000 kw.h of electrical energy and of this, 458,642,000 kw.h, or about 25 per cent. of the total, was delivered to electric boilers. This is estimated to be equivalent to a coal consumption of 88,500 tons, and thus Canada is saving coal at a rate of over 1,000,000 tons a year by using electric boilers.

It is interesting to note that the first electric boilers in Canada were installed 14 years ago by the Shawinigan Water and Power Co. at the Belgo-Canadian Pulp and Paper Mills at Shawinigan Falls, Quebec. Numerous electric boiler installations have since been added by other firms, the total capacity now reaching about 1,250,000 kw.h. If all the boilers were used to their rated capacity they would be capable of consuming a total of 9,000,000 kw.h of energy.

World Record for Cargo Ship Economy

What is claimed to be a world record for economy of consumption for marine engines of normal power has been set up by the cargo steamship "*Addistone*." During a voyage from the Tyne to Genoa, she used only 130 tons of Diesel oil, an average of 12.5 tons per day, equal to 19 tons of north-country coal. On the voyage the vessel maintained an average speed of 9.73 knots, and was using only one of her Scotch boilers, which is 15 ft. 6 in. in diameter and 11 ft. 6 in. in length, and has a working pressure of 200 lb. per sq. inch.

The "*Addistone*" is 400 ft. in length between perpendiculars, 52 ft. in breadth and 31 ft. in height. She carries 7,780 tons deadweight with a draught of 25 ft. $4\frac{1}{2}$ in. An interesting feature is that only a short time ago her propelling machinery was converted from single-screw geared turbines to the White form of drive, consisting of a White combined reciprocating engine and exhaust steam turbine. White's Marine Engineering Co. Ltd., the constructors of the special propulsion machinery, claim that if a 9,000-ton vessel of modern design were to be fitted with their form of drive, only 14 tons of north-country coal a day would be required to maintain a speed of 10 knots, an extremely economical consumption.



An interesting photograph showing the Grand Trunk Canal where it cuts through Harecastle Hill, Staffordshire. The tunnel on the left was constructed by Telford and the one on the right by Brindley. Our photograph is published by courtesy of the L.M.S.R.

250-ton Crane at U.S. Navy Yard

The fitting out facilities at the Puget Sound Naval Yard, Washington, U.S.A., have recently been increased by the addition of a fine 250-ton revolving crane. The crane consists of a fixed octagonal tower 125 ft. high, carrying a horizontal superstructure that rotates on a steel track 60 ft. in diameter. The revolving superstructure is 310 ft. long, and consists of a front cantilever of 190 ft. and a rear cantilever of 120 ft. One of the most important of the tasks carried out by the crane is the accurate placing of heavy guns and turrets on naval vessels undergoing repair or being fitted out at the yard. We hope to give a detailed and illustrated description of this crane in an early issue.

Roller Bearing $3\frac{1}{4}$ Tons in Weight

Four tapered roller bearings recently made by British Timken Ltd., are each $3\frac{1}{4}$ tons in weight and 4 ft. 3 in. in diameter. They are claimed to be the largest tapered roller bearings in the world, and are capable of carrying loads up to about 200 tons.

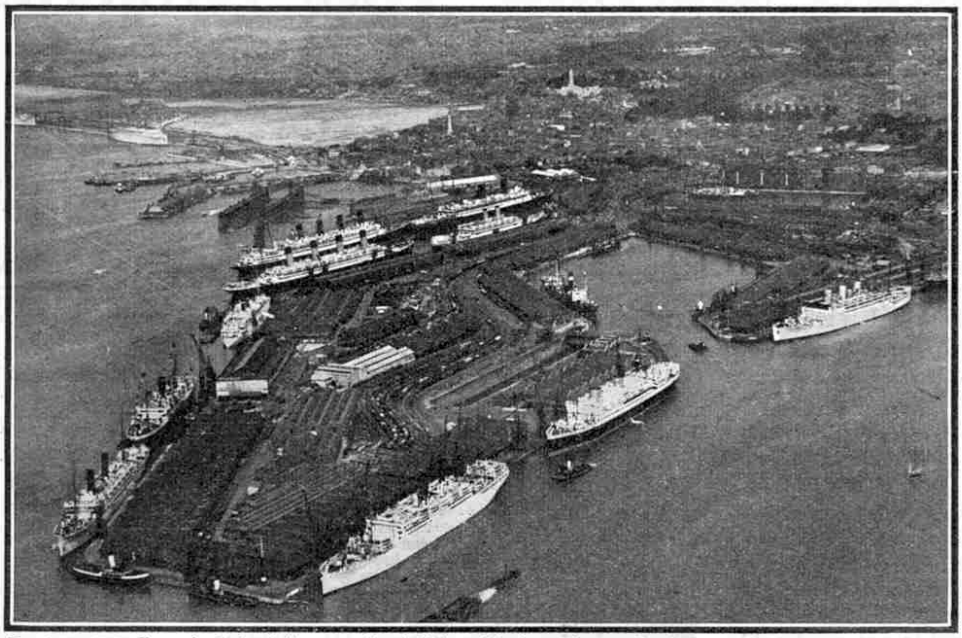
In the manufacture of these bearings it was necessary to employ special methods and equipment, the shaping of the inner cones necessitating the removal of $3\frac{1}{2}$ cwt. of steel from each cone, an operation that took 47 hours in each case. The heat treating of the parts also called for special attention, and they were all left in gas-fired furnaces for 200 hours in three stages.

During the running-in tests on one of the bearings a thrust load of 200 tons was imposed, and the bearing carrying the load was rotated for $8\frac{1}{2}$ hours at a speed of 42 r.p.m. The load was then taken off and the bearing dismantled. It was running quite cool, and all the working surfaces were found to be in perfect condition. In order to check the trueness of the bearing a special indicator was applied to the outer race when it was being rotated under the load, and it was found that the eccentricity of the unit was only eight ten-thousandths of an inch!

Rapid Steel Construction

Work is now proceeding rapidly on a new power station that is being built by the Metropolitan Borough of Fulham. For the shell of this structure 17,000 tons of steel have been used, all of which was fabricated, delivered to the site and erected by Dorman, Long and Co. Ltd. in the short space of 33 weeks, an average of 515 tons of metal placed in position every week for more than eight months.

During the peak period of construction 165 men were employed on erecting the steel framework, the main members of which were lifted into position by means of two 45-ton travelling cranes. Each of these cranes had a gib 140 ft. in length, which is equal to the height of the Nelson column; and the heaviest lift attempted was one of 66 tons.



Fourteen ocean liners in dock at the same time! This aerial view, taken at Southampton, includes the "Homeric," "Mauretania," "Empress of Britain," "Aquitania," "Berengaria," and the "Olympic." The photographs on this page are published by courtesy of the Southern Railway Co. Ltd.

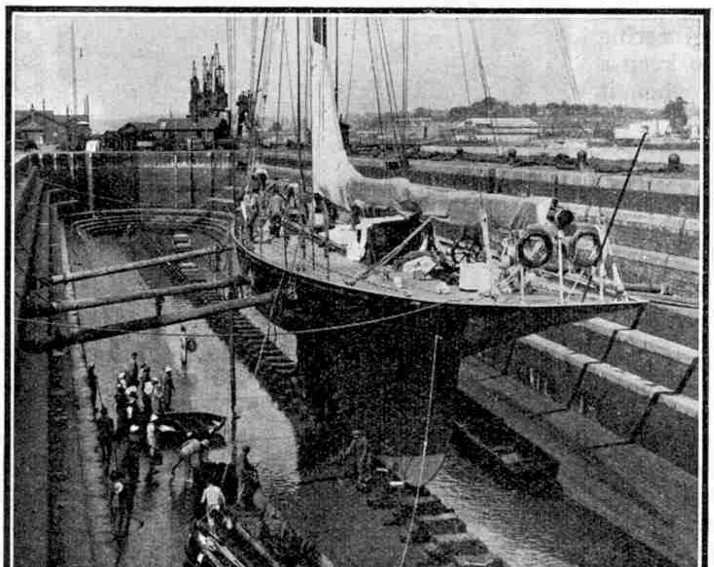
A Roofless Tyre Factory

A motor car tyre manufacturing plant that will be capable of making 300 tyres and 300 inner tubes every day is now being constructed at Buitenzorg, Java, in the Dutch East Indies, for the American Goodyear Tyre and Rubber Co., of Akron, Ohio. About 200 workers will be employed. An unusual feature is that the whole of the works will be entirely open to the air, with the exception of the engine and boiler rooms, which will be housed in a building separate from the main factory. The factory will be made of steel throughout and will conform to the most modern engineering practice for building in tropical countries. It will measure 460 ft. in length and 200 ft. in width, and is being built on the site of an old 28-acre rubber plantation.

Launching 530 Tons of Concrete

During work in connection with the construction of a dam in the United States, an interesting method of erecting the foundations was evolved. A box-like structure of reinforced concrete, 52 ft. long, 32 ft. wide, 16 ft. high and some 530 tons in weight, was built on a launching way. The concrete structure, which formed the inlet well, the foundations and lower part of the dam, was then slid into the water and towed three miles to the site of the plant.

A similar method was used when a ciasson 52 ft. by 42 ft. by 30 ft. was sunk for the Hudson River tunnel, The structure was provided with double walls of steel, and after it had been towed into position, the space between the walls was filled with concrete as the caisson was sunk.



The King's famous racing yacht, "Britannia," in dry dock at Southampton.

A Mine Shaft 5,000 ft. Deep

A vertical shaft 19 ft. long by 13 ft. wide is now being sunk to a depth of 5,000 ft. in South Dakota, and it has already been driven down to 2,350 ft. Work on the shaft, which has two hoist compartments each 6 ft. square, and a third compartment to take the counterweight, was started in 1933 and has proceeded steadily. For the first 300 ft. the shaft is provided with concrete lining, as the ground is not very stable; but below this no lining has been found necessary. The hoisting equipment consists of three electric hoists each controlled by a 1,500 h.p. motor connected to drums grooved for 5,600 ft. of wire rope, $1\frac{7}{8}$ in. in diameter. The power is supplied from a hydro-electric station in the vicinity.

When it is finished, the shaft will be provided with special crushing equipment that consists of two gyratory primary crushers and two cone crushers each of which is 7 ft. in diameter.

Scotland's Newest Road

The new highway between Edinburgh and Glasgow is the most important road that has been built in Scotland for many years. It is only $43\frac{3}{4}$ miles in length, but the work has taken 11 years owing to the many unexpected engineering difficulties that were encountered. The road is of concrete structure, and for about the first four miles from Glasgow is 120 ft. in width between fences, traffic being accommodated in two separate carriageways, each 30 ft. in width, separated by a 30 ft. reserve space. All the rest of the road on to Edinburgh is 100 ft. in width between fences, but so far only a single carriageway has been driven. This is 30 ft. in width except for the last $1\frac{1}{2}$ miles, where it has been increased by 10 ft.

In the comparatively short distance traversed by the new highway it has been necessary to build 21 railway bridges, one canal bridge, and six bridges over rivers or streams. Much difficulty was experienced in making these structures owing to the fact that the road passes through a coal mining area, and consequently special precautions had to be taken to prevent sinking. The new road is only a quarter of a mile shorter than the old one joining the two towns, but it follows a different route for the greater part of its distance and the gradients on it are much easier.

During most of the time that work has been proceeding, an average of 850 men have been employed on the scheme every day, the total number of man-days being about 1,787,400. About 3,000,000 cu. yd. of material have been excavated for cuttings and embankment, and 106,000 tons of tarmacadam, 115,000 tons of asphalt, 32,000 tons of cement, 8,000,000 bricks and 3,300 tons of steel have been used.

Pneumatic Drills Used Below Water

In Honolulu, pneumatic drills are being employed below water to remove coral that projects above the sand on the beach. This coral is exposed from time to time by the shifting of sand caused by the action of the waves, and is of course very dangerous for bathers. Until recently they have had to avoid sections of the beach where it was known or thought that coral was exposed, while jetties were constructed to cause a new layer of sand to be deposited. Recently, however, an area of about 5,000 sq. yd. has been completely cleared of coral by 15 men working with ordinary pneumatic pavement breakers entirely submerged.

Ingenious Machine Tool Attachments

Cutting Spur Gears on a Shaper

MANY ingenious attempts have been made in recent years to devise schemes by which the scope of machine tools such as lathes, shapers and drilling machines could be widened; in other words to make it possible for such a machine to add to its normal functions certain operations for which it was not originally intended. Notable among such devices are some very interesting gear-cutting attachments that have been introduced by Matterson Ltd., of Rochdale. On page 487 of the June *"M.M."* we described one of these devices for cutting bevel gears on a shaping machine. As the result of an unfortunate misunderstanding it was stated in this article that the attachment could be fitted to a lathe, and we take this opportunity of making it clear that the device is designed for use with a shaping machine, and is not applicable to a lathe. In this article we describe another attachment of a somewhat similar type that can be used in conjunction with an ordinary shaping machine for generating spur gears.

Automatic gear-generating machines are very expensive, and unless large numbers of gears are required many small engineering shops have their gears made outside rather than go to the expense of installing special machines. Even large engineering works find that it is costly to keep a special gear-generating plant when it is used only occasionally.

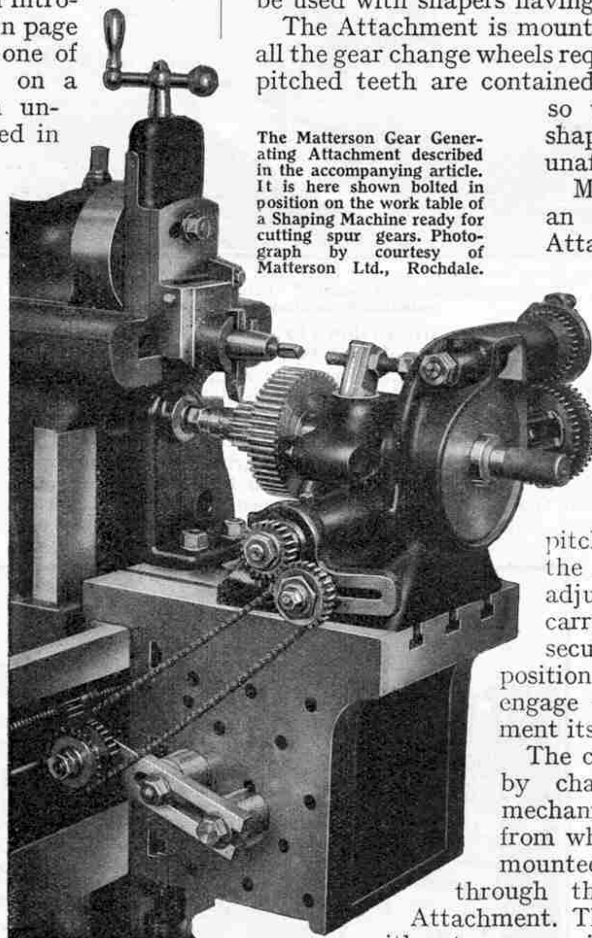
Apart from keeping the shaper machine fully occupied on circular shaping, small internal gears and the like, when the Matterson Attachment is used as an ordinary dividing head, or in work where a better quality is desired than that obtained from ordinary milling cutters, it is possible to cut shoulder pinions and pinions of special pitches and with special characteristics. When it is not required for use on the shaper, the Spur Gear Attachment can be used as an ordinary or spiral dividing head on a milling machine.

It will be seen therefore that the Matterson Attachments are very useful appliances, and their introduction reduces gear making to its simplest possible form. They are capable of cutting gears from any material.

The Attachment can be fitted to a shaper in a remarkably short time, and its cost is small compared with that of a universal milling machine or other special gear-generating machine, although it is capable of turning out the very highest class work.

The illustration on this page shows the Matterson Attachment for cutting Spur Gears on a shaping machine. The only permanent alteration to the shaping machine necessary is the cutting of a spline in the cross feed screw to receive a pinion, the existing feed motion of the shaper being used to operate the Attachment. The dividing for the various numbers of teeth is effected by hand through a graduated hand-wheel operating a driving plate and plunger mechanism. It will be seen from the accompanying illustration that the entire Attachment is very compact, a fact that enables it to be used with shapers having only small work tables.

The Attachment is mounted on the shaper table, and all the gear change wheels required for cutting differently-pitched teeth are contained on the Attachment itself, so that the operation of the shaper for its ordinary work is unaffected.



The Matterson Gear Generating Attachment described in the accompanying article. It is here shown bolted in position on the work table of a Shaping Machine ready for cutting spur gears. Photograph by courtesy of Matterson Ltd., Rochdale.

Matterson Ltd., also supply an additional fitting to the Attachment for generating spiral gears on a shaping machine. This device is capable of dealing with right and left-hand spirals up to 50° and 60° angle respectively, also straight or helical spur gears and spiral faced worm wheels. In this case also the gearing for cutting different pitched gears is incorporated on the Attachment itself, but two adjustable bracket arms that carry the change wheels are secured to the shaper, in such a position that the wheels they carry engage with those on the Attachment itself.

The change wheels are linked up by chain drive with the feed mechanism of the shaper. The blank from which the gear is to be cut is mounted on a mandrel passing through the hollow spindle in the Attachment. The hollow spindle is provided with a taper cone in the nose, for which interchangeable collets can be supplied to handle shank pinions, and the dividing worm is adjustable for wear. Similarly, the nut on the spindle nose is provided with a differential locking device giving fine endwise adjustment.

One advantage of this method of cutting spiral gears is that it is unnecessary to know the lead of the spiral, the normal pitch and angle of tooth only being required.

In changing blanks, the mandrel is withdrawn straight through the hollow spindle and similarly replaced for threading through a further set of blanks.

Gauges for involute cutters, spline shafts, cluster gears for car gear-boxes, are suitable work for the Attachment, and it is used by one well-known manufacturer of air-drills for cutting a small pinion. A rack cutter is used long enough to allow the pinion blank to be cut to roll one complete revolution without dividing.

Cottages Where George Stephenson Lived

Wylam and Killingworth Days

THE two cottages illustrated on this page, one of which was George Stephenson's birthplace and the other his home for 18 years, serve as a reminder of the humble circumstances in which the great pioneer of railways passed his early life. Both cottages are now about 150 years old and are still occupied.

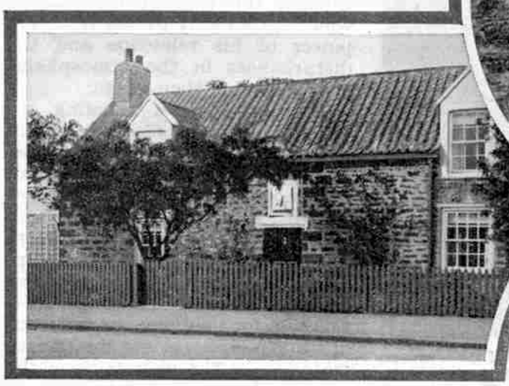
In the cottage shown in the right-hand illustration George Stephenson was born on 9th June, 1781. It is at Wylam-on-Tyne, near Newcastle, and was at one time known as High Street House because it stands on what was the old post road between Newcastle and Hexham, along which the mail was carried on horseback. This two-storeyed cottage was divided into four separate single-roomed dwellings, each with the unplastered walls, exposed rafters and, in the lower rooms, clay floor, typical of labourers' dwellings of that time. The Stephensons occupied the lower room in the western half of the cottage and lived there until 1789. In front of the cottage there was a wooden wagonway along which the coal wagons to and from Wylam colliery were hauled by horses.

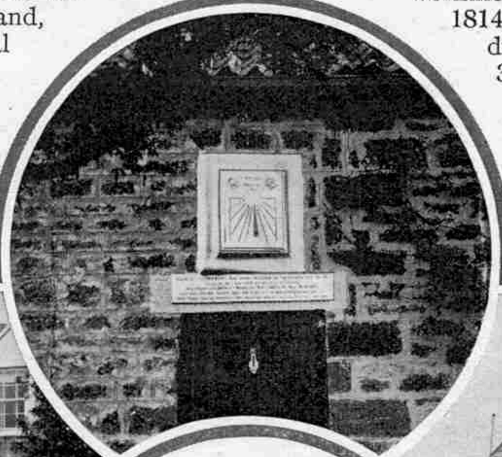
In 1789 the colliery closed down, and Stephenson's father, who had been employed there as fireman, obtained similar work at Dewley Burn Colliery, several miles away. It was necessary for him to be close to his work, and therefore the family removed to Dewley Burn, where they lived in one of a group of old single-roomed cottages. In front of this cottage there was also a wagonway, which led from the colliery to the wharf; and George Stephenson's first paid employment was his engagement by a widowed neighbour to keep her cows off this track. For this service he was paid twopence per day.

The cottage shown in the other two illustrations on this page is at Killingworth, and is associated with the period of Stephenson's life during which he produced his first steam locomotive. Much had happened since the old days at Wylam. He had risen from a small beginning as a colliery "picker," when his duties consisted of picking out stones and clinkers from the coal sent up from the mine below, to the responsible position of brakesman. He married in 1802, and on being appointed brakesman at the West Moor Colliery, three years later, he transferred his home to the cottage at Killingworth. The cottage consisted of a single room on the ground floor, and an attic above to which access was obtained by a ladder. Stephenson set to work to enlarge the building, and made it into a comfortable four-roomed dwelling. He also built and installed an oven.

A wagonway crossed the road at the east end of the cottage, and on this track Stephenson tried out his first steam locomotive. This was built in the adjacent wagon shops of the West Moor Colliery, and was called "*My Lord*," but was nicknamed "*Blucher*" by the workmen. The trial took place on 25th July 1814, and the engine succeeded in drawing eight loaded wagons, totalling 30 tons in weight, at a speed of 4 m.p.h. up a gradient of 1 in 450.

The sundial over the cottage door was made by Stephenson and his son Robert during one of the boy's school holidays. When Stephenson proposed the task, Robert protested that he did not know sufficient astronomy and mathematics to be able to make the necessary calculations, but his father insisted on the job being tackled. A textbook on astronomy was closely studied, and many hours were spent in making the calculations necessary to adapt the sundial to the latitude of Killingworth. Stephenson then obtained a large stone and, aided by his son, hewed and polished it and engraved on it the dial markings.





(Left) The cottage at Killingworth in which George Stephenson lived from 1805 to 1823, and (above) the sundial and inscription over the door. (Right) The birthplace of George Stephenson at Wylam-on-Tyne.

One of the accompanying illustrations gives a close view of the sundial, which is dated August 11th, 1816. The tablet seen immediately below it bears a long inscription to the effect that George Stephenson lived in the cottage from 1805 to 1823, and mentions the "*Blucher*."

In 1838 George Stephenson was one of the Vice Presidents of the Mechanical Science section of the British Association which met that year in Newcastle. During the session he found an opportunity to revisit his old home, where he pointed out with pride some of his handiwork to distinguished members who accompanied him.

The Planets and Their Atmospheres

I—Methods of Study

By Dr. Walter S. Adams (Director, Mount Wilson Observatory of Carnegie Institution of Washington)

THROUGHOUT the years since primitive man first raised his eyes to the heavens and saw the evening star, the planets, called by the Greeks the wandering stars, have held remarkable interest for the human mind. With the progress of human thought and discovery our interest in the planets has naturally turned more and more toward their physical characteristics and constitution. The earliest great problem was that of their motions, and with its solution man gained an answer to many of the questions that had so long baffled him—the mystery of Venus as a morning and an evening star; the elusive glimpses of Mercury, now on one side of the Sun and now on the other; and the strange motions of the outer planets, which appear to move among the stars, then stop and retrace their steps.

When the telescope and accurate methods of measurement were developed we rapidly gained a knowledge of their distances, their sizes, masses, and forms. So our knowledge of the individual planets considered as astronomical bodies is very complete. Naturally the degree of accuracy varies with different planets. The mass of Mercury is uncertain within a considerable range, and in the case of Pluto we can do little more than form probable limits for its size and mass based upon considerations of brightness and the disturbances it produces in the motions of other planets. But in general our facts regarding the planets as a whole are very reliable.

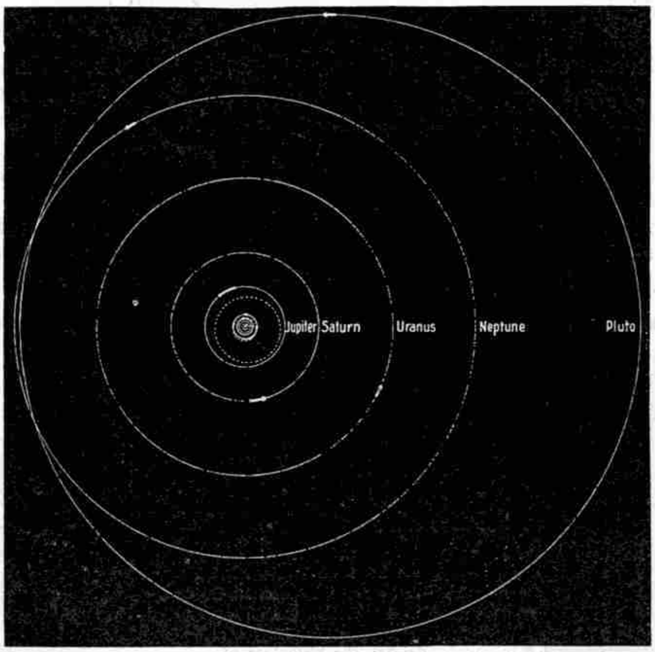
It is quite different when we begin to consider the constitution of the planets, their atmospheres, and the conditions prevailing on their surfaces. In the first place planets shine by reflected light and are not self-luminous. Hence the light we receive from a planet is simply sunlight modified to some degree by transmission through the planet's atmosphere in case such an atmosphere exists. Difficult as it is to realise, it is a much more serious problem to learn the composition of the surface of our satellite, the Moon, the nearest object in the sky, than of a star the light of which may be thousands of years in reaching us.

The gases of the elements composing the atmosphere of the Sun or a star radiate or absorb their own characteristic light and give immediate evidence of their presence when the light is analysed with a spectroscope, while the Moon acts as a mirror and simply reflects the light it receives from the Sun. In fact almost all our knowledge of the nature of the material composing the surface of the Moon is obtained through a study of the influence of reflection by different kinds of materials upon the plane of vibration of light waves, a phenomenon skilfully utilised by Dr. Wright of the Carnegie Institution to prove that the Moon's surface cannot consist of exposed rock, but must be covered by a layer of very fine sand or, more probably, volcanic or meteoric dust.

Much of our information regarding the planets must depend upon direct visual and photographic observations. Surface markings, the periods of rotation, clouds, and varying features on the apparent surface, and to some extent the presence or absence of an atmosphere itself, must all be studied with the telescope, and here we encounter the serious difficulty of atmospheric disturbances.

When a telescope is pointed to the sky it is looking out through the entire depth of the Earth's atmosphere. Each irregularity in the temperature and density of the air through which the light passes bends and twists the beam of light, and as such irregularities change very rapidly there is a continual blurring and quivering of the image. This is the familiar twinkling of the stars so often seen on a windy winter night, and in a telescope the effect is increased in proportion to its magnifying power. Such a blurring effect goes far towards obliterating the surface details and finer markings on the planets or the Sun and Moon, and explains why astronomers seek to locate their observatories where the air is most steady and free from disturbance, and why Percival Lowell established his observatory, primarily for the study of Mars, on an isolated plateau in central Arizona.

It also answers the question most frequently asked of astronomers—whether a telescope cannot be built sufficiently large to bring the Moon within a few miles and Mars within a few hundreds of miles, and so make even the smallest details visible. There is ample light for such observations with existing telescopes and the magnifying power may be made as high as may be desired; but unfortunately the disturbances due to the Earth's atmosphere are magnified along with the planet's disc and nothing is gained.



Scale drawing showing the planetary orbits for 1933. The length of the arrow on the orbits of the outer planets, Jupiter, Saturn, Uranus, Neptune and Pluto, represents the distance travelled by the planets in one year. The illustrations to this article are reproduced by courtesy of the Carnegie Institution of Washington.

If the Earth's atmosphere could be removed the astronomer could use a compound microscope attached to his telescope to view the Moon, and the limit of magnification in the case of the planets would be set only by the resolving power of his telescope and the disturbances in the atmospheres of the planets themselves.

These difficulties affecting observations of the planets explain in part why our knowledge of their physical state is less complete than our knowledge of them as astronomical bodies. Much has been learned, however, and much more may be expected with the development of new and more sensitive instruments for measuring radiation and for studying the influence of the atmospheres and the surface materials of the planets upon the quality of the reflected light.

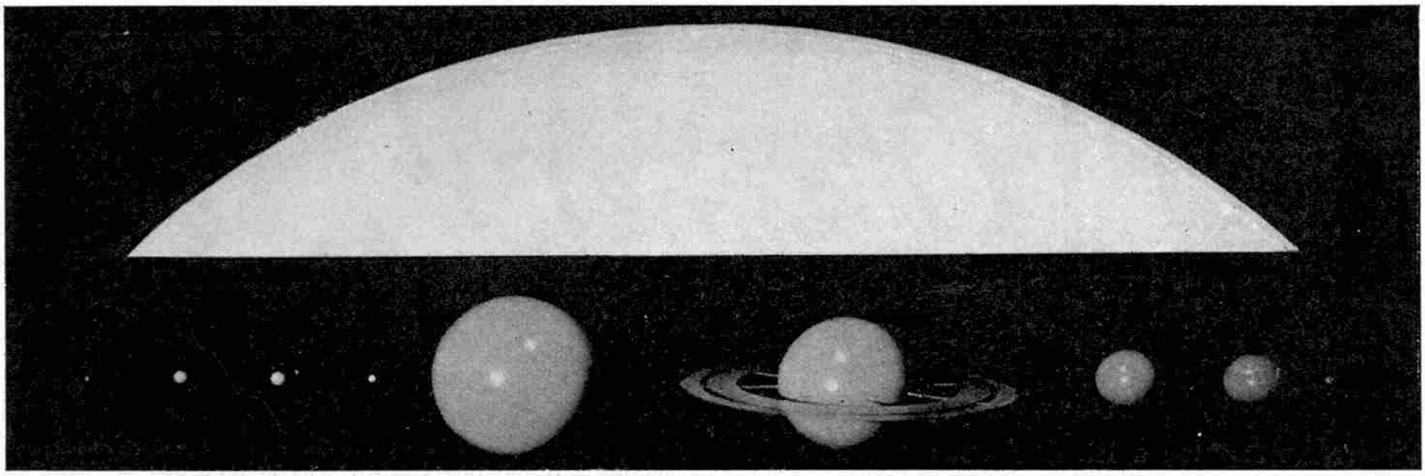
There are three important factors that govern to a large extent physical conditions upon a planet and what we may call its climate. The first is, of course, its distance from the Sun. This determines the amount of heat and light that it receives, a quantity that varies for each unit of area as the square of the distance. Thus Neptune, which is 30 times as far away from the Sun as the Earth, receives only one nine-hundredth as much light and heat on equal areas of its surface.

The second factor is the length of the planet's day, its period of rotation on its axis. This regulates the amount of time during which the Sun's heat falls on different portions of the surface. The more rapidly a planet rotates, the more nearly uniform will be the amount of heat received by all its parts.

An extreme case is that of Mercury, which is generally believed to rotate in the same period of 88 days in which it revolves about the Sun. Hence the planet always turns the same face to the Sun, as does the Moon to the Earth, and one side is intensely heated by the powerful solar radiation while the other side never receives any sunlight and must be extremely cold.

The third consideration that bears especially upon the question of planetary atmospheres is that of the masses of the planets. We do not know definitely that all the planets originally had atmospheres, although this seems probable; but if they did several of the planets would have lost them either completely or in part because they were not massive enough to retain them.

The molecules composing the gases of an atmosphere are constantly flying about with high velocities, colliding with one another



and rebounding in all directions. These velocities are highest for the lightest gases like hydrogen and helium, and lower for the heavier gases like oxygen and nitrogen. Furthermore the velocities are increased by increase of temperature. As a result, if a rapidly moving molecule in the upper part of a planet's atmosphere, where collisions are infrequent, is not attracted by the planet with a force sufficient to counteract its velocity of escape, it will fly off into space and be lost. So a planet has to have a considerable mass in order to retain its atmosphere, and especially to hold the lighter gases like hydrogen and helium, which would be the first to escape. In the earlier stages of their history, when the planets were probably much hotter, the rate of escape for all gases must have been much more rapid.

If we compare the results of observation with what might be expected from theory, we find remarkably good agreement. Mercury, with a mass about one twentieth that of the Earth, has no atmosphere; while Venus, with nearly the mass of the Earth, has an extensive atmosphere.

The Earth has probably lost some of its free hydrogen, but shows a small amount of helium and abundance of the heavier gases like nitrogen and oxygen. Our satellite, the Moon, with one eightieth the mass of the Earth, has no atmosphere, and on Mars, with one tenth the Earth's mass, the atmosphere is thin and of low density.

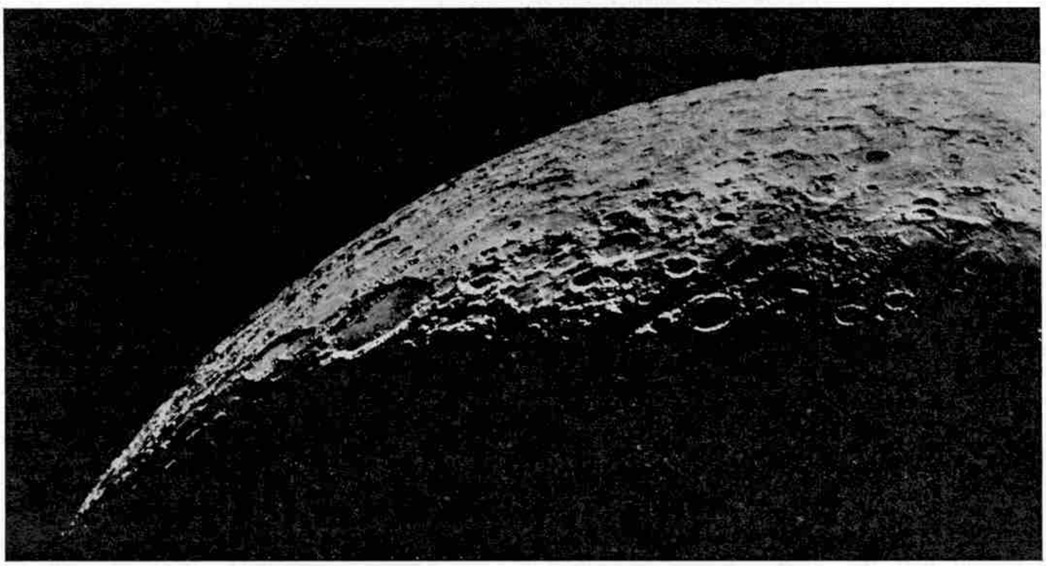
On the other hand, the giant major planets with masses ranging from 15 times the mass of the Earth, in the case of Uranus, to over 300, in the case of Jupiter, have dense and extensive atmospheres. They have doubtless retained all of their original gases, including hydrogen and helium, the gravitational attraction of their great masses binding the molecules of the gases firmly to the planets.

The presence of an atmosphere around a planet is usually detected from observations of clouds and variable markings or, as in the case of Venus, from the extension of the horns of the crescent beyond the diameter of the planet owing to the diffuse reflection of light in the planet's atmosphere—an effect similar to our twilight. For our knowledge of its composition we must then depend upon the spectroscope, which analyses the light and shows what modifications the sunlight has undergone in passing through the atmosphere. These usually occur in the form of bands and lines that are due to the absorption of the cold molecules of gas, and appear for the most part in the red and infra-red portions of the spectrum.

The most prominent in the Earth's atmosphere are those due to oxygen, water vapour, and carbon dioxide. Ozone produces a few faint lines in the yellow portion of the spectrum, but its principal bands lie in the ultra-violet and are so strong that they set a definite limit to the extent of the spectra of the Sun and stars. Astrophysically this is most unfortunate but, as Dr. Abbot and others have emphasised, life could hardly exist upon the Earth if exposed directly to this highly penetrating radiation from the Sun.

Since the surfaces of planets must be observed not only through their own atmospheres but through that of the Earth as well, the bands and lines due to our atmosphere are always present in the spectra of the planets. There are two ways in which the effect due to the Earth may be separated from that due to the planet, and the relative abundance of the gases in the two atmospheres may be determined.

The first is by comparing the intensities of the bands in the spectrum of the planet with those obtained from light transmitted through the Earth's atmosphere alone. For example, the spectrum of Mars, in which the light from the Sun has passed first through the planet's atmosphere to the surface, then outward from the surface toward the Earth, and finally through the Earth's atmosphere, is compared with the spectrum of the Moon, which has no atmosphere.



The upper photograph shows models prepared by the Carnegie Institution's Mount Wilson Observatory to illustrate the relative size of the Sun and planets. In the top row is a segment of the Sun modelled to the same scale as the planets in the bottom row. The planets, from left to right, are Mercury, Venus, Earth and the Moon, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto. The lower photograph was taken with the 100-in. telescope at the Observatory, and is of the southern portion of the Moon 26 days after the "new moon" appears.

If the altitude of the Moon in the sky is the same as that of Mars, the length of path through the Earth's atmosphere is the same in both cases, and any excess of intensity in the lines of the spectrum of Mars must be ascribed to the gas in the planet's atmosphere. Allowance must, of course, be made for the double path of sunlight through the atmosphere of the planet, which should increase the intensity of the planetary lines.

A second method of separating planetary lines from those of terrestrial origin depends upon the fact that the motion of a planet towards or away from the Earth produces a displacement of the spectral lines. Accordingly, if a time is selected when a planet is approaching or receding rapidly from the Earth and the spectrum can be photographed on a sufficient scale, the planetary lines will appear completely separated from those due to the Earth's atmosphere. This method has marked advantages *(Continued on page 793)*

Of General Interest

Photographing a Bursting Soap Bubble

I see that two American scientists have succeeded in taking photographs showing how a soap bubble bursts, and how a pane of glass is broken by a bullet travelling at the rate of about 400 ft. per second. The exposures necessary for these remarkable photographs are about one hundred-thousandth of a second. It is impossible to devise any form of mechanical shutter to give such short exposures, and instead a short but brilliant flash of light is produced, the duration of this being the exact time of exposure required. Thus in taking the photograph it is only necessary to open the shutter, flash the light, and then close the shutter again.

The flash is really a miniature lightning discharge, for it is an electric spark from a condenser charged to 16,000 volts. It occupies only one hundred-thousandth of a second, or even less, and is timed automatically. For instance, in photographing the bursting of a bubble, the bullet is made to pass through the bubble and then strike a contact that releases the electrical energy in the condenser and causes the spark. The contact can be adjusted to produce the flash at different times after the bursting of the bubble, and thus successive stages in the action can be photographed. A series of photographs is obtained by using several bubbles, and these show first the collapse of the near side of the soap film, then the extension of the breakage round the bubble, and finally the wisps of film left hanging from the pipe from which the bubbles was blown.

Other photographs of special interest secured by similar means show the break up of a glass containing milk when dropped on the floor from a height of 5 ft. In this case the impact of glass itself set up the contact that produced the flash, and the fragments into which it broke can be seen separated from each other before they have fallen to the ground, with the milk beginning to pour out of the gaps between them.

It is interesting to compare a photographic triumph of this kind with the laborious efforts of the pioneers of photography. As many of my readers know, photography was made practicable by J. N. Niepce, a French scientist, who discovered that a silvered copper plate that had been exposed to the vapour of iodine was sensitive to light. The image produced on this plate was made permanent by washing in salt water. The chief drawback to the method was the length of exposure necessary, for the images were faint even after light had been allowed to fall on the plate for several hours. This difficulty was overcome by Daguerre, a scenic artist who helped Niepce, and discovered after the older man's death that mercury vapour had such a surprising effect on an exposed plate that exposure could be reduced to about half an hour.

Daguerre announced his discovery in 1839, and in the same year Henry Fox-Talbot, a retired Englishman living in the secluded Wiltshire village of Laycock Abbey, placed on record a description of a method of obtaining photographic images on paper. Daguerre's process was the more beautiful in its results, as well as being the more practicable, and in consequence its discoverer has come to be regarded as the true inventor of photography, despite the almost equal claims of Henry Fox-Talbot and the work of Niepce and others. At any rate, Daguerre's name has become inseparably associated with the first commercial photographic process, and the photographs that were made on silvered copper plates became known throughout the world as "daguerreotypes."

The First Photographic Portrait

It is interesting to find that Daguerre was not the first man to photograph a human face, and indeed when making the announcement of his discovery he stated that he had not yet succeeded in portraiture, but hoped to do so later. Daguerre's early photographs were of whitewashed walls, cottages and landscapes, and his earliest plates were so slow that exposures of impossible length would have been required for portraits, even in brilliant sunshine.

The first photographic portrait. This was the work of Professor Draper, of the University of New York, and the sitter was Miss Dorothy C. Draper, his sister, who remained still during an exposure of half an hour!

The distinction of taking the first human photograph belongs to Professor J. W. Draper, of the University of New York. Draper was born in St. Helens, Lancashire, in 1811, and emigrated to America in 1833, where he became Professor of Natural Science in Hampden Sidney College, Virginia, in 1837, and Professor of Chemistry in New York University in 1839. When Daguerre gave to the world his discovery of photography, Professor Draper, who had long been interested in the chemical effects of light, determined to apply the discovery to the making of human portraits. Together with Professor Morse, the originator of the Morse Code, he erected a little glass studio on the University roof, and there he conducted experiments on photographic portraiture with the aid of his laboratory assistant, who acted as "sitter." The "camera" used in these early efforts consisted merely of a cigar box to which was fitted a spectacle lens. With this crude instrument Professor Draper succeeded in obtaining photographic images of brick buildings, a church spire and other objects, but the features of his laboratory assistant failed to impress themselves upon the plate.

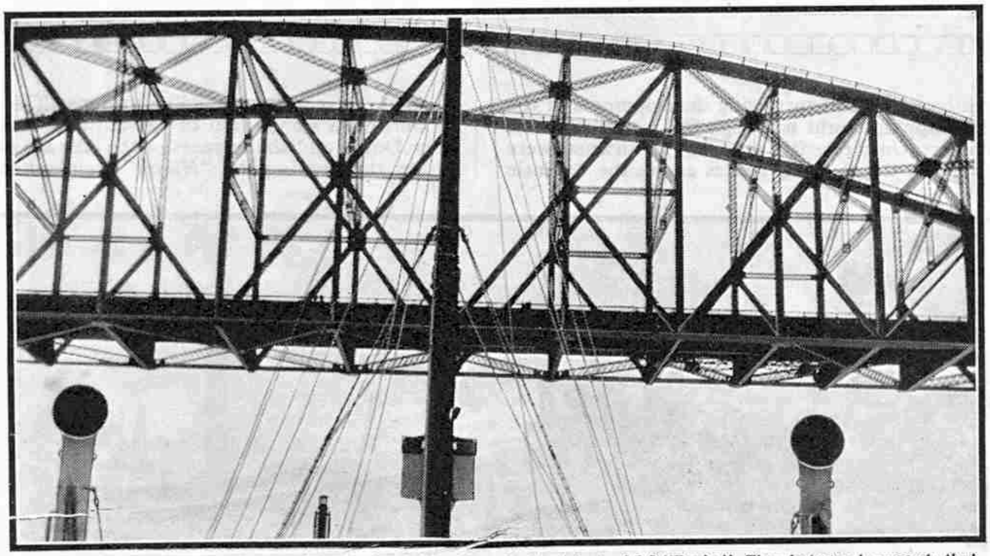
Shortly afterwards, acting upon the suggestions of a Mr. Towson, of Liverpool, an optician of some note, Professor Draper employed a more elaborate camera that was fitted with a wide aperture lens to admit more light to the plate. This lens was a huge affair, with a diameter of five inches and a focal length of seven inches. It proved effective, however, for with its aid Professor Draper towards the end of 1839 photographed his sister, Miss Dorothy Catherine Draper. This lady submitted to having her face carefully dusted over with white powder in order that her features would reflect as much light as possible, and to remaining absolutely motionless during an exposure of half an hour in bright sunshine! The portrait has been carefully preserved as a scientific rarity of fascinating and ever-increasing interest, and is reproduced on this page.

In the following year the daguerreotype process of photography was speeded up and applied commercially in most of the civilised countries of the world. In April, 1840, Professor Draper, in conjunction with his colleague Professor Morse, opened a portrait gallery on the roof of New York University, and the fashionable people of New York flocked to the studio in large numbers to have their portraits made by the wonderful new invention.

Scientific Hunt for Buried Treasure

Those of my readers who have revelled in *"Treasure Island"* and other stories of pirate hoards hidden on the islands of the Pacific will be interested in the expedition that sailed to Cocos Island in search of the vast treasure supposed to be buried there. The story of the chief hoard to be sought on that lonely island was told on the Editorial page of last month's *"M.M."* No less than nine different methods of detecting masses of metal underground are to be employed in looking for it. Some of these methods are as yet secret, but the general idea can be gathered from one of them, in which ultra high-frequency currents will be passed through measured portions of ground and their course followed by means of surface measurements. Naturally the conductivity will be greatest in areas where metals are buried, and it is hoped that the tracks of the high-frequency currents will reveal the presence of the gold and silver believed to have been buried by the pirates who made Cocos Island their headquarters.

Methods of this kind are now used by prospectors in the search for underground metallic deposits, and their employment on Cocos Island will go far towards proving or disproving the truth of the many legends of hidden gold that have been rife since the decay of piracy. Success will give an immense impetus to treasure seeking, especially in South America, where the greater part of the wealth of the Incas, the former rulers of Peru, is supposed to have been carried for safety into the Andes after the conquest of Peru by the Spaniards.

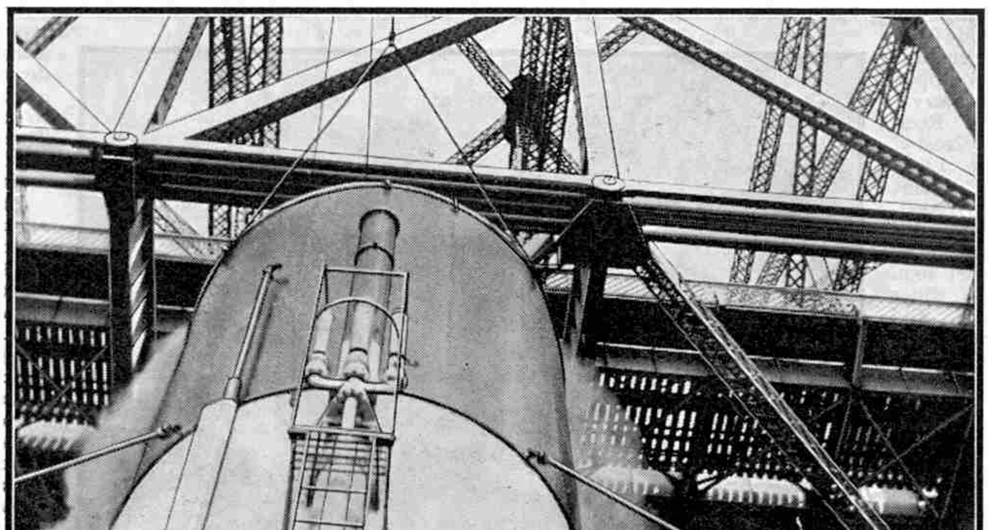


A novel view of the suspended span of the Quebec Bridge from the boat deck of S.S. "Doric." The photograph suggests that the mast of the vessel will collide with the steelwork of the bridge.

Tower Twice the Height of Snowdon

For many years the Eiffel Tower retained the proud distinction of being the highest man-made structure in the world, and it is only within recent years that two of the skyscrapers of New York have exceeded it in this respect. The Eiffel Tower is 984 ft. in height, and to-day the Empire State Building and the Chrysler Building hold the record with heights of 1,046 ft. and 1,030 ft. respectively. It has now been proposed to restore the distinction to the Old World by building in Paris a giant tower of reinforced concrete 6,540 ft. in height.

The new tower is planned in connection with a great Exhibition to be held in Paris in 1937, and will be nearly seven times the height of the Eiffel Tower and almost twice as high as Snowdon. Its base will be 650 ft. in diameter, and even at the top the gigantic structure will measure 130 ft. across. At different elevations platforms will be constructed from which aeroplanes can be launched through gigantic openings, and anti-aircraft guns mounted on the tower will help to protect the city from aerial attack.



The funnel of the "Doric" about to pass under Quebec Bridge. This photograph was taken immediately after the one reproduced above, and both are by Miss E. Wilson, Bowdon, Cheshire.

The World's Tallest Chimney

The tallest chimney in the world is that of the Anaconda Copper Company, at Anaconda, Montana, in the United States. It is built of brick and is 550 ft. in height, its inside diameter at the top being 60 ft. The summit of the chimney actually is 585 ft. above ground level, for the stack stands on a concrete base 30 ft. in height. It is interesting to note that this immense chimney is almost exactly three times the height of the Nelson Column in Trafalgar Square, London.

There is a chimney 510 ft. in height at the smelting works of the International Nickel Co. Ltd., in Ontario, Canada, and this is the largest and tallest in the British Empire. The tallest chimney in Europe is 492 ft. in height and was built in 1931 for a power house in Hamburg. Chimneys of such huge dimensions are of course only required in special circumstances and consequently are rare.

How to Treat Ducks

I was greatly interested recently to find that a Government publication insists on the necessity for tact and courtesy in the treatment of ducks! This publication is a bulletin on ducks and geese published by the Stationery Office, and in it the intelligence and highly strung temperament of the duck is emphasised and those who keep the creatures are warned that they will not stand bullying or bustling. A still more surprising suggestion in the same bulletin is that the duck pond should be abolished because exercise on the water, enjoyable as it may be to the ducks themselves, does not improve their quality. Needless to say, the judges of quality who make this pronouncement are not the birds themselves, but those who eat them!

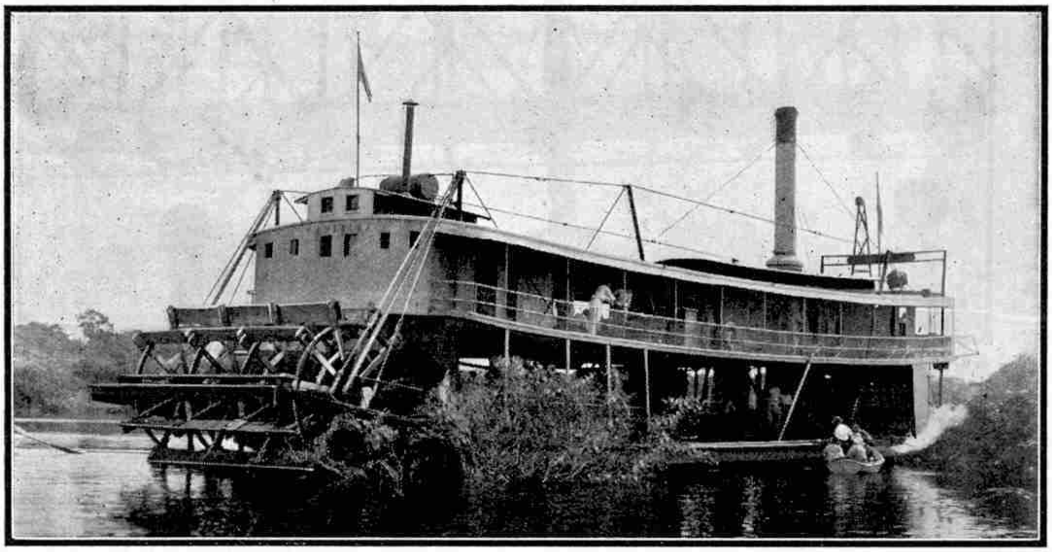
Colour in Industry

New machinery installed in the factory of the Armstrong Siddeley Company at Coventry is painted a pleasant shade of green, instead of black and grey in accordance with the usual custom. This is not the result of an effort to give a more picturesque appearance to the factory, but is the result of a careful study of the effects of colour. There is nothing irritating in the quiet tone of the green paint employed, and it is believed that its restfulness will cause less distraction and irritability on the part of the employees, who will therefore carry out their work much better. Another interesting reason for the innovation is that oil and dirt show up very prominently on objects painted in the new colour. Thus the experiment will help in the detection of oil leaks, and generally will encourage cleanliness, which invariably carries with it greater efficiency. This interesting experiment, if successful, may lead to a great change in the appearance of workshops generally.

One Thousand Miles up the Amazon

Thrills of a Brazilian Cruise

ONE of the most interesting and surprising developments of the depression in the shipping world has been the introduction of cruises for holiday makers. Until recently the giant ocean liners were used almost exclusively on the shipping routes across the Atlantic Ocean, or to South Africa, India, the Far East and Australia; to-day active employment is being found for many of them on pleasure excursions ranging in duration from a few days to several weeks. This policy has proved remarkably popular, and thousands of people are seizing the opportunity afforded them of seeing other lands in a convenient and easy manner.



The stern-wheel river steamer "Parahyba" at Taruma, near Manáos, Brazil. The illustrations to this article are reproduced by courtesy of the Booth Steamship Co. Ltd., Liverpool.

One of the most interesting of these excursions is the "Forest cruise" of the Booth Steamship Co. Ltd., that takes the holiday-cruiser on a wonderful voyage to Manáos, 1,000 miles up the Amazon River. This great trip is made from Liverpool, where we embark in the splendidly-equipped Booth liner *"Hilary."* After passing the Rock Light, and the Crosby, Formby and Bar Light vessels, we reach Point Lynas, where we say good-bye to the pilot, who embarked at Liverpool. The St. George's Channel soon gives place to the wider spaces of the Atlantic, and 36 hours after passing Land's End we see away on the horizon the lofty headland of Cap Villano. On the third morning a lovely vista of green hills and red-roofed villas facing a sunlit sea greets us, and by breakfast time the ship has dropped anchor in the harbour of Leixões, our first port of call.

A victim being shaved by King Neptune's Court during the "crossing the line" ceremony aboard the Booth liner "Hilary."

Going ashore by motor boat, we find cars in waiting to convey us seven miles along the coast road to Oporto. All the way we pass constant processions of women walking barefoot to market, and bearing on their heads enormous loads. In that country it looks as if women do all the heavy work, while their menfolk stand by and watch them. At Oporto a conducted tour around the city enables us to visit all the places of interest, including the Dom Luiz Bridge, shown in one of the accompanying illustrations. This bridge spans the River Douro in a single arch of 650 ft., and from it beautiful views of the Douro and the terraces of the city are obtained.

In the evening the *"Hilary"* weighs anchor and steams along the coast, and after passing the delightful Bay of Cascaes enters the River Tagus. Eight miles upstream is Lisbon, where we arrive early next morning. Lisbon lies on seven hills, and presents a magnificent picture of white churches, red-roofed houses with green balconies, and noble public buildings standing loftily on the heights. Motor cars take passengers through the capital, and out to the Cintra Hills to visit the old palaces of Moorish and Portuguese kings and queens, and to inspect one of the wonderful gardens that are to be found there. The return journey is made along the range of hills and down to the sunny sea coast of the Portuguese Riviera to the bathing resort of The Estorils. The way back to Lisbon is along a fine coast road.

The ship steams seaward again at sunset, and $1\frac{1}{2}$ days later we come in sight of the island of Madeira. Funchal, the capital of the island, nestles at the foot of high mountains with green hills in the foreground up which climb terraces of villas among vineyards. Almost before the anchor has been lowered a dozen diving boys climb laughingly over the rail and demand with much gesticulation "sixpence to dive from the middle rail, a shilling from the top." These youngsters are bred and born to the water; there is no fear of their coming to harm, and they besiege every ship that anchors in the bay. After an interesting day ashore we return to the *"Hilary"* to commence the nine days' voyage to the tropics. With a farewell blast of the siren she glides gently out of the bay, and her course is set across the 2,000 miles of ocean that still separate her from the coast of South America.

The swimming bath is now filled, awnings are unfurled, and two