silencing and keeping the interior cool, specially designed baffle plates being fitted at the bottom of each pipe to prevent oil being drawn up into the cylinder. The athwartship disposition of the engines, with the paddle shaft running between them, makes a useful arrangement for a shallow draught boat. Drawings appeared in our issue of June 21st last.

## ENGINEERING AND MACHINERY EXHIBITION AT OLYMPIA.

No I.

The first effort made by the Machine Tool and Engineering Association, Limited, to promote and organise an exhibition is proving a decided success, and the society may be said to have already justified its existence in this respect. There have in recent years been numerous—far too numerous for the makers—exhibitions of a more or less miscellaneous character at which machine tools have found a place, but there has been no exhibition in these islands, at any rate, in which the products of the machine tool making industry have been so well represented as at the display now open at Olympia. Altogether the Exhibition comprises over 400 stands, and although machine tool exhibits undoubtedly predominate, it must not be inferred by those interested in other branches of engineering that the Exhibition is of a one-sided character. Far from it. There is scarcely a department of engineering science which is not represented, from quite the most up-to-date system of steam raising as invented by Messrs. Bone and McCourt, to foundry equipment, gas engines, oil engines, air compressors, transmission of power by oil, toothed gearing of the most modern design, tin box making machinery, scientific instruments, and last, but not least, the engineering Press.

Originally we believe it was the intention of the promoters to confine the Exhibition to British productions, but finally it was decided to admit appliances made by engineers of other nationalities. Apart from the commercial aspect of the case, the later decision was undoubtedly the wiser, for while the British exhibitors have lost nothing by the comparison of their machines with those from the Continent and America, the organisation as a whole has certainly gained in attractiveness. The most disappointing feature of the Exhibition is the almost complete absence of heavy machinery, such as steam engines and turbines and high-powered oil engines. A display of high-powered marine Diesel type engines would have proved an immense attraction at the present juncture, but no doubt makers are reserving them for the special exhibition in a few months' time. Before passing on to review some of the more important exhibits a word of praise is due from us to the management for the manner in which the stands have been arranged. No built-up offices or high partitions have been permitted on any of the stands in the main area. The society has also wisely excluded the numerous miscellaneous exhibits which are nearly always to be met with at such displays. We regret to have to utter a complaint when the general effect is so harmonious, but there is real cause in connection with the compilation of the bulky catalogue. It is open to several criticisms.

In a special Supplement, which will be published with our next issue, we shall deal with the bulk of the British tools. We discuss several other exhibits below, and shall refer to more in succeeding issues.

Detail drawings of the new Bateman planer exhibited by Smith and Coventry, Limited, are given on page 381. These drawings show a side elevation, a front elevation, a sectional plan, and a transverse section showing the arrangement of the gearing. In Fig. 1 are given a series of power curves taken from a 4ft. machine running light and in Fig. 2. curves are given showing the cost of energy to drive the machine under different conditions with current at a penny per unit. Referring to the drawings on page 381, it will be observed that the machine is driven by means of a three-speed cone pulley A on the shaft B, on which is also keyed the raw hide pinion C. This meshes with a spur ring, which forms part of the fly-wheel D. The latter wheel runs loose on the first motion shaft E, which extends right across the machine. On this shaft is keyed a pinion F, which engages with circumferential teeth on the spring wheel G. This spring wheel is designed so as to absorb the shock on reversing, and is connected by suitable means with the pinion H, which in turn drives the bull wheel. It will be observed that all the above gear wheels, with the exception of the pinion F, are loose on their shafts and are driven through their peripheries. The return drive is brought about by means of a belt on the fly-wheel J running loose on the first motion shaft E and through gearing F, G, H to the bull wheel. This arrangement does away with high belt speeds on the return stroke. The reversal is effected by means of the tappet K, bevel wheels L on the rocking shaft M, and through the segments N, thus operating the plunger shafts O, $O^1$ by means of connecting-rods P, $P^1$ which are fitted with pivoted joints. The plunger shaft O is also a toothed rack, and gears with a rack pinion Q, which forms part of an ingeniously devised train of gears around the shaft R, and employed to move the cam wheel U. This operation serves to tighten the friction band V round the circumference of the pulley W, and as this is keyed on to the first motion shaft, the fly-wheel, pulley, and shaft all revolve together.

On the cutting stroke a secondary and positive system of driving is provided, in addition to that above outlined. Immediately after the reversal of the motion of the table by the friction band gripping the circumference of the pulley an additional tappet on the side of the work table engages with the lever X, which is coupled up through connecting-rods and bevel wheels on to the rocking shaft N. This serves to give further rotary movement to the cam wheel U, releasing the lever Z, and allowing the pawl $Z^2$ to engage with the wheel $Z^1$. As this wheel is keyed on to the boss of the pulley $W^1$, a positive drive is added from the cone pulley A to the rack of the table.

The most powerful lathe in the Exhibition is to be seen on the stand of the makers, John Stirk and Sons,

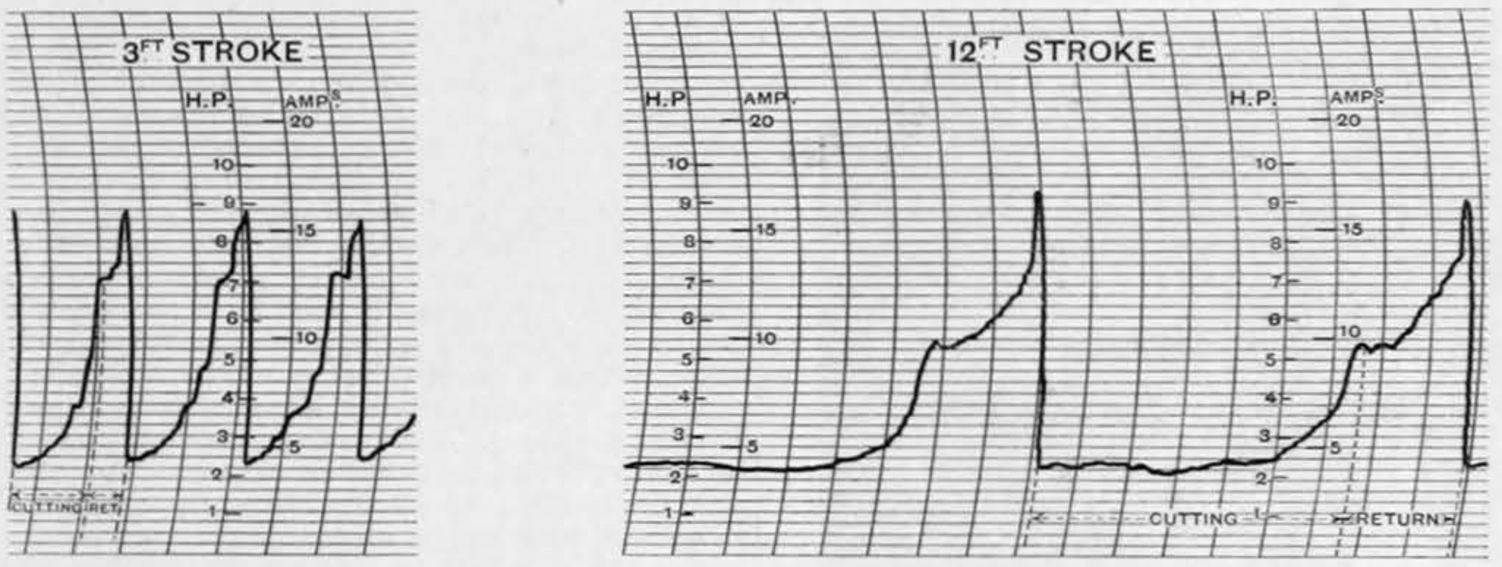



Fig. 1—POWER CURVES OF 4ft. PLANER RUNNING LIGHT

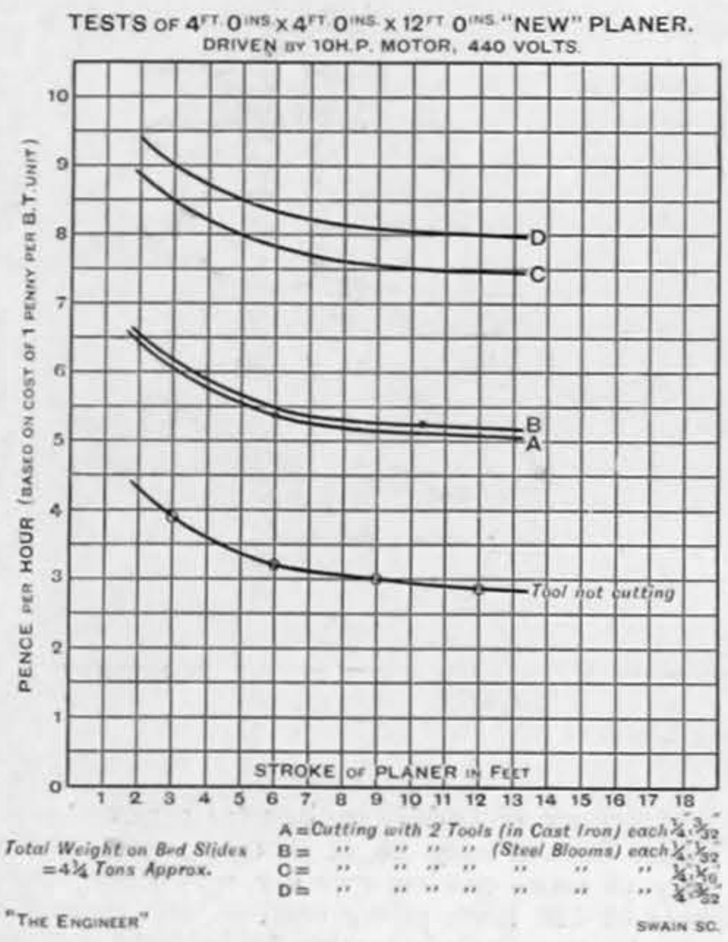



Fig. 2—PLANING MACHINE COST CURVES

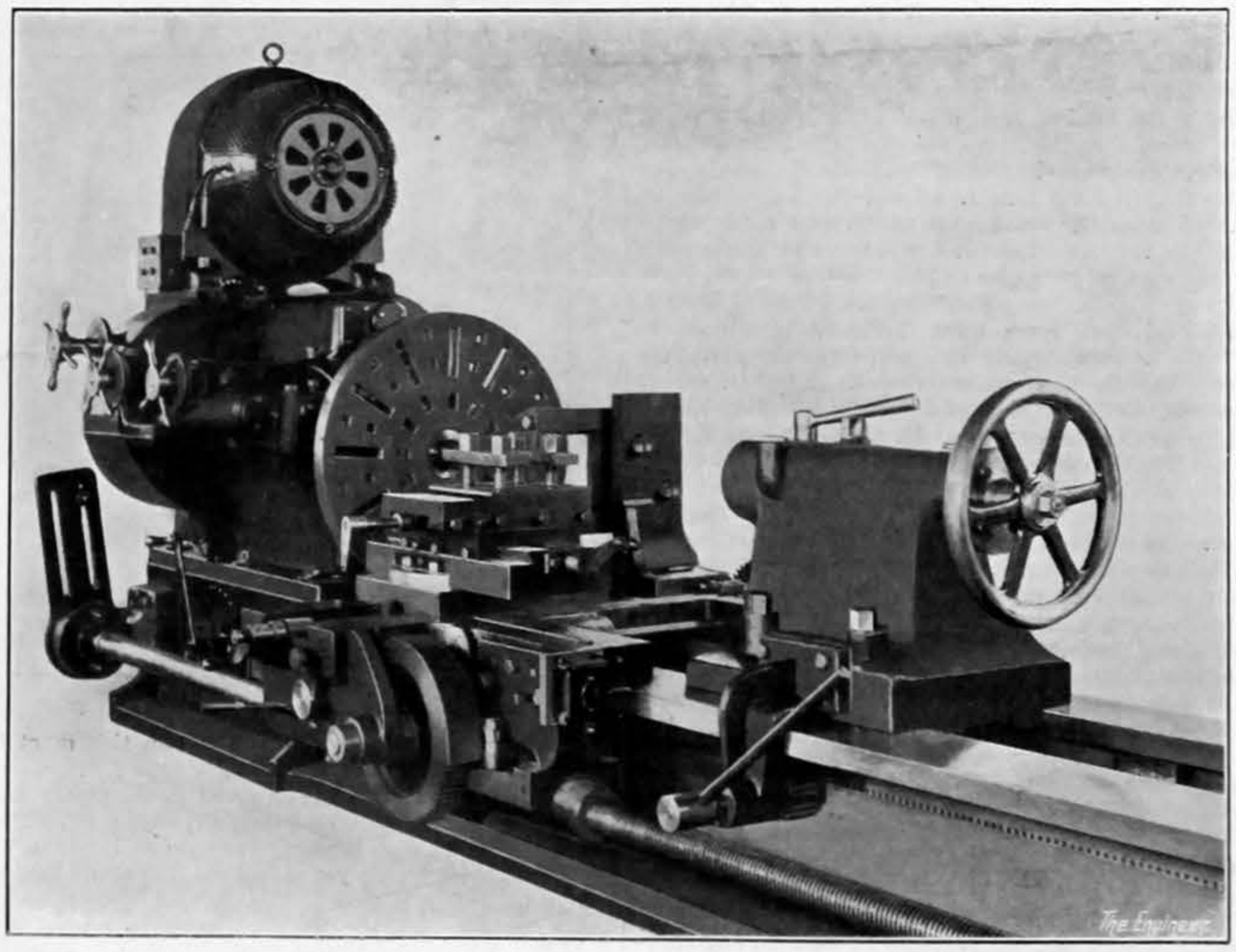
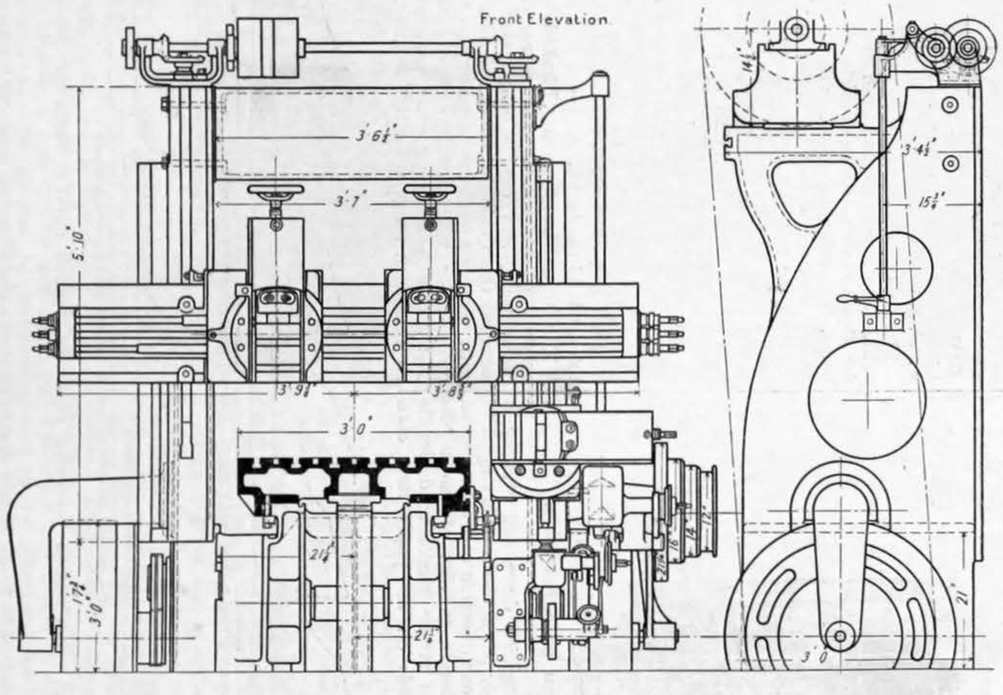


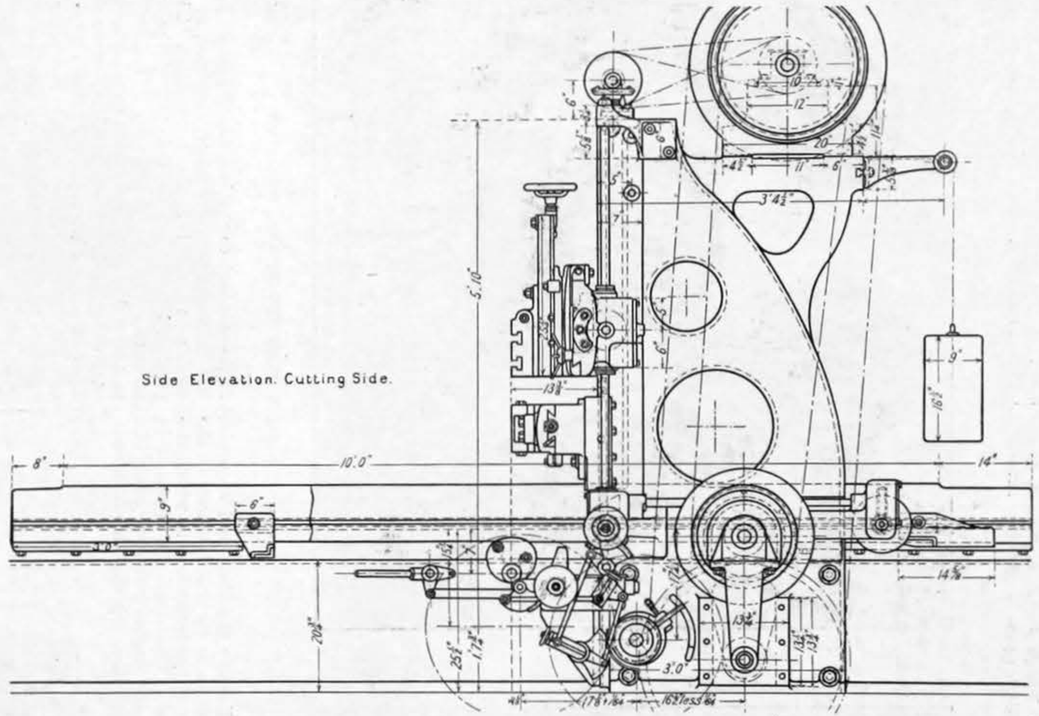

Fig. 3 -18-INCH LATHE, JOHN STIRK AND SONS

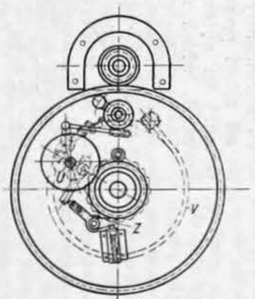
# BATEMAN PLANING MACHINE AT OLYMPIA

SMITH AND COVENTRY, LIMITED, MANCHESTER, ENGINEERS

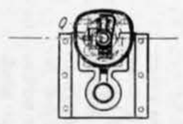
*(For description see page 380)*



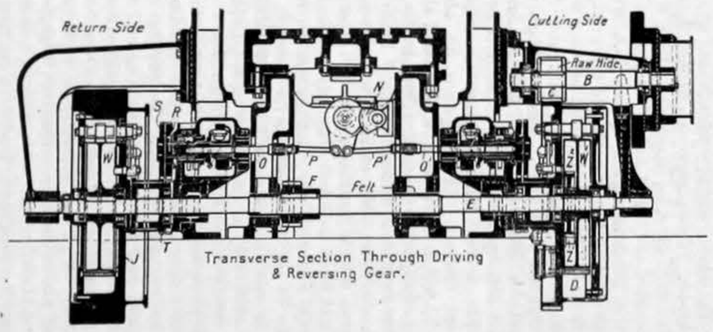



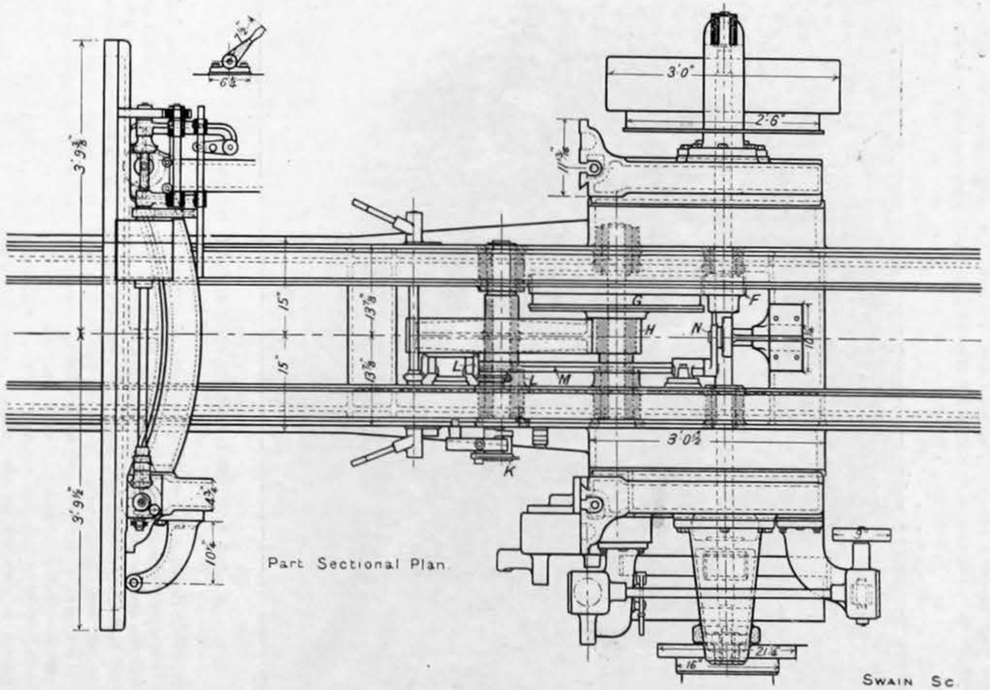

View Looking from Inside Bed to Drive Cutting Side




Section Through Reversing Bracket




Transverse Section Through Driving & Reversing Gear.




Part Sectional Plan

SWAIN Sc

Limited, of Halifax. An illustration of this tool is given in Fig. 3. It is an 18in. machine driven by a 30 horse-power electric motor and Renold chain. The headstock is of the "all-gear" type, giving fifteen spindle speeds. The gears are secured on square shafts, and are of machine-cut forged 0.4 carbon steel. They are securely interlocked to prevent possible damage by getting two sets of gears into mesh simultaneously. The spindle is of ample dimensions, and is provided with a ball thrust bearing. The bed is very substantial, with wide, square shears and strong, deep box bars. It is devoid of legs and feet. The saddle is provided with sliding, surfacing, and screw-cutting motions, and carries a heavy compound rest with in-cutting slide. Reversing mechanism is carried on the saddle, and there are four rates of feed and quick power traverse. The machine is fitted with Stirk's electric saddle control, by which the driving motor can be instantly started, stopped, accelerated, or retarded by simply pressing one of four buttons. Another electrical device on the saddle gives a high speed traverse, which saves a lot of time when operating on long pieces of work. The machine is shown in operation, and is said to be capable of removing a ton of metal per hour. The same firm also exhibits an electrically driven 42in. boring and turning mill. A 6 horse-power variable-speed motor drives the machine through a three-speed gear in which sliding wheels on square shafts are employed. The control is effected by Stirk's electric starter regulator, by means of which the machine can be started on "full field," and automatically takes up the predetermined speed. A special form of switch enables the operator to do an almost unlimited amount of "inching" when setting work, &c. The machine is worm driven, and the cross-slide can be elevated by power. Messrs. Stirk are also represented on Messrs. C. E. Lugard and Co.'s stand by an 8ft. by 3ft. planer, which is operated by the Vulkan drive. This system is already familiar to our readers. It comprises an electro-magnetic clutch, which consists of a cast steel shaft drilled for lubrication, a disc armature fixed to the shaft, and two electro-magnetic bodies running loose on the shaft. Each magnetic body is fitted with an annular energising coil and a ventilating ring. The disc armature is fitted with a thrust ring adjustable and renewable without dismantling. Continuous current is supplied to one of the energising coils through the slip rings, and as soon as the circuit is closed the loose running magnetic body is held by magnetic attraction to the disc armature. The magnetic faces of the clutch are kept apart by the thrust ring leaving an air gap between them, any heat generated being dissipated by the ventilating ring. To reverse the current is switched over from one energising coil to the other.

In these days of excessive competition in manufacturing too much attention can scarcely be paid to economy in power production, and owners of large power plants cannot afford to take for granted the cost of their power. An ordinary indicator diagram from a steam engine cylinder, of course, gives approximately a measure of the work done on an engine piston, but greater accuracy in indicating can really only be secured by taking diagrams from both ends of a cylinder simultaneously and continuously over a given period. A device called a continuous indicator stroke diagram attachment has been invented by Mr. Wallace, and is being exhibited by the Crosby Steam Gage and Valve Company, of Boston, Mass. This ingenious instrument, besides providing a continuous record, also enables the diagram taken at any moment on one side of the piston to be co-ordinated with the diagram at the corresponding moment from the other end of the cylinder. The device may be fitted to any two Crosby indicators, whether of the inside or outside spring type. Referring to Fig. 4, it will be seen that the device consists essentially of two parts, a stationary magazine drum, which holds a roll of paper about 100ft. long, fitted upon a bracket arranged to couple the two indicators together, and a special clutch drum, which has to be mounted instead of the ordinary drum on one of the indicators to which the attachment is secured. This drum is operated in the usual way from the engine reducing gear, but only moves in one direction, withdrawing the strip of paper from the magazine drum and winding it on itself. The indicator paper therefore is caused to move continuously in one direction and with a speed at all times proportionate to that of the engine piston. An automatic stroke recording device is provided, which records on the paper strip each reversal of the direction of motion of the engine piston. An electrical or mechanical "timing" attachment is provided to be fitted when desired for recording time on the indicator strip, and is useful when there is an irregular variation in the speed of the engine. This enables the piston speed to be obtained at any moment. A double three-way cock connection is supplied to receive the two indicators, and this is designed so as to allow either indicator to be put into communication with either end of the cylinder or opened to the atmosphere. This connection fixes the indicators at the correct distance apart to receive the attachment, and allows the indicator pencil levers to be brought as close together as possible without touching. The diagrams produced in this way are not of the closed form characteristic of the ordinary indicator, but appear as two continuous wavy lines crossing and re-crossing each other, and are such that the distance between the lines at any point represents the effective pressure on the piston. The stroke recording appliance provides the means whereby the position of the piston may be co-related to the endless diagram. Fig. 5 shows a plan of the apparatus, and Fig. 6 a section of the drum. From these views it will be seen that a detent is provided on the top of the clutch drum for starting or stopping the forward movement of the paper as desired. The construction of the clutch mechanism on the lines of the bicycle free wheel is also seen in Fig. 6. Fig. 7 represents two typical continuous diagrams taken by this instrument, which are self-explanatory.

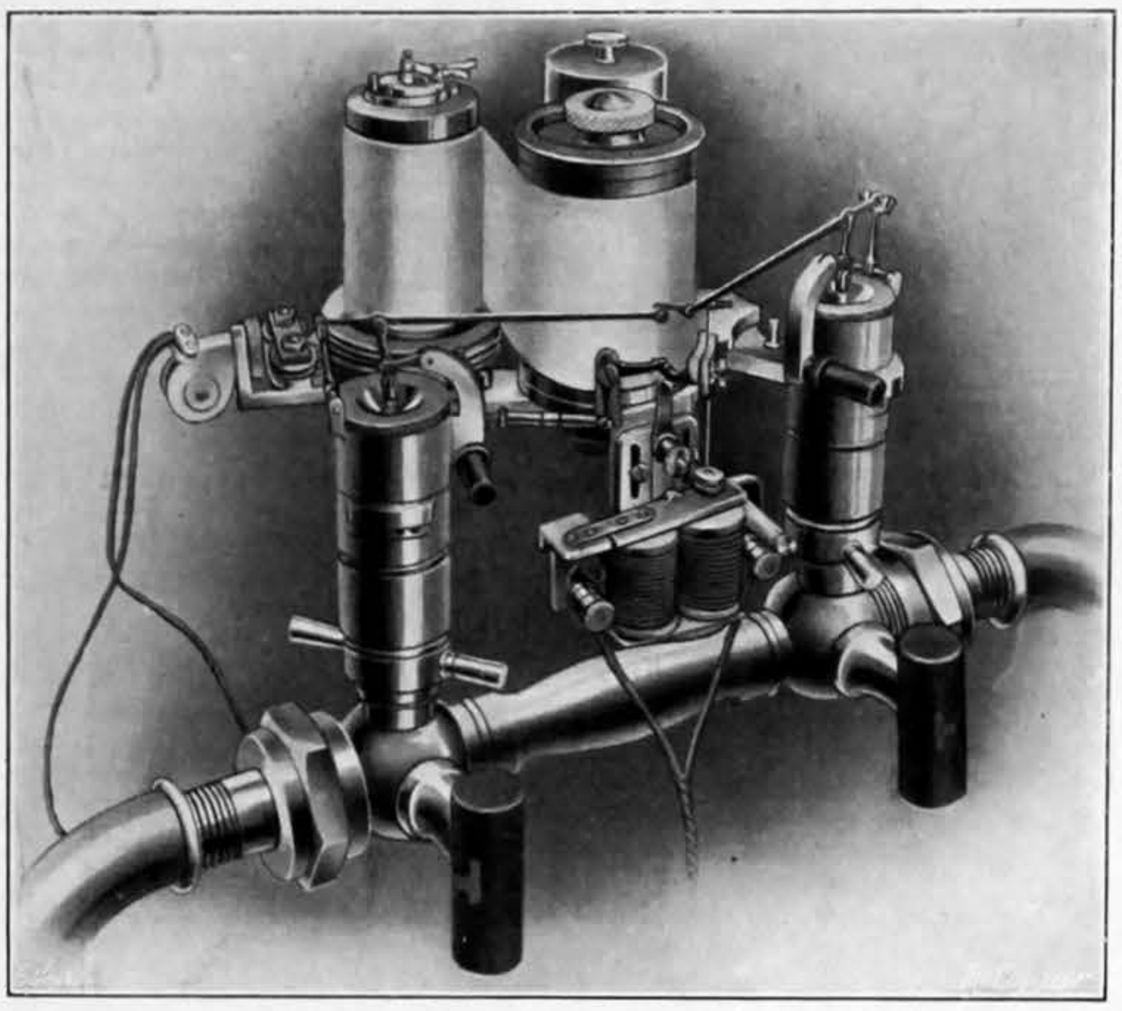


Fig. 4—CROSBY CONTINUOUS DUPLEX INDICATOR

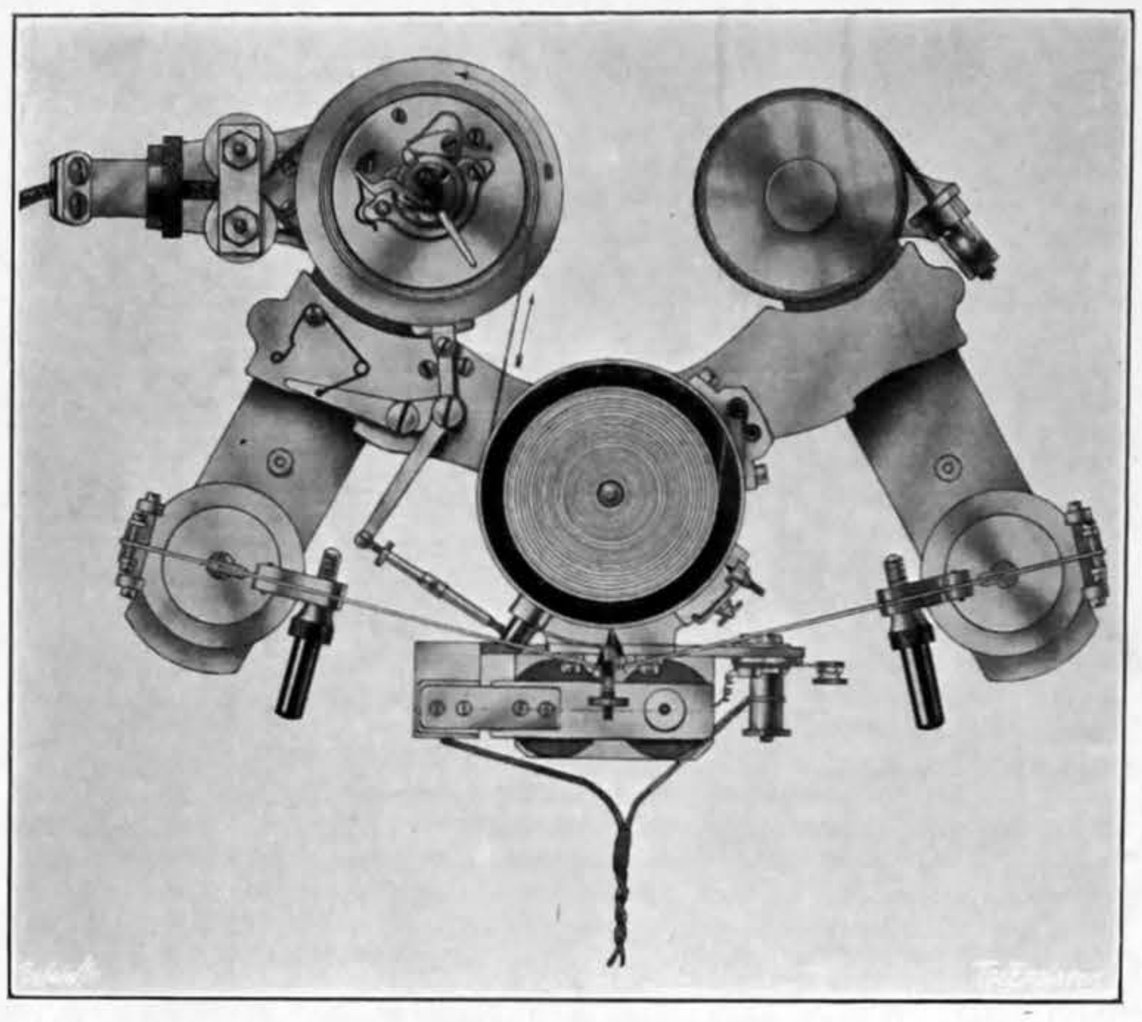


Fig. 5—PLAN OF DUPLEX INDICATOR

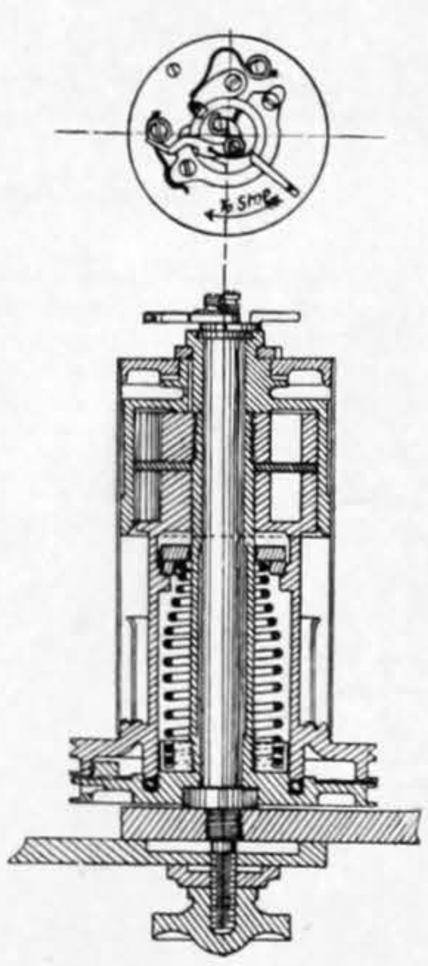


Fig. 6—SECTION OF PAPER DRUM

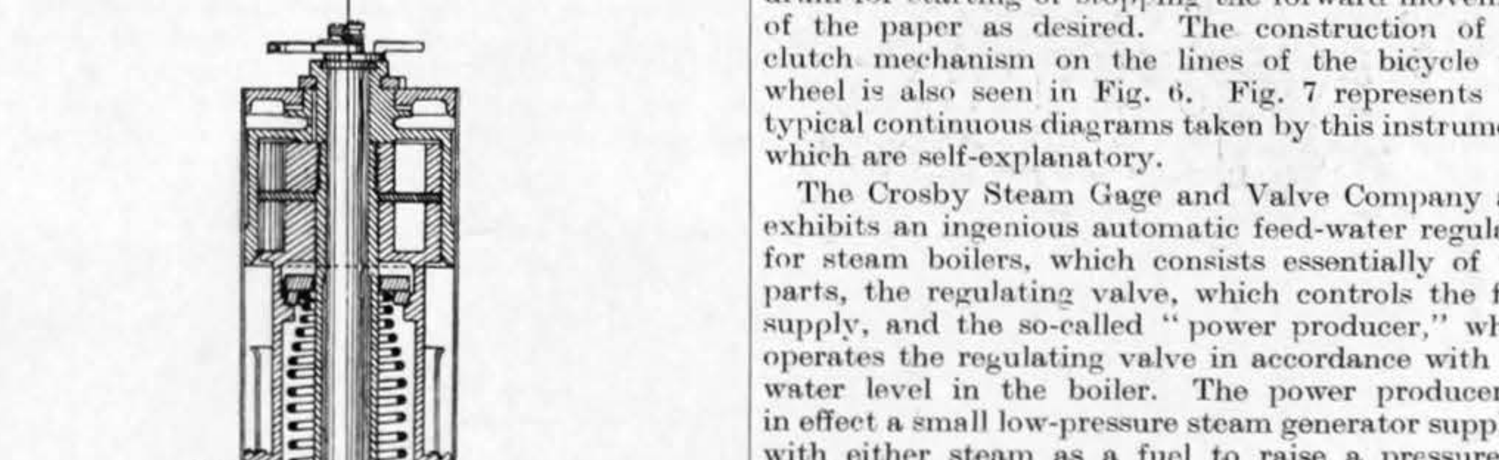



Fig. 7—CONTINUOUS DIAGRAMS TAKEN BY CROSBY DUPLEX INDICATOR

The Crosby Steam Gage and Valve Company also exhibits an ingenious automatic feed-water regulator for steam boilers, which consists essentially of two parts, the regulating valve, which controls the feed supply, and the so-called "power producer," which operates the regulating valve in accordance with the water level in the boiler. The power producer is in effect a small low-pressure steam generator supplied with either steam as a fuel to raise a pressure or water as a damper to lower this pressure, according to the variations of the water level in the boiler to which it is attached. The pressure obtained is utilised to control the feed regulating valve, and travels through only a limited range, just sufficient to open and close the valve as required to supply the needs of the boiler.

The Power Plant Company, Limited, West Drayton, exhibits double helical spur gears, double helical bevel gears, and double helical racks. Prominent amongst these exhibits are double helical spur gears with staggered teeth produced by this firm's hobbing process, for which extreme accuracy is claimed. The double helical spur gears with staggered teeth on exhibition range from the smallest model gears to a set of rolling mill gears with a face width of 2ft. and capable of transmitting 600 horse-power at 35 revolutions per minute. All these gears have a distinctive appearance, owing to the fine pitch and wide face with which they are made. Continuous

tooth gears of the triple helical variety are shown, both spur and bevel type. A pair of double helical bevel gears shows that this type is well adapted for high ratios. All these gears have remarkably good tooth shapes, and turn easily. The main feature of the stand is a large range of self-contained totally enclosed speed reducing and increasing gears, the smallest being designed for electrical organ blowing and the largest for transmitting 300 horse-power,

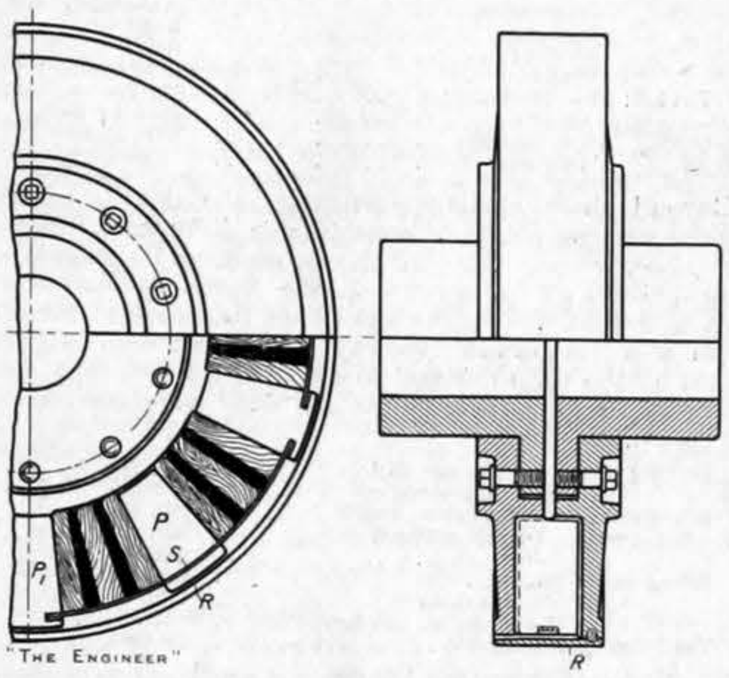



Fig. 8—POWER PLANT CO.'S HEAVY DUTY COUPLING

with a ratio of 5 to 1 for driving a large factory. All ratios up to 15 to 1 are obtained by a single train of gears, whilst for higher ratios up to 80 to 1 a double train is used. One of the gears designed to transmit 24 horse-power when increasing from 475 to 3000 revolutions per minute is shown in operation, and runs at about 5000 revolutions per minute with the slightest hum only and without any noticeable vibration.

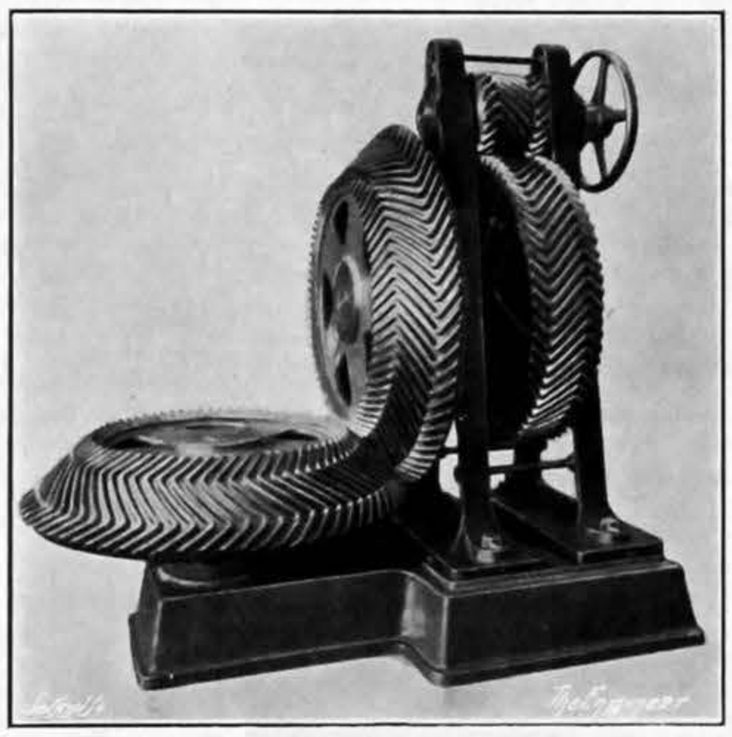


Fig. 9—POWER PLANT CO.'S TREBLE HELICAL GEAR

This firm further displays a whole series of flexible couplings of neat appearance. In most of them leather is used, as the flexible medium, but instead of the single leather strap a number of leather rings are fitted over circular projections on one half and engaged by suitable projections cast on the other half. These leather rings are of uniform size for each size of coupling, and can, it is claimed, be fitted without requiring any engineering knowledge or experience in leather jointing.

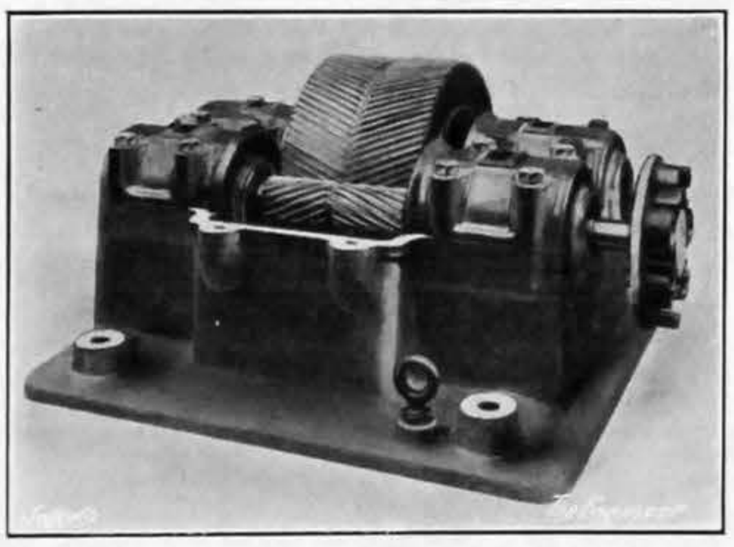


Fig. 10—POWER PLANT CO.'S SPEED INCREASING GEAR

A heavy duty coupling, specially designed for winders, rolling mills, &c., is shown in Fig. 8. In this coupling the flexible medium is in compression. The coupling consists of two symmetrical parts, on each of which a suitable number of projections P and $P_1$ are cast. The space between the projections is filled in with packing pieces, partly consisting of specially prepared felt, which can always be procured with a definite amount of resilience and is not perishable. For convenience in erection springs S are provided to hold the packing pieces in position when the coupling is turned round before the outer ring is fixed. The periphery of the coupling is formed by a forged steel ring R, which is only fastened to one half of the coupling. The coupling is either made with each half in one piece with the boss or with detachable bosses. The latter design has the advantage that either of the shafts which are connected by the coupling can be lifted clear vertically after withdrawing the outer portion of the coupling without any need to move it laterally. This feature is of importance where heavy machinery in a confined space has to be dealt with.

Fig. 9 represents an interesting exhibit by the Power Plant Company of a treble helical spur and bevel gear mounted as a model. Fig. 10 is the speed-increasing gear transmitting 24 horse-power when increasing from 475 to 3000 revolutions per minute. The wheel consists of a solid high carbon steel forging, and the pinion is of nickel steel. The numbers of teeth are 15 and 95, 7 diametral pitch by 8in. face. The bearings are of the ring lubricating type, with renewable cast iron bushes lined with anti-friction metal. This type of bearing is only being used for the smaller sizes of this class of gear; in the larger sizes forced lubrication is resorted to.

A new pattern of sensitive radial drilling machine exhibited by the Selson Engineering Company, Limited, Queen Victoria-street, London, has been specially designed for drilling holes at high speeds in articles too large for the ordinary light sensitive pillar drilling machine, and enables the user to take full advantage of jigs. It is a 3ft. machine made complete with a separate tapping spindle, so that holes can be drilled and tapped at one setting without altering the position of the arm or necessitating the removal of the drill to make room for the tap. As will be observed from the accompanying drawing—Fig. 11—there is a separate tapping spindle set centrally with the hole already drilled by means of a movement of the pilot wheel. This feature renders the machine of particular utility for work in which a number of holes of the same size have to be drilled and tapped on one and the same article and effects a considerable saving of time. The drilling spindle has ball bearings, and is entirely belt-driven. The machine is operated directly from the line shaft by means of fast and loose pulleys, and the belt is shifted by a handle situated close to the hand of the operator. The table is mounted on two cabinet supports, and is planed on the top and front surfaces with T grooves for bolting the work down. It is surrounded by a tray to receive the lubricant. The portion of the tray on the front of the table is removable so that deep objects can be bolted to the side. The arm is mounted on a central pillar, and can be swivelled through an angle of 180 deg. The weight of the arm is carried on ball bearings. The tapping spindle has a reversing motion, which is instantaneous. This spindle is driven by gearing, which is out of action during drilling operations, and is started, stopped, and reversed by a handy lever. In order to allow articles of varying heights to be dealt with, vertical adjustment is provided for by a slide on the carriage which carries the lower portion of the spindles. This adjustment, together with the hand traverse, amounts to 14½in. Six spindle speeds varying between 280 and 1280 revolutions per minute are provided, and these can be readily changed.

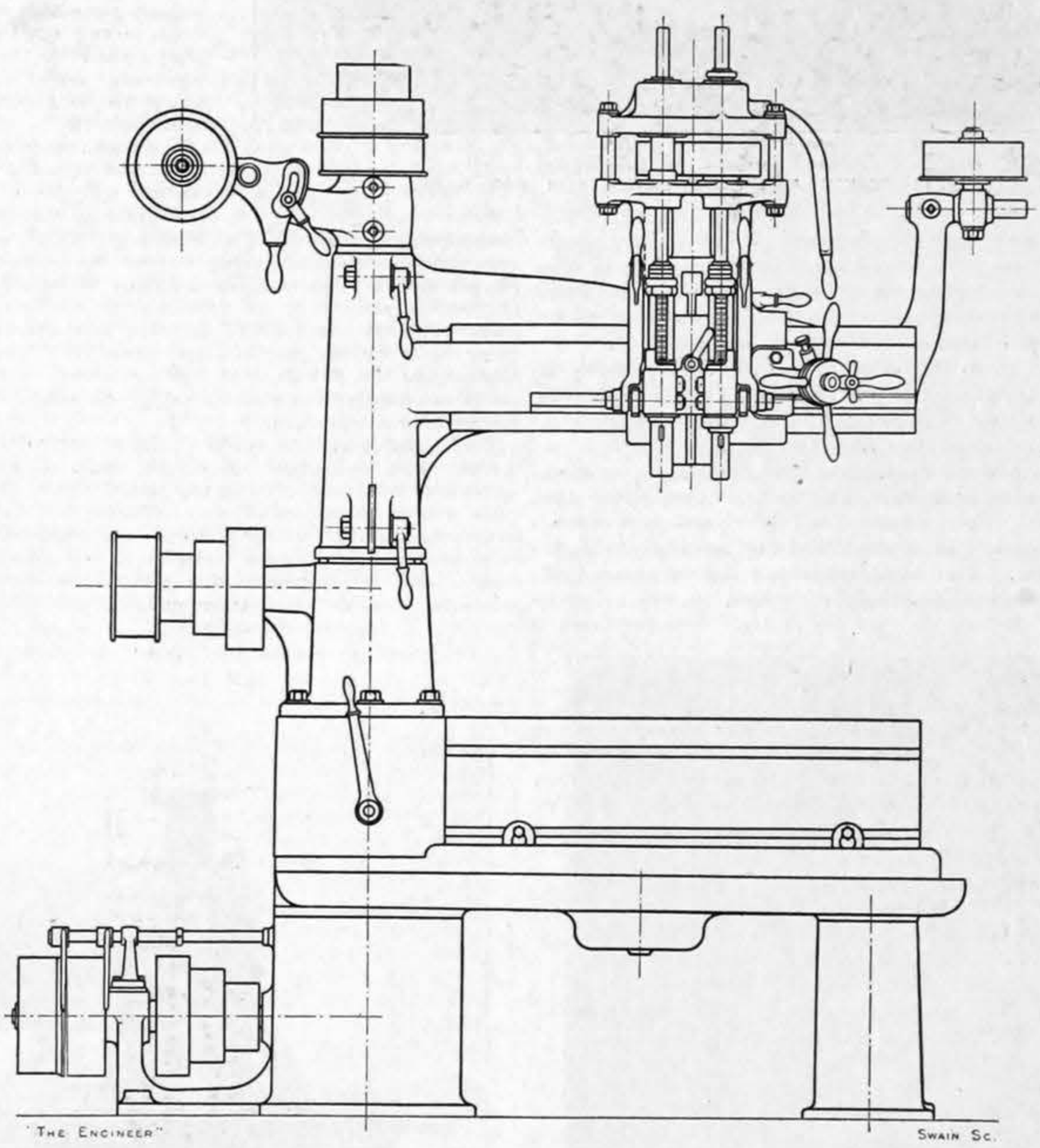



Fig. 11—SELSON ENGINEERING CO.'S SENSITIVE RADIAL DRILLING MACHINE

The illustration—Fig. 12—represents an 8½in. lathe, embodying some novel features, shown by Perkin and Co., Limited, Leeds. This tool has been designed specially to deal with bar work such as armature shafts and spindles having numerous diameters and shoulders. With this object the lathe is fitted with automatic longitudinal stops to the saddle for duplicating lengths exactly, and for each a dead stop is provided. The operation of this stop motion will be understood by referring to the illustration—Fig. 13—which shows the top of the saddle with the compound rest removed. On the right-hand side of the engraving a long bar, ⅜in. thick and 1⅜in. broad, will be seen, on the left-hand side of which is cut a saw-toothed rack. A smaller rack is fixed into the surface slide, and the teeth of one engage with the teeth of the other by the medium of a spring plunger, a latch being provided for holding one rack out of engagement with the other when desired. A groove is cut in the bar and a scale is fitted, which is one-half full size, a pointer being provided to the surface slide, which projects above the scale on the rack. In operating the stop and measuring motion a standard collar is provided which fits on the loose head centre, and the operator fixes the tool in the rest approximately in the correct position. He then releases the latch on the rack bar, and one rack is forced against the other.

By giving the surface slide screw part of a revolution, and bringing the surface slide and tool backwards away from the work, the teeth of one rack engage with the corresponding recesses on the other, and provide a dead stop. The tool is then fed forward by means of the top rest, which is furnished for this purpose, up against the collar, 2in. diameter, placed on the loose head centre. The perator then moves the half scale until the 2in. division on the scale comes opposite the pointer. The teeth on the rack are $\frac{1}{16}$in. pitch exactly, and it will thus be seen that by disengaging one rack from the other and moving the surface slide one tooth a variation in the diameter of the work of $\frac{1}{8}$in. is obtained. These diameters can be readily seen on the scale. To obtain the smaller divisions, such as $\frac{1}{64}$in. and $\frac{1}{32}$in., the rack is mounted on a stud, on which revolves an excentric bush capable of being locked in any position. By turning this bush round the stud the rack is moved forward, say, $\frac{1}{128}$in., making a variation in the diameter of the work of $\frac{1}{64}$in. These divisions are marked on the outside of the bush and the pointer is placed on the scale.

The lathe swings 11in. over the saddle, and there

are thus 704 dead stops on the cross slide. The longitudinal stop motion to the saddle and tool is obtained by using a dropping worm, a small pawl engaging with the various stops. This pawl is fixed on a lever, which can be revolved on its axis to clear the various stops. The means of setting all the various stops on a bar placed beneath the saddle is claimed by the makers to be new. A scale the full length of the bar slides in a groove in the bar, provision being made instantly to lock the scale in any desired position. To set the stops the piece to be operated upon is first placed between the centres and the tool fixed in the slide rest to its correct position longitudinally. The

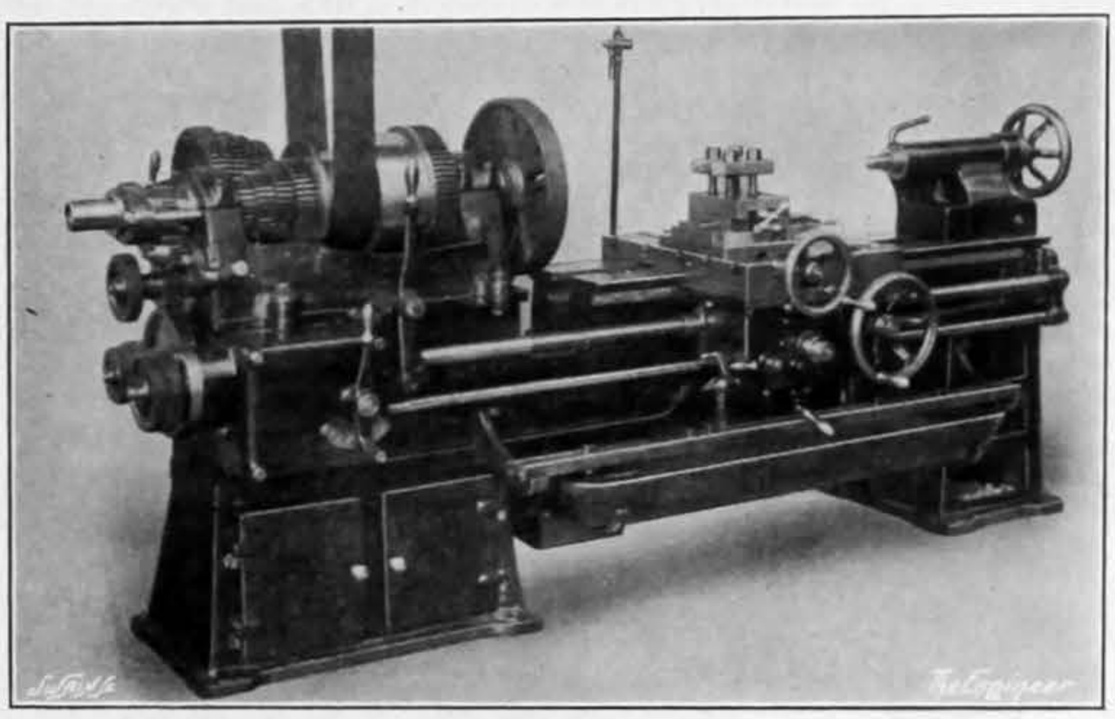


Fig. 12—PERKIN AND CO.'S LATHE FOR BAR WORK

saddle is then brought forward towards the headstock until the tool measures exactly 6in. from the end of the bar. The pawl in the lever for the stop motion is next brought immediately over the scale, and the scale is moved along in its groove until it registers $6\frac{1}{16}$in. to the edge of the tool. The sides of the stops which face the pawl are set to the dimensions on the scale that it is required the various lengths of the shoulders shall be, and the tool is set for the diameters as described, and the machine is then fixed up ready for work. The feeds of the saddle are interlocking. Four rates of feed are provided. These are operated from the lever at the front of the gear-box. The fast headstock has a two-speed cone, the largest diameter of which is 11in. for a

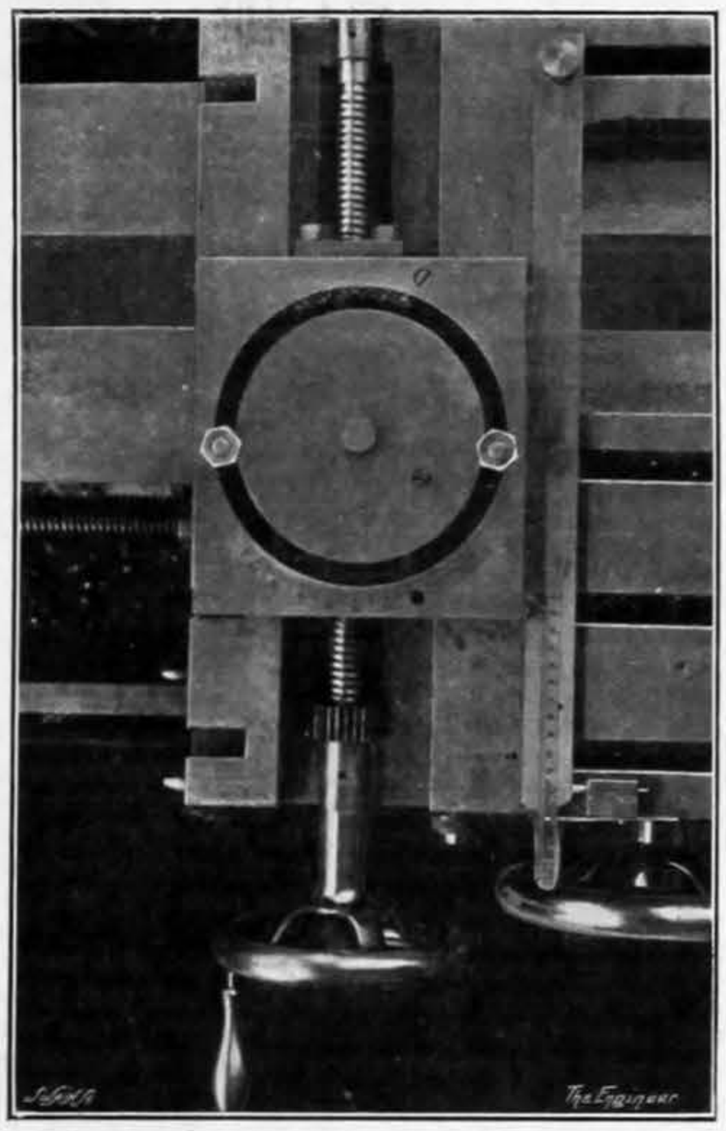


Fig. 13—TOP OF SADDLE OF PERKIN'S LATHE

$4\frac{1}{2}$in. belt. The smallest diameter is $8\frac{5}{8}$in., and the headstock is provided with four ratios of double gear, which are respectively 7.4 to 1, 5.75 to 1, 4.5 to 1, and 3.5 to 1. The countershaft speed is 300 revolutions per minute, and the spindle speeds are as follows:—40, 51.5, 66, 85, 109, 140, 180, 232, 296, and 383, the speeds being in geometrical progression.

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We learn that Dr. M. Coplans, of Leeds University, has gone to America in order to carry out experiments with a new system for locating icebergs. He will proceed to the ice zone in a United States cruiser. His system depends upon variations in the electrical conductivity of sea water, and is based upon the fact that the presence of icebergs sensibly influences this conductivity over a wide area.

## A NEW SPANISH HYDRO-ELECTRIC POWER UNDERTAKING.

A company called the "Energia Electrica de Cataluña" was formed last year for the exploitation of important waterfalls in the Pyrenese region, transforming their energy into electric power to be distributed for light and power purposes in the province of Catalonia. In order to make the scheme complete this company is also erecting at San Adrian de Besos, 7 kiloms. from Barcelona, and close by the sea, several large armoured concrete buildings, in which will be erected some powerful steam turbines and alternators to be used as a reserve to the hydraulic power stations. The buildings for the steam plant are advancing rapidly towards completion, advantage being taken for their erection of the gravel and sand which are excavated from the beach near by.

Long before the actual formation of the company plans and careful surveys had been made, so that the work of constructing the dams and aqueducts in the Pyrenees was begun without loss of time. One of the falls is 800 m. (over 2620ft.) high, and the horse-power to be derived from it is expected to reach 50,000 as a minimum. This is the highest fall in Spain utilised for the production of electricity, and one of the highest anywhere else. The total power of the waterfalls owned by the Energia Electrica de Cataluña is stated to be about 150,000 horse-power.

The steam machinery which is to be erected at San Adrian will be of 100,000 horse-power, turbines being exclusively employed. The buildings, which are all of armoured concrete, are being erected by contract by the Pavimientos y Construcciones Company, of Barcelona. All the boilers will be of the Delaunay-Belleville type, and made at Saint Denis. The turbines and alternators are being built by the Société Alsacienne de Constructions Mécaniques de Belfort. All the transformers from the main stations and sub-stations have been ordered from the Siemens-Schuckert firm.

The initial electric pressure will be 80,000 volts, and the current will be carried on double lines of conductors suspended from insulators of the latest type. The 80,000 volts will be transformed to 11,000 in the main transformer stations and delivered to the customers at 110–220 volts after a second transformation in sub-stations. All feeders can be supplied with electric current by the hydraulic or steam stations independently, so as to avoid stops due to failures or accidents.

It is hoped to supply current to customers, who are already numerous, from the steam power station by the end of this year, and to use this station only, until the hydraulic works are ready. It is proposed to make the price of the kilowatt very low—though the actual price has not been stated to us—in the hopes that the users of steam engines in the numerous factories in Catalonia will discard them and have their machinery converted for electric driving.

German, French, and Swiss firms are already getting orders for large electric motors to take the place of steam engines, and it is anticipated that a good many orders will come to this country.

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## SUPERHEATER ENGINES FOR THE INDIAN STATE RAILWAYS.

On this page and on page 386 we illustrate five different types of locomotives which the Vulcan Foundry, Limited, of Newton-le-Willows, Lancs., has recently built for service on the Indian State Railways. These engines are of particular interest in that they are the first superheater locomotives to be used on the system named.

The following particulars are common to all five types:—

| | | |
|---|---|---|
| Cylinders | | 20in. by 26in. |
| Boiler: | Diameter inside | 4ft. 6in. |
| | Length | 11ft. |
| | Plates | $\frac{7}{16}$in. |
| Copper fire-box: | Length inside at top | 6ft. $1\frac{1}{4}$in |
| | Width inside at top | 4ft. $1\frac{1}{8}$in. |
| | Depth, front | 6ft. $2\frac{3}{4}$in. |
| | Depth, back | 4ft. $10\frac{3}{4}$in. |
| | Plates | $\frac{7}{16}$in. |
| | Tube plate | 1in. |
| Tubes: | Outside diameter | $1\frac{3}{4}$in. |
| | Length | 11ft. $4\frac{1}{2}$in. |
| Heating surface: | Fire-box | 128 sq. ft. |
| Grate area | | 25.3 sq. ft. |
| Driving wheel journals | | 8in. by 9in. |
| Fittings: | Injectors | Gresham and Craven's |
| | Lubricators | Wakefield's 8-feed |
| | Packing | Earle |
| | Sanding | Hand |
| | Brake | Automatic vacuum |
| Tender: | Wheels, diameter | 3ft. 7in. |
| | Journals | $5\frac{1}{2}$in. by 10in. |
| | Tank capacity | 3000 gallons |
| | Fuel capacity | $7\frac{1}{2}$ tons coal |

Beyond these leading particulars the details of the engines present points of considerable difference. In the first place, we may say that the locomotives illustrated on page 386 are all for service on the North-Western Railway, and that the engine shown on this page is for the Oudh and Rohilkund Railway. The first two engines shown on the page referred to are of the 4–4–0 type, and are intended for passenger work. They have the following points in common:—

| | | |
|---|---|---|
| Driving wheels: | Diameter on tread | 6ft. 2in |
| | Diameter of centre | 5ft. 8in |
| Bogie wheels: | Diameter on tread | 2ft. 7in. |
| | Diameter of centre | 3ft. 1in. |
| | Journals | $6\frac{1}{2}$in by 9in. |
| Wheel base: | Rigid | 9ft. 6in. |
| | Total, engine | 22ft. 11in. |
| | Total, engine and tender | 44ft. $9\frac{1}{2}$in. |
| Tender weight, loaded | | 40 tons |

The first engine has the following characteristics peculiar to itself:—

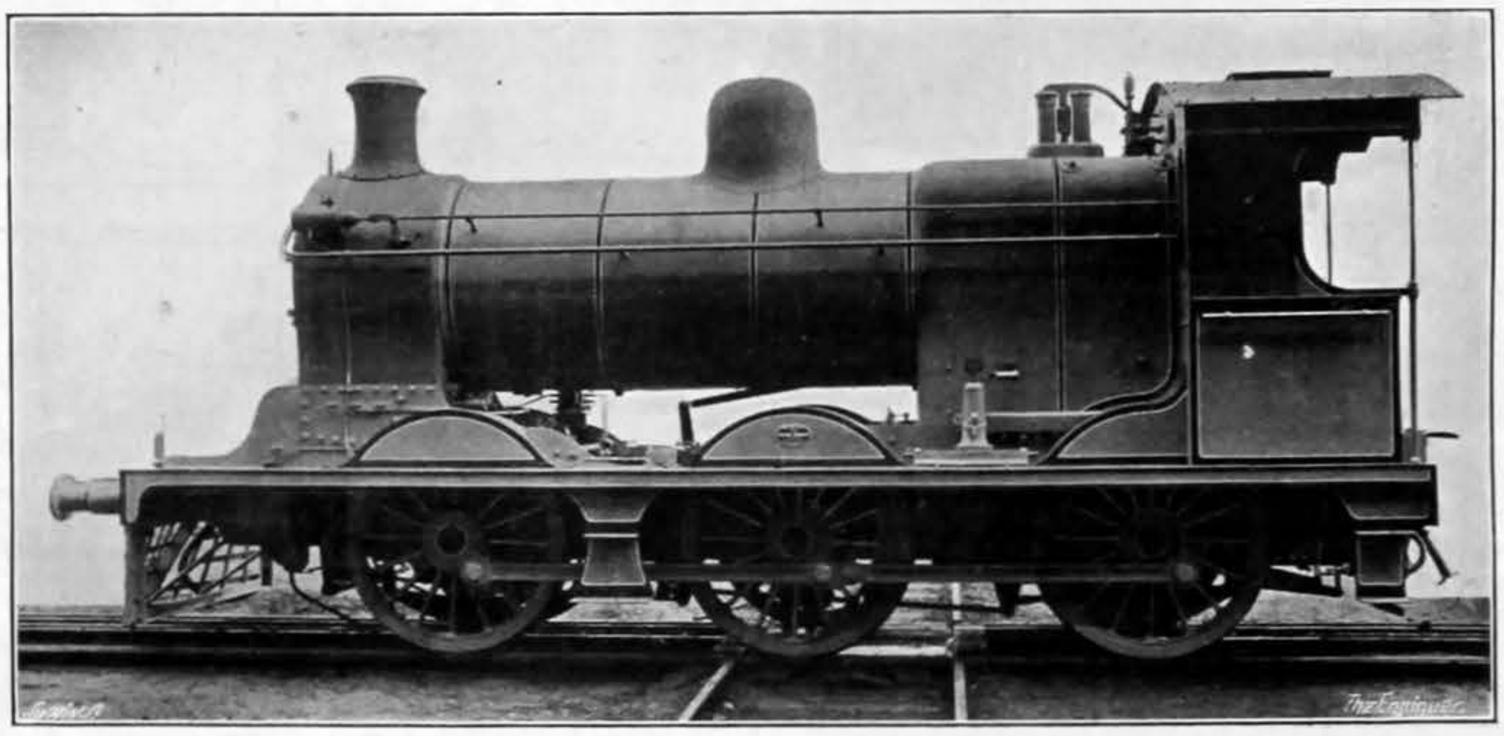
| | | |
|---|---|---|
| Cylinder valves | | Piston |
| Superheater | | Phœnix |
| Tubes: | Number | 229 |
| | Heating surface | 1193.3 sq. ft. |
| Weight: | On drivers | 33.1 tons |
| | On bogie | 20.8 tons |
| | Total, engine | 53.9 tons |
| | Total, engine and tender | 93.65 tons |
| Working pressure | | 160 lb. |

The second engine has the following characteristics peculiar to itself:—

| | | |
|---|---|---|
| Cylinder valves | | Schmidt's piston |
| Superheater | | Schmidt's |
| Tubes: | Number | 130 |
| | Heating surface | 677.43 sq. ft. |
| Superheater smoke tubes: | Number | 18 |
| | Outside diameter | $5\frac{1}{4}$in. |
| | Heating surface | 281.34 |
| Weight: | On drivers | 33.7 tons |
| | On bogie | 19.45 tons |
| | Total, engine | 53.15 tons |
| | Total, engine and tender | 92.9 tons |
| Working pressure | | 180 lb. |

The third and fourth engines are of the 0–6–0 type, and are intended for goods service. They have the following points in common:—

| | | |
|---|---|---|
| Working pressure | | 180 lb. |
| Driving wheels: | Diameter on tread | 5ft. $1\frac{1}{2}$in. |
| | Diameter of centre | 4ft. $7\frac{1}{2}$in. |
| Wheel base: | Rigid | 15ft. 6in |
| | Total, engine and tender | 39ft. $0\frac{3}{4}$in. |
| Tender, weight loaded | | $39\frac{1}{4}$ tons |



SUPERHEATER ENGINE FOR THE OUDH AND ROHILKUND RAILWAY

The third engine has the following characteristics peculiar to itself:—

| | | |
|---|---|---|
| Cylinder valves | | Piston |
| Superheater | | Phœnix |
| Tubes: | Number | 229 |
| | Heating surface | 1193.3 sq. ft. |
| Weight: | On drivers | 50.25 tons |
| | Total engine and tender | 90 tons |

The fourth engine has the following characteristics peculiar to itself:—

| | | |
|---|---|---|
| Cylinder valves | | Schmidt's piston |
| Superheater | | Schmidt's |
| Tubes: | Number | 130 |
| | Heating surface | 677.43 |
| Superheater smoke tubes: | Number | 18 |
| | Outside diameter | $5\frac{1}{4}$in. |
| | Heating surface | 281.34 sq. ft. |
| Weight: | On drivers | 49.6 tons |
| | Total, engine and tender | 89.35 tons |

In the case of the two engines fitted with Schmidt superheaters, the superheating surface for the steam amounts to 218·4 square feet.

The Oudh and Rohilkund engine illustrated on this page is for goods traffic, and is exactly similar to the Schmidt superheater goods engine illustrated on page 386.