cutting edge should have hardly any round on it or it will offer too much surface to the hole, so that it will be sprung away from it, and will thus not be able to correct it. On no account should the top-slide be used for this kind of work, as it is almost impossible to tell if it is set parallel or not. If the lathe is of that type that the live-head is adjustable, and has a mark to show when the spindle is set to bore parallel, it should be set to this before the work is started. The lathe should be run fast, and if the treadle is not operated too rapidly, the fastest speed of all might not be too high for cast iron, and would certainly not be so for brass. The cut should be taken right through the hole and then the lathe brought to a stand, and, without shifting the screw of the facing-slide, the tool should be drawn out clear of the hole by diconnecting the clutch and moving the saddle. Each cut should be taken right through the hole from end to end, and on no account should two or three cuts be taken a little way down the hole, as this will make it what is termed bell-mouthed, or larger at that end, and if this once sets in, it is almost impossible to get rid of it The tool should be kept sharp or it will be pushed away from the work, and will thus not correct it.

When turning, boring, or drilling cast iron, no water, oil, or other fluid should ever be applied with the hope of improving the surface, as it will at once spoil the cutting edge of the tool. When drilling a deep hole in cast iron, the drill will sometimes make a screeching noise, as if it required lubrication, but no notice should be taken of it, as no harm is being done. After one or two cuts have been taken through the hole, a pair of inside calipers are required, and we prefer the American pattern, as the English kind are too thick at the ends, though they are better for outside work. The inside calipers are adjusted thus, when they are applied to the hole. If the ends are too near together, they should be rapped on the corner of the slide-plate, so as to force them apart, until they touch the opposite sides of the hole; but if they are too far apart already, they can be brought nearer together, by rapping one leg on the tool-post.

The calipers should be held very lightly with the fingers and thumb, by the joint, and this should be level with the hole, or they will give a false measurement. They must be held so that the points are vertical, and as they are passed through the hole, the lower one should rest on the bottom, and the calipers should be swung slightly on it from side to side, as shown in Fig. 16. By this means, where the calipers go easiest, and which is the real diameter of the hole (as shown by the dotted line) can be felt. If this is not done, the calipers may be forced against one side of the hole, which would then appear to be smaller than it really is. The calipers must be set so that the points only just touch the opposite sides of the hole, for if any force is used in pushing them in, when they are withdrawn they will spring open and cause the hole to appear larger than it really is. The hole should now be approaching its required size—namely, half-inch—and, if all is right, should be parallel, for which it should be tested with the calipers before it is bored to the full size. For certain reasons, a hole may not always be found to be parallel; various differences of hardness, or blowholes, or what is known as sponginess, in the casting may disturb the drill and cause an imperfect hole, and the number of cuts taken by the boring-tool may not have been enough to correct this, but it should mostly come right by the time the hole is bored to its full size, unless the axis of the spindle is not really parallel with the bed; but this is a matter which will be gone into later. If there is a slight taper in the hole, it does not matter. In an engineer's shop, holes are nearly finished with a reamer, or else bored to fit a plug gauge, which is of hardened steel, and an exact size It is not likely that an amateur would possess either of these, so the calipers mut be set as near as possible to the required size by means of a rule, and light cuts continued to be taken through the hole until they enter.

The greater the number of cuts that are taken through a hole, and the lighter they are, the better the surface of the hole will be, and the more nearly approaching one that had been finished with a reamer. All holes that are finished with the boring-tool

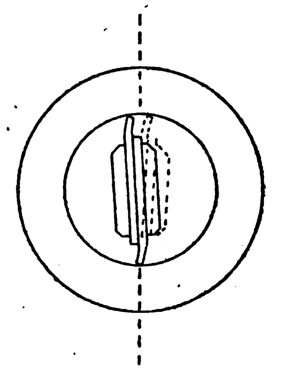


FIG. 16.

are produced in the manner here described, so we propose to leave the matter of the various methods of setting and holding work on the face-plate for the time being. This is a somewhat extensive subject, and some readers may wish to get on with other work. A piece of work of the kind of Fig. 8, if it has no arms through which bolts can go, to hold it on the face-plate, and if it cannot be held with the jaws of a self-centring chuck going inside the rim, can only be turned on the outside by holding it on an arbor. In order to do this, the reader must learn the art of making a fit, so that the arbor can be driven into the pulley or whatever the piece of work may be, so that it can be turned between the centres. I therefore propose to leave the subject of face-plate and chuck work for the time being, and shall return to it later.

HOW TO MAKE FITS.

Very little can be done at the lathe without a knowledge of this branch of the art of turning, and it perhaps gives amateurs more trouble than anything else, but there is really very little difficulty about it if the system on which it should be carried out is clearly explained. All that is wanted, then, is a little care and practice. In the ordinary way, a piece of work cannot be turned to fit a hole; it either will not go in at all, or else it goes in and is loose. In the case of a piece like the arbor on which to turn the pulley (Fig. 8), it will be found that it is not possible to take a cut of less than a certain depth, and this limit is not fine enough to produce a fit. The professional turner leaves the work slightly large, and reduces it with a file. By this means he can take as little off at a time as he wishes, he can produce any kind of fit that he requires, and it also renders him, to a great extent, independent of the condition of the lathe and its adjustment. Some writers on turning (for amateurs) have stated that the file should not be used, and it is possible to make fits without it. In my opinion, it is not practicable, and in the piece of work that I am describing it is never attempted by professional turners. Even if it could be done as a kind of tour de force, it would be a great deal more trouble than it was worth. It is possible to turn a short piece, like, for instance, the spigot on the cover of a cylinder, so that it will push into the bore; but, in the case of a spindle or arbor fitting a hole of any length, the case is different. To do this without the use of a file would imply, in the first place, that the lathe was faultless, and was absolutely adjusted in a certain manner. When I explain the different kind of fits, and how they are made, the reader will be better able to judge for himself. Of course, in the better classes of work, at the present day, many fits are produced by grinding, the work, after turning, being ground in a special machine. The grinding-wheel will take off, if required, any amount of metal, however small, and this the turning-tool will not do. It is possible to do this in an ordinary lathe by means of a grinding attachment, and in order to make this series as complete as possible, I shall, later on, describe the finishing of work by this method. To return to the making of the arbor on which to turn the pulley, the fist thing is to obtain a piece of mild steel —Bessemer for choice—five-eighths diameter, and, say, five inches long. This should be centred, the ends countersunk and faced, as already described in the case of the armature spindle (Fig. 4). When turning this, the lathe should be set so that the work has a slight taper on it that is just perceptible to the calipers, and should be smaller at the tailstock end. It should be made certain that this taper is being produced, and the work should be tested with the calipers with this object while the first cuts are being taken over it, and before it is reduced to the required size, as it would be too late then to alter matters. In our next issue I shall explain how the diameter of the arbor should be found, with reference to the hole in the pulley, and how the fit should be made.

(To be continued.)

THE UNDULATOR.

A MODIFIED RECIPROCATOR FOR ORNAMENTAL LATHES.

"Atkinson's Reciprocator," as an adjunct to the spiral apparatus of the ornamental lathe, is well known to ornamental turners. By this appliance simple waved lines are produced lengthwise upon cylindrical and taper forms, and radially upon surfaces, by combining a rocking motion imparted to the mandrel by an eccentric clamped to one of the gear-wheels with the traverse of the tool or a revolving drill in the slide-rest.

The chief difference between the original apparatus and that now to be described lies in the substitution of "cams" for the eccentric. Cams may be either counteracting or single-acting. The counteracting cam, as its name implies, gives a positive motion; while the single-acting requires the use of a spring or weight to obtain the return action. The cam has this great advantage over the eccentric, that as its shape can be varied to an almost unlimited extent, so the motion imparted by it will be similarly varied. With cams, undulations can be produced on the work such as zigzag or dog-tooth patterns, step patterns, and complex patterns composed of curves, angles, and straight lines. By the adoption of the single-acting cam patterns may be made to proceed spirally round cylindrical and taper work. Spiral effects were obtained by the older apparatus; but what is referred to here is the spiral advance round the cylinder of the single waved or undulated line. Another variation can be produced which is analogous to the effect of the stop-screw upon the Rose cutting-frame, which limits the action of the rosette by preventing the roller from descending to its full depth.

Enough has been said to show that a considerable addition may be made to the powers of the original appliance; but before com-

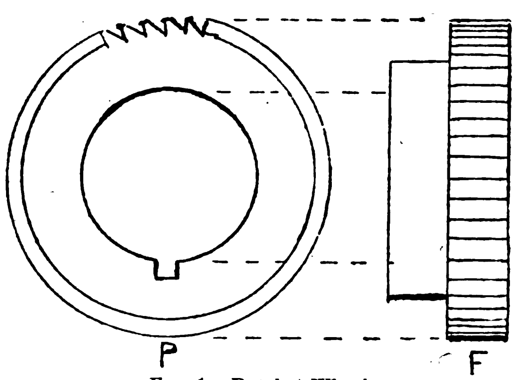


FIG. 1.—Ratchet-Wheel.

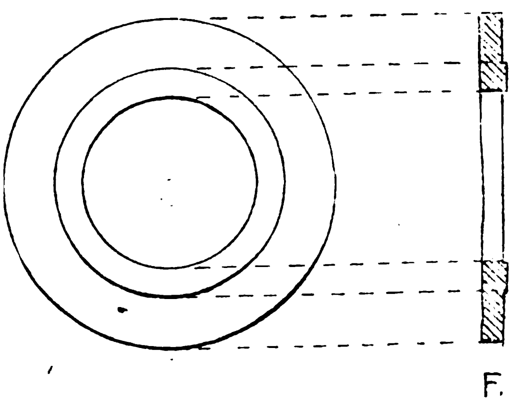


FIG. 4.—Washer.

mencing to give details of construction it will be well to premise that correct measurements can scarcely be given to suit all lathes. The parts to be described may be adapted to any lathe which has facility for fixing a gear-wheel at the rear end of, and outside, the headstock. It is presumed that there will be a feather or studs let into the mandrel at this point, upon which the screw-guides of the traversing mandrel or the pinion-wheel fit.

A gunmetal wheel is bored out to fit upon the mandrel and turned up to 1 11-16in. diameter and ⅜in. in thickness, and the keyway is cut. One side of the wheel is then reduced to form a boss 1¼in. diameter and 5-16in. long. This leaves the edge of the wheel 5-16in. thick. This edge is cut into ratchet-teeth forty-eight in number, and the direction of the teeth the same as in Fig. 1. This wheel and the boss of the radial lever, which is hollowed out to receive it, together form the dividing-chuck. The radial-lever has a long slot instead of the numbered holes of the older apparatus. (See Fig. 2.) Its dimensions are 6¾in. long over all, by 5-16in. thick, by 1¼in. wide; boss 1 15-16in. outside diameter, thickness of boss and lever together ⅝in. The slot is ⅜in. wide. The ratchet-wheel is wholly contained within the thickness of the lever and boss, and should fit freely, but without shake. The axle which rides in the slot is shown in Fig. 3. It is ⅜in. diameter, collar ⅝in. diameter, and 3-16in. thick. Both ends are tapped and fitted with 5-16in. nuts, and the end of the axle is drilled up and carries a steel pin, upon which is hung the spiral spring which provides the return motion required by the single-acting cam.

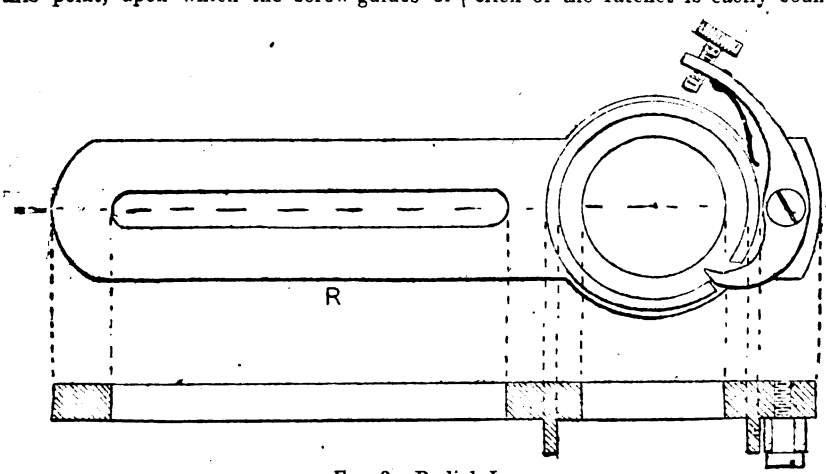


FIG. 2.—Radial Lever.

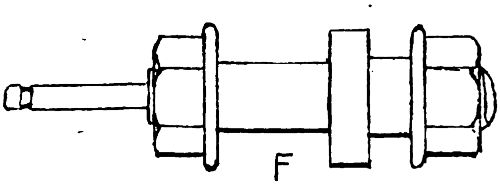


FIG. 3.—Axle.

A short continuation of the radial lever carries the long-tailed ratchet shown in Fig. 2. The milled-headed screw, which is tapped through the tail of the ratchet, locks the ratchet-wheel and radial lever together after using the device as a dividing chuck. When a movement of the ratchet-wheel is required the screw is slackened, and the click of the ratchet is easily counted as the lathe pulley is slowly moved round. The wall of the recess in the boss is cut away at one point to allow the point of the ratchet to reach the teeth.

The ratchet-wheel is placed upon the mandrel first, with the boss outside; the radial lever is next put on over the wheel, the large washer with the raised projection, as shown in Fig. 4, is put in place, and then all are screwed up with the nut or screw at the end of the mandrel. The projection on the washer bears upon the boss of the ratchet-wheel, so as to fix it, while still leaving the lever free to move when the milled-headed screw is loosed.

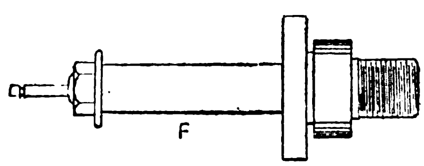


FIG. 6.—Cam-Wheel Axle.

In the original apparatus the hub of the eccentric and a gear-wheel were clamped together upon a revolving axle. In the present case the cam is screwed to the boss of a gear-wheel with two 3-16in. countersunk head screws, and the axle on which they work is a fixed, and not a revolving, one. A special wheel should be made, of 120 teeth; the boss should be 1¼in. across the face—not larger; the bore is to be ⅝in., and the thickness the same as the other wheels of the set. With this sized wheel and a suitable combination of the gear-wheels, the wave length may be reduced to two tenths and increased to 3in. or more. To fit the ⅝in. hole in this wheel a steel sleeve will now have to be made, ½in. longer than the thickness of the wheel, and with a thin collar at one end 3-16in. thick and 15-16in. diameter. (See Fig. 5.) The hole through the sleeve is to be ½in., as this is the size of the axle on which it will run. In use the sleeve centralises the cam upon the wheel, and allows both to be screwed together without tightening the running fit upon the axle. It also prevents the wearing of the holes in the wheel and cam.

Fig. 6 shows the cam-wheel axle, the sizes being collar ¼in. thick and 1½in. diameter; fitting for banjo plate 1in. diameter filed down to ¾in. to fit slot; thread 1-19in. pitch

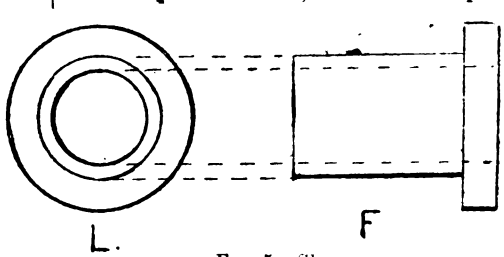


FIG. 5.—Sleeve.

= ⅜in. gas-barrel thread, length ⅝in. The axle is turned up ½in. diameter to fit the sleeve, the end is reduced and tapped 5-16in., and a hole is drilled up the end for a steel pin to carry the lower end of the spiral reaction spring.

The next part to be taken in hand is the connecting-arm, which is shown in Fig. 7. This is a flat arm 9¼in. long, 1½in. in width at the wider end, and 1in. at the narrower. The total length of the arm may be shortened if the size of the banjo-plate requires it. The slot is 3in. long by ⅝in. wide, and the boss is ⅞in. diameter by ⅝in. through the hole, which is bored out ⅜in. to fit upon the axle (Fig. 3). At distance ⅜in. from the inner end of the slot a ¼in. tapping hole is drilled and tapped. This is to carry the axle for the roller which is operated upon by the cam. Fig. 8 shows section of roller, and its axle, locknut, and retaining screw. The roller is ¾in. diameter and ½in. long, 5-16in. in the hole, recessed at one end for the head of the retaining-screw, and is casehardened. The locknut serves a double purpose. It is only ⅜in. diameter, and being made cylindrical, it has a saw-cut across the end, to allow of it being screwed up with a forked screwdriver. The cylindrical exterior to the nut serves as one of the two ⅜in. studs, upon which a stop-plate (Fig. 9) rides by means of its slot. The plate is 3½in. long by ⅞in. wide, and 3-16in. thick, and has a slot ⅜in. wide and 2½in. long. The second stud (Fig. 10) is tapped into the connecting arm at a distance of 13-16in. away from the centre of the roller axlo. This stud is also ⅜in. diameter where the slot of the stop-plate rides upon it. One end of the stud screws into the arm and has a locknut on the back, and the other end carries a washer and nut to fix the stop-plate in any position it may assume under the guidance of the two studs. The hollowed end of the stop-plate strikes against a loose sliding boss which rides upon the cam-wheel axle and in the slot of the connecting arm, and so prevents the roller from reaching the bottom of the cam. This is the device referred to when mention was made of the rose cutting-frame.

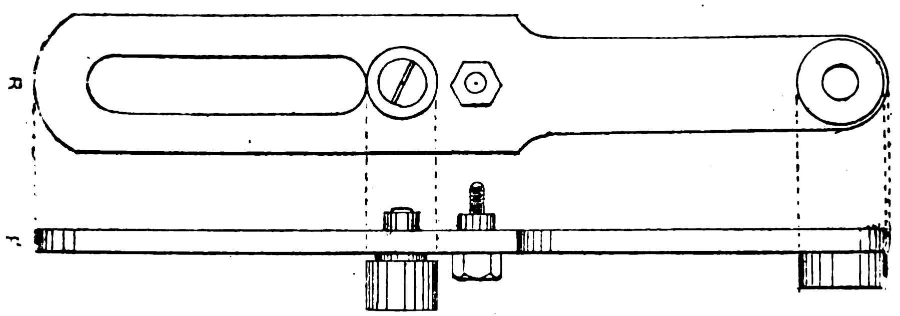


FIG. 7.—Connecting Arm.

Fig. 11 shows the sliding boss, which is made in two parts. Cast iron is a better material for the main part than gunmetal or brass. Get a circular casting 1 7-16in. diameter by ⅝in. thick, bore out the ½in. hole to fit the cam-wheel axle, and turn up on a

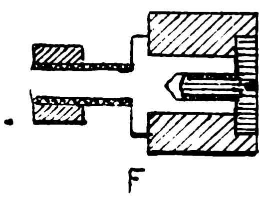


FIG. 8.—Roller and Axle.

mandrel to 1 5-16in. by ⅝in. Then file or plane part of the sides away at one end until two shoulders are formed, and the part so reduced will enter and fill the slot in the connecting arm, and slide smoothly from end to end. The hole through the boss will serve as a guide for centralising the fitting, and

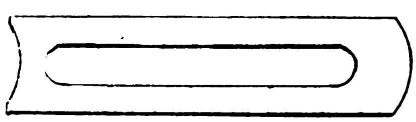


FIG. 9.—Stop-plate.

a line scored round the boss while in the lathe will give the depth of the shoulders. A gunmetal washer 1 5-16in. diameter, with a ½in. hole and 5-32in. or 3-16in. thick, should now be screwed to the cast-iron boss by two 3-16in. countersunk-head screws, one screw being tapped into each end of the boss. It

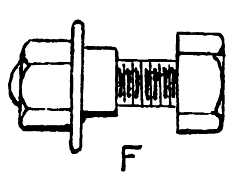


FIG. 10.—Stud.

is against the edge of this washer that the stop plate strikes.

The movement of the sliding boss in the slot of the connecting arm should be greater than 1½in., and if the reduced part of the iron casting be rounded at the ends this amount of movement will be easily attained. The reason for this requirement lies in the

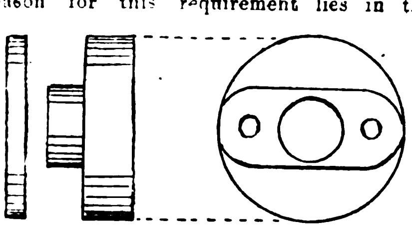


FIG. 11.—Sliding Boss.

dimensions of the cams, which have a throw—from lowest to highest point—of 1½in. The central inoperative part of the cam is also 1½in., and for this reason the boss of the 120 tooth cam-wheel should not exceed this diameter; as otherwise the roller, when at the bottom of the cam, might strike and interfere with the proper motion.

At this stage a sketch of one of the cams will be useful. (See Fig. 12.) The cam here shown produces a pattern which may be described as a zigzag with the apices

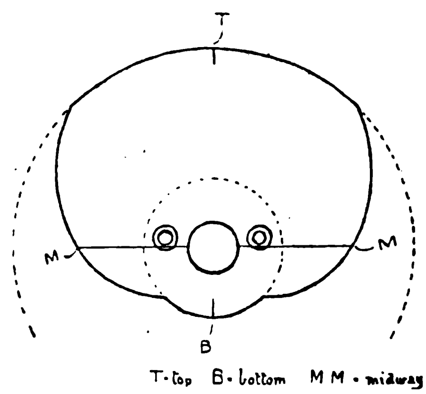


FIG. 12.—Cam.

flattened. A simple jig, Fig. 13, for drilling the two screw-holes should be made from a piece of 1¼in. by ¼in. iron or steel plate, 2½in. long. Bore out a clean hole ⅝in. diameter to fit the steel sleeve, scribe a line ⅛in. away

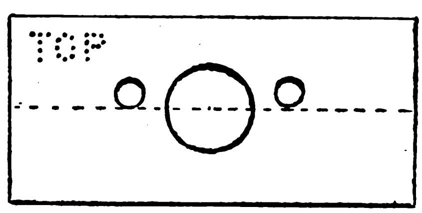


FIG. 13.—Jig.

from, and parallel to, the diametrical line, and having put the sleeve through the hole, drill two 3-16in. thoroughfare holes upon the line and just avoiding the collar of the sleeve. To use the jig, bore a ⅝in. hole through the material for the cam, lay the jig upon it, and put the sleeve through both holes, collar uppermost. Drill one hole first with a twist-drill, insert a well-fitting peg, and then drill the other hole. The jig will be used in the same way for drilling the holes in the boss of the 120 cam-wheel, except that the holes will be marked with a full-sized drill and finished with tapping size.

The jig should always be used with the same side upwards, and the holes in the cams should be countersunk on the same side on which they were drilled, and then every cam will go in its place without fail.

In designing this apparatus, regard has been had to easing the motions of the cams as much as possible; the wear of the cam is thereby reduced, and a very satisfactory cam can now be made out of ¼in. white holly, a material easily obtained from fretwood dealers. Metal cams are necessarily superior to wood, and rolled brass ⅛in. thick and 3in.

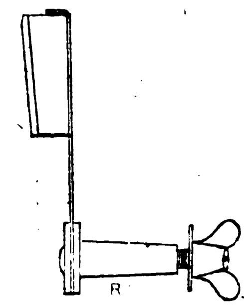


FIG. 17.—Brake.

to 3½in. wide, is a handy form of material for the purpose.

Referring again to Fig. 12, a line drawn on the cam will be noticed, and it denotes the two points midway between the bottom and the top of the rise, or the middle point of the motion of the connecting arm. When the roller is upon these midway points, the connecting arm and the radial lever must stand at right-angles to one another, or else the wave will be distorted. This adjustment is attained by moving the cam-wheel axle in the slot of the banjo-plate until the position is found. The banjo-plate is then lowered until the cam-wheel gears with the wheel upon the leading-screw extension shaft, or one of the compounding wheels, as the case may be. Bear in mind any movement of the axle in the slot of the radial lever requires a readjustment to the right-angle *central* position.

An adjustable coupling has been introduced between the end of the slide-rest screw and the small steel shaft connecting it with the first gear-wheel, as a more certain and convenient means of shifting the wave lengthwise upon the work than the old method of lifting the wheels out of gear while the leading-screw is moved. This coupling is on the ratchet principle, and the wheel is of the same size, but only half the number of teeth of the one enclosed in the boss of the radial lever, Fig. 2. The ratchet is precisely similar. Figs. 14, 15, and 16 show details of the construction of the adjustable coupling.

The dimensions in Fig. 15 are: Ratchet-wheel 1 11-16in. diameter by 5-16in. thick, 24 teeth; boss, 1½in. diameter by ⅞in. long. This boss should be bored out to fit upon the socket fixed on the left-hand end of leading screw. Fig. 14 represents the other half of the coupling, and consists of a boss 1in. diameter by ⅞in. long (boss is shown 1½in. diameter in sketch); a flange 2¼in. diameter by 5-16in. thick, and which is eccentric to the boss; and a receptacle to carry the

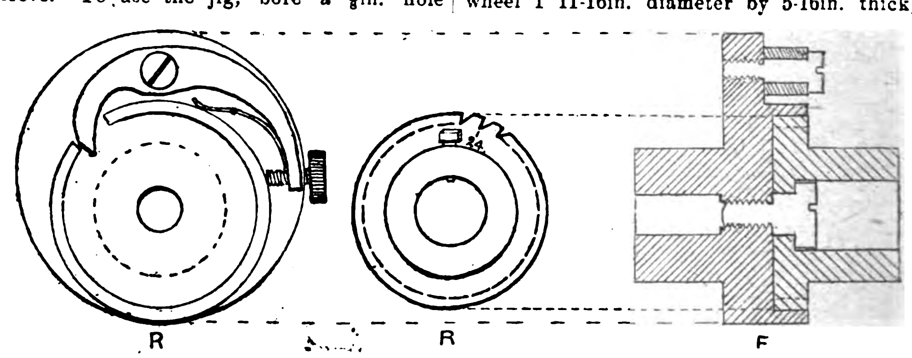


FIG. 14. FIG. 15. FIG. 16.

Adjustable Coupling.

ratchet-wheel. This receptacle is concentric with the boss, and has inside measurements of 1 11-16in. diameter by 5-16in. deep, and outside 1 15-16in. by ⅜in. The eccentricity of the flange is such that its edge just coincides with the outside of the receptacle at one point in its outline. The boss on this

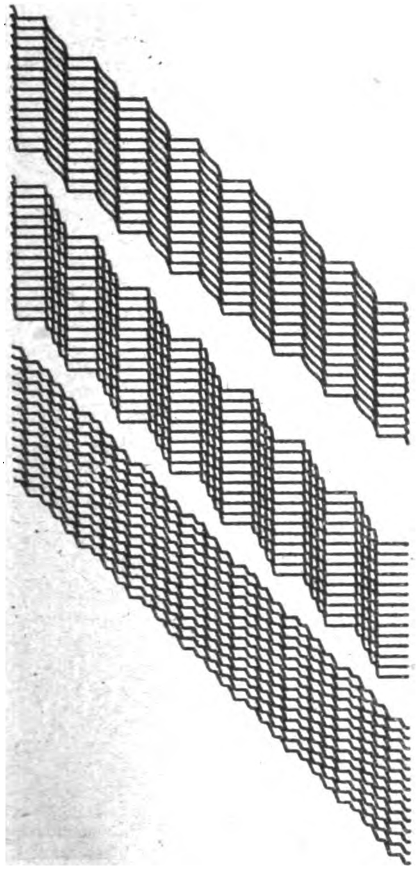


FIG. 18.

side of the coupling is bored out to fit the end of the light steel shaft connecting with the gear-wheels; but this hole should not be bored until the central internal screw shown in section in Fig. 16. has been fitted.

The lengthwise shifting of the wave to elaborate the pattern usually requires a considerable movement of the winch-handle of the leading-screw. Supposing a wave-length of 5 tenths is to be shifted one-sixth of its length for the second series of cuts, and again one-sixth for a third series, and so on. To do this, slacken the milled-headed screw of the ratchet, hold the eccentric flange, turn the handle of the leading-screw (assumed to

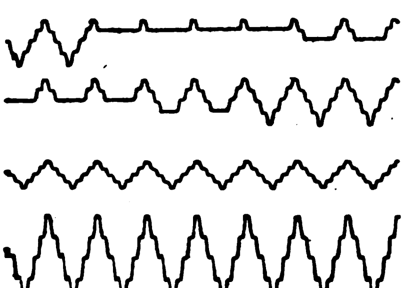


FIG. 19.

be 1-10in. pitch), and count twenty clicks of the ratchet—*i.e.*,

$$\frac{5 \times 24}{6} = 20.$$

Then tighten the ratchet-screw again. If whole turns of the leading-screw are required, loosen the ratchet-screw, observe the reading of the micrometer upon the leading-screw, hold the eccentric flange, give the requisite number of turns, and fix the ratchet-screw again. Further, if the tail of the ratchet be depressed after the ratchet-screw has been slacked, movements may be made in either direction at will, counting by divisions figured on the side of the ratchet-wheel.

The spiral advance of the single waved line round the cylinder, which has been previously mentioned, involves the use of a brake or friction-pad to steady and control the movement of the lathe mandrel. This brake is carried in the socket of the dividing index, and is shown in Fig. 17. The pad or brake bears upon the flat surface of the division plate, which is not hurt in the slightest by its use. A taper fitting, reduced at the smaller end to carry a washer and a small wing-nut, is made to the socket. The

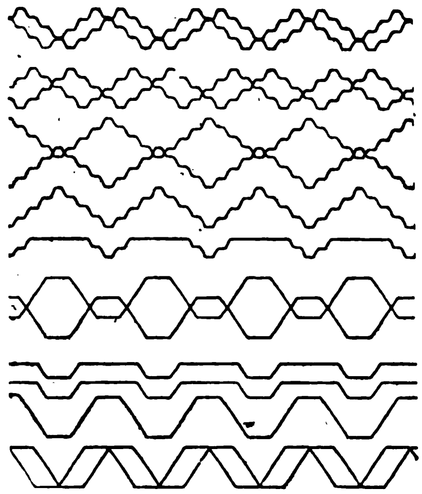


FIG. 20.

larger end, nearest the division plate, is turned down, and a piece of strong clock-spring, about ⅜in. wide and 3¼in. long is riveted on, with a washer under the head of the rivet to support the spring. About ¼in. of the upper end of the spring is bent over at right-angles towards the division plate, this end being softened before bending. The spring and taper fitting are then put in place and screwed up with the wing-nut. A block of wood about 1¼in. square is then made, rather thicker than will fill the space between the spring and the division

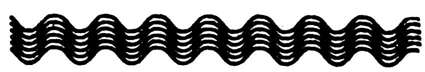


FIG. 21.

plate, and is fixed to the spring close under the bent end. Two short wood screws ⅜in. long will suffice to hold it. The block and spring are then tried in place, together with a piece of new "boot-upper" leather the size of the block. It will probably be found that the wood block requires tapering down in thickness to make it fit the division-plate. The leather is then fixed to the wooden block with "Prout's elastic glue"—an invaluable compound—and four wooden boot-pegs are driven through the leather and into

FIG. 22.

the wooden block, to make all secure. The leather should then be greased.

When the brake is in place the lathe-pulley should move stiffly if pulled round with one finger and thumb. All that is required is that the revolving drill shall not have power to move the work while the mandrel is controlled by the brake alone. There are really three points to consider when the advancing spiral wave is being made: First, the resistance of the brake; second, the power of the spring under the ratchet tail—and this should be only strong enough to make the point of the ratchet sure of bottoming in the tooth of the wheel; and, third, the power of the spiral spring which provides the return motion, and this may be fairly strong. A suitable spring is made of 17 B.W.G. hard-drawn steel wire, barrel ¼in., length over all about 5½in. This spring requires a pull of 6lb. to extend it to 6½in.

The spiral produced is necessarily of an interrupted character, the rising half of the cam causing the advance, while during the falling half the mandrel is at rest; for the ratchet being left quite free to work uncontrolled by the milled-headed screw, and the mandrel being held by the brake, the radial lever returns to its first position without moving the work, and then rises again and causes a further advance. The effect upon the work is that one-half the wave is followed by a straight line, which is, in turn, followed by another half-wave, and so on.

With reference to the sketches accompanying this paper, some of the figures are lettered F, R, and L. These letters denote the position in which the parts stand when seen from the front of the lathe. F = front, R = right side, L = left side.

A few specimens drawn by the apparatus are given, just to show the kind of patterns obtainable, the selection being made to show how completely they differ from the patterns produced by the older apparatus. Figs. 18, 19, and 20, Undulator; Fig. 21, Old Reciprocator Wave; Fig. 22, Ditto doubled.

A. S. ROGERS.

SEX DETERMINATION.

Professor Ciesielski's theory of sex determination, that the age of the male gamete is the all-important factor, and that fresh (twenty-four hours old) spermatozoa will produce males, and stale (more than twenty-four hours old) spermatozoa will produce females, is attractive from its very simplicity, and from the fact that its correctness should be readily proven or disproven within a comparatively short time by observations on the higher animals, and even on man himself. A priori, however, one would not be inclined to accept this as a question of striking simplicity, although the apparently complex chemical questions involved do not on their face, at first sight, negative Ciesielski's position; for it may be, and, in fact, is not improbable, that the male gamete, or the fluid in which it moves, may, with age, undergo a change in chemical composition that corresponds more or less closely to the conditions observed or imposed by the biologists on the lower forms of life.

The facts already collected as to man seem to bear no relation to Ciesielski's theory. Regions rich in food supplies show a relatively high proportion of female births. To still further emphasise the part that abundant nutrition seems to play in sex determination, high altitudes and Northern latitudes, where food supplies are scanty and obtained with difficulty, both show a large proportion of male births. That more boys are born in the country, where the food supplies come from, than in the cities, is explained by the fact, that many physicians can testify to, that city diet is generally more varied and abundant, especially in the matter of meat. Düsing gives figures showing that "in Prussia the numerical excess of boys is greatest in the country districts, less in the villages, still less in the cities, and least in Berlin." Still more significant is the fact that the proportion of boys and girls rises and falls with the proportion of the amount of circulating medium (money) in a country to the purchaseable foodstuffs available for purchase—in other words, in times of war, famine, or other national disaster, more boys are born, a beneficent provision of nature, apparently, to fill up the depleted ranks of the armies, or to furnish additional male hands to dig irrigating ditches and till the neglected soil. Even the poverty of an individual family is said to have a distinct influence upon sex determination, and the poorer districts of a city show a larger proportion of male births than do the well-to-do sections. Ethnologists state that "polyandry is found almost exclusively in poor countries," where there is a scarcity of women and an excess of men, this excess of males being possibly or even probably due to the poor food conditions.

Geddes and Thompson, in their "Evolution of Sex," give the following account of some of Yung's experiments:—"When (hermaphrodite) tadpoles were left to themselves, the females were rather in the majority. In three lots the proportion of females to males was: 54-46, 61-39, 56-44. The average number of females was thus about 57 in the 100. In the first brood, by feeding one set with beef, Yung raised the percentage of females from 54 to 78; in the second, with fish, the percentage rose from 61 to 81;

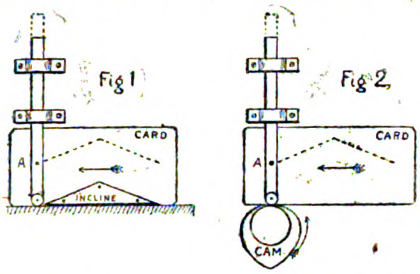
quicker than the rule and calipers, which, in the hands of the above class of reader, leave so much to guesswork.

(To be continued.)

CAMS FOR THE "UNDULATOR."

DESIGNING AND DRAUGHTING.

A cam may be simply described as "a wedge, or incline, wound round a cylinder." Just as a double wedge wound horizontally



under the foot of a vertical sliding-rod would cause the rod to rise and fall, so the cam, with its circular motion, produces the same effect, and by the same wedge principle. (See Figs. 1 and 2.) In the case of Fig. 1, if a card moving in unison with the double incline be carried past a pencil fixed at the point A, an exact duplicate of the line of the double incline will be traced. The same would be the case with Fig. 2, but with this possibility of error, that if the cam were not accurately shaped the two lines of the double slope would cease to be straight; probably becoming a series of humps and depressions, or even convex and concave curves. Here, then, is the gist of the whole matter—almost any undulating line may be produced by the cam, it being merely a question of the accurate transference or draughting of the required design from a rectangular diagram to a circular diagram; or, in other words, of correctly "winding the wedge round the cylinder."

Cams and inclines have these advantages over their relatives the eccentric and the crank, that neutral points can be arranged or prolonged, and rise and fall may be varied or repeated, all within the limits of one revolution of the cam or movement of the incline. In ornamental turning the incline finds its use in the curvilinear apparatus attached to the slide-rest; but for the present purpose the wave design has to be repeated over and over again in the same line. The cam, in its repeated revolution, meets this requirement in a convenient manner and a compact form. Neutral parts in the cam produce straight lines upon the work, varying in length according to the duration of the neutral part; variations from the normal diagonal or zigzag line produce concave or convex curves.

The cams for the Undulator have been planned upon a large scale, giving a rise of 1½in., and having a circumference which varies from 8in. to 12in., according to pattern. The design also should be liberally planned, and paper ruled in ¼in. squares, with a length of 8in. and a depth of 2in., is a very good scale, giving a length of thirty-two squares and a depth of eight squares for the diagram. If the design is a symmetrical one, with both rise and fall equal in form and length, mark the centre of the top line and proceed to sketch in the design, taking care that corresponding points of the two halves of the pattern cross the vertical and horizontal lines of the diagram in corresponding positions. (See Design 1, Fig. 3, "The old wave.")

The design being finished, a circular diagram for the cam must be prepared. The equivalent of the base line of the rectangular diagram will be a circle 1½in. diameter, and a circle 4½in. diameter will represent the top line. Between these two circles strike seven other circles 3-16in. apart, making nine concentric circles, each representing one of the horizontal lines of the design diagram. The outer circle is now to be divided into 32 equal parts, and radial lines ruled. Each square of the design diagram will now have its equivalent space upon the circular one.

An appliance for the quick production of these cam diagrams is shown in Fig. 4. It is made of stout roofing zinc, and consists of 32 equidistant holes upon a 4½in. circle, and eight other holes upon a radial line at intervals of 3-16in. apart, and a central hole. The size of the holes is about 1-20in., and with the use of the slide-rest, the division-plate, and the drilling-spindle, the appliance is easily made. To use it, pin a piece of drawing-paper upon the drawing-board, and fix the plate upon it by a drawing-pin through the centre hole, so that the plate will revolve freely upon the pin. Pass the point of a "H" pencil through the bottom radial hole, and revolve the plate with it, thus striking the inner circle upon the paper. Do the same with the other radial holes until all nine circles are struck. Now pass a drawing-pin through the top hole, and mark with the pencil each one of the remaining holes in the outer circle. Rule the radial lines from these points, and the diagram form is completed.

Assuming now that No. 1 design is to be

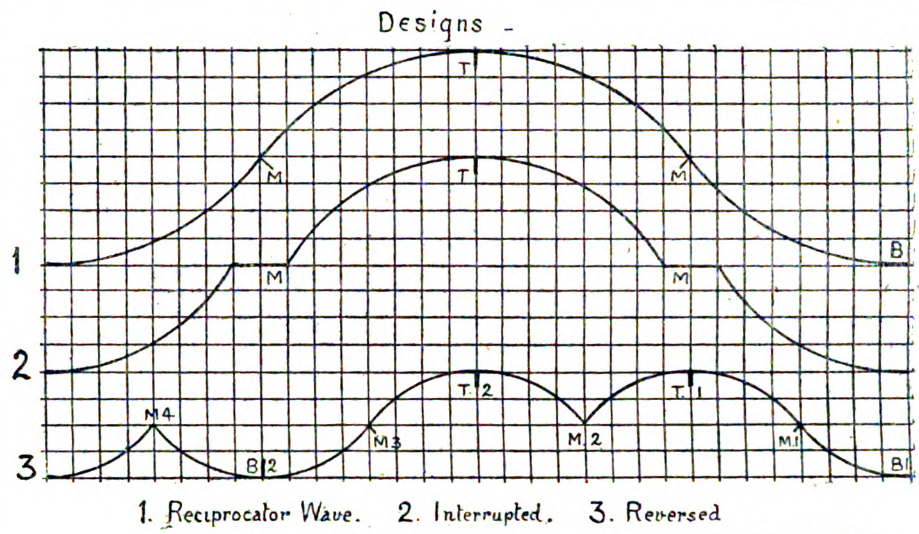


FIG. 3.

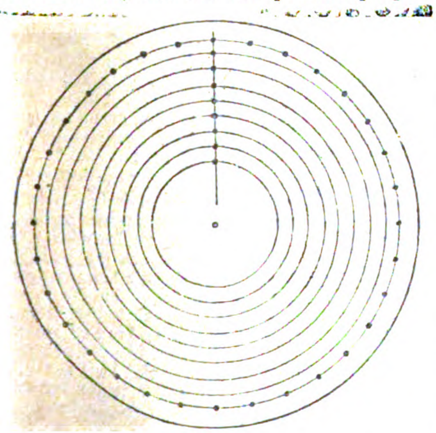


FIG. 4.

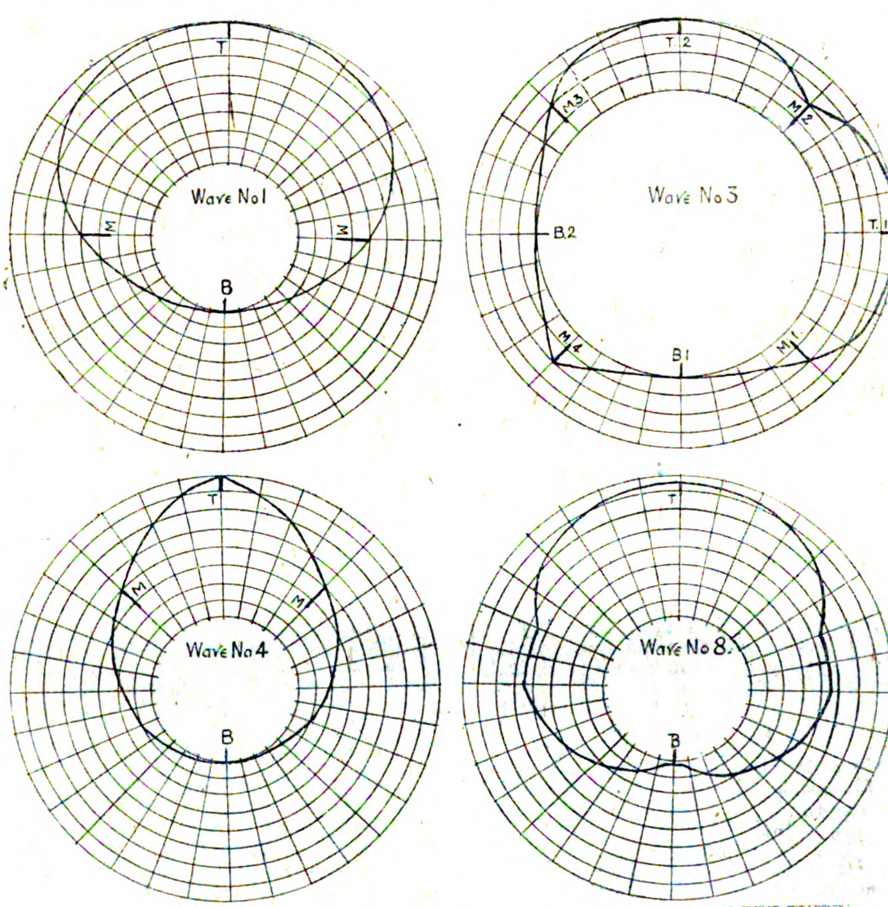
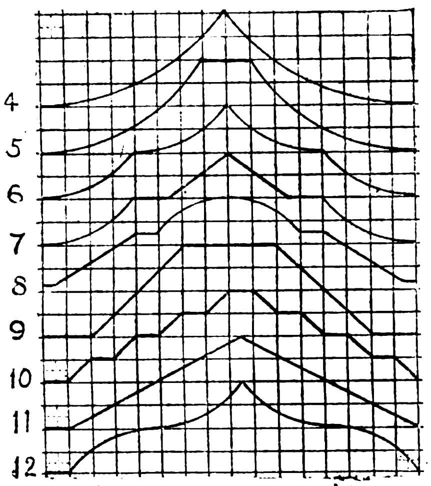


FIG. 5.

plotted upon the cam diagram, mark two opposite points, the top one being upon the outer circle and the bottom one upon the inner. Comparing the first square upon the base line of the design, draw a corresponding line in the first space to the left of the lower mark, and proceed all round, crossing one radial line whenever the pattern crosses a vertical one, and rising (or falling) into the next circle whenever the pattern crosses a horizontal line. (See cam diagrams, Wave No. 1, Fig. 5.)

Any straight lines upon the design diagram become on the cam diagram convex ones; convex curves become more rounded; and only in the case of some concave curves can they become straight lines upon the cam. Bearing this in mind, the points where the design intersects the squares of the diagram may be transferred to the circular diagram, and connected up with short, straight lines, which are subsequently blended into flowing lines, care being taken not to depart from the intersection points.

It will be noticed in draughting this cam how much more space there is in the second and third quarters of the circular diagram than there is in the first and fourth. This calls attention to a point to be observed when commencing to design a pattern. If one-half of the design should commence with



Reduced Scale 16×4

FIG. 6.

a steep rise from the base line it will be better to reverse the design and bring the steep ends up to the centre of the top line, from which position they will be plotted upon the largest spaces in the circular diagram. Such a design is seen in No. 4, Fig. 6, which shows the right way of treating it. If this cam design were drawn the other way it would be an arc of a circle, and the commencing and finishing squares would be crossed at a steep angle. When a design is such that a steep commencement and corresponding ending are unavoidable, an allowance will have to be made upon the rectangular diagram, as otherwise the roller may not be able to reach the base circle of the cam, and the resulting pattern may be more or less distorted. This allowance may be made by leaving the first and last (or the two last) squares upon the base line neutral, the design being drawn upon 30 squares only, as shown in Designs 8, 10, 11, and 12, which, it must be noted, are drawn half-scale.

While a design eight squares in depth is generally a convenient one, there are sometimes reasons for varying the depth of the diagram to suit the design. Design No. 3 is a case in point, which is a long pattern, with three rises and three falls. Here a depth of four squares has been chosen, which brings the proportions of each of the two complete regular waves exactly the same as in Design No. 1—i.e., each of the arcs of which the pattern is made up has a depth of one-fourth of the length of the chord, being as 4:16 in the case of No. 1, and 2:8 in No. 3. This is a very suitable proportion in all arcs used in designing, as the steepest part of the rise is about equal to an angle of 45deg. from the base line, which angle should not be exceeded if the cam is to work easily. The following proportions are convenient in use, and are approximations to the above rule as to angles:—

Chord of Arc.	Depth of Arc.	Radius required.
16	4	10
14	4	8
14	3½	8¾
12	3	7½
10	3	5½
10	2½	6¼
8	2	5
6	1½	3¾

The arcs in Design No. 2 have been drawn with a radius of 8, and upon the design the steepest rises show at a greater angle than 45deg.; but the position at which this occurs—at the midway horizontal line—makes it of less importance, because when plotted on the cam diagram they are placed where the segmental spaces are getting larger, which flattens the angle again.

Where there are less than eight squares in the depth of the design, as in No. 3, the inner circles of the cam diagram should be omitted. The base circle in this case is enlarged to 3in., which gives so much more room in the segments that it would scarcely be necessary to make any allowance for the roller, even if the pattern began and ended with a quick rise of 1 in 1, or 45deg. on the design.

While a rise of 45deg. is about the limit, there is no reason why a falling motion should not be very much accelerated. A fall

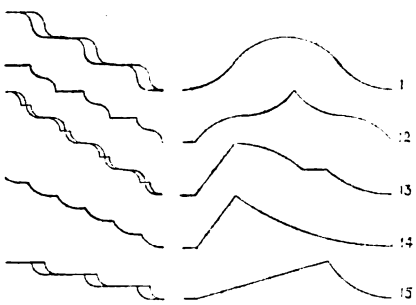


FIG. 7.

of 4 in 3, or eight vertical squares in six horizontal ones, will work comfortably if the roller be lifted off the cam on the return trip.

For spiral effects any ordinary symmetrically-shaped cam may be used; but the quick-return motion just referred to may be of service in designing some special patterns. The quick return leaves more room on the rising side of the cam for the half-wave, and at the same time shortens the period while the brake is holding the mandrel stationary, and so shortens the neutral lines which connect the half-waves upon the work. Or, on the other hand, the return motion may be made to include more than one-half of the design diagram, which will have the effect of increasing the pitch of the spiral. (See No. 15—diagrams showing spiral effects, reduced scale.)

If the cams are to be cut in ¼in. white holly fretwood, as suggested in the recent article on the "Undulator," the outline of the cam upon the circular diagram should be carefully cut round, and the cam shape pasted upon the wood, with the sharpest point of the cam placed to "end grain." When dry, shape up to the paper outline with saw, rasp, and file, and cut a ⅜in. hole accurately through the centre to fit the steel sleeve.

In conclusion, reference may be made once more to No. 1 design, and to No. 1 cam diagram, where the form of the cam is seen to be a perfect ellipse (errors of drawing excepted), with the proportions of 3¼in. to 3in. This curious result may be verified by turning an ellipse of the above proportions in the elliptical chuck, marking a central line with the tool across the shorter diameter while the chuck is in a vertical position, and cutting the ⅜in. hole for the steel sleeve upon a point on the line midway between the centre and the side of the ellipse. A cam so made will produce the old "Reciprocator" wave.

A. S. ROGERS.

HUMPHREY INTERNAL-COMBUSTION PUMPS.

The first of a series of two lectures on his internal-combustion pump was delivered by Mr. Herbert A. Humphrey at the Royal Institution, in the afternoon of Saturday, the 10th inst. The following abstract is taken from the *Engineer*:—

Mr. Humphrey first of all pointed out that the history of that branch of engineering which dealt with the production of power was largely a record of the complications and refinements which had been added to obtain increased efficiency. A comparison, he said, of the simplicity of the early steam-engines with a modern triple-expansion engine with its superheater and condenser, and all the gear involved sufficiently emphasised this point, but the remark applied equally to gas- and oil-engines. The most notable return to simplicity of construction was found in the steam turbine, and the rapid attainment of this prime mover to a foremost place among its rivals was, he added, largely due to its simpler construction. In recent times, continued Mr. Humphrey, probably no combination of well-known principles had produced so simple a method of utilising the energy of combustion as that found in the Humphrey pump, and the widespread interest it had created was due to this fact, and to the improved thermal cycle which it employed.

Mr. Humphrey then gave a brief review of apparatus using gas explosions in contact with water from the date when Pierre Martin filed a provisional specification in 1858. This specification was, he said, so short, that it might be reproduced:—"My invention consists in obtaining motive power from the explosion or dilatation produced by the combustion by means of the electric spark of a mixture of combustible gas and air, or by the combustion and decomposition by the electric spark of combustible gas, air, and water vaporised. The gases or vapours may be employed to produce motive power in the same manner as steam is now or may be applied."

The development of the idea was then traced by the lecturer by means of records of patents taken out in this country and abroad, and it was pointed out that a considerable number of these was concerned with the propulsion of ships. They were, however, mostly very crude in design, and quite impracticable. Backeljau seemed to have been the first actually to make an explosion-pump for lifting water; but the most scientific work was done by Adolf Vogt, a clever German, who came nearer to success than any of his predecessors. In Vogt's apparatus an explosion drove water into a high-pressure air vessel, from which it passed through a water turbine doing work, and back to a low-pressure air vessel. From the latter the water was returned to the apparatus under such conditions that it compressed a fresh combustible charge.

The lecturer then showed why the previous efforts had all failed, and that even when the inventor had recognised the necessity for compression of the charge before combustion, yet the pump had been designed too much on the lines of ordinary pumps with water-delivery valves. Valves which had to be opened or closed suddenly by explosion were, he said, so affected by shock that they could not last.

To illustrate the new principles involved in the Humphrey pump, the simplest form of this pump was then described. It was of a type which had been designed to deliver twenty tons of water per explosion, or, say, 200 tons of water per minute, and it was pointed out that units capable of discharging fifty tons of water per explosion had been designed. In connection with this 4-stroke cycle-pump, the lecturer explained that among the novel features which were embodied in his 4-stroke cycle-pump:—

(1) The column of liquid swung absolutely freely backwards and forwards, and its momentum completely controlled the cycle.

(2) When the explosion occurred, all the valves were shut and no valve moved, except under the slight pressure changes above and below atmospheric pressure. This was, therefore, no shock on the valves, and they were thus permitted to work smoothly.

(3) The momentum of the outwardly-propelled column of liquid was utilised to draw in both fresh a combustible charge and fresh water.

(4) The momentum of the liquid returning under its head or pressure compressed the fresh combustible charge.

(5) As the height of lift increased the compression pressure increased, so that the pump was assisted to meet the increased duty, and the pump became self-regulating.

(6) The length of the column was proportioned, so that the maximum velocities were

to the plane of the coil, and in which these vary most with any movement of the diaphragm.

(Letter 348, p. 315.) The permeability of a permanent magnet which is practically saturated, is infinitely small: hence the use of soft iron pole-pieces. The permanent magnets should possess the following properties to a marked degree—viz., retentivity and coercivity. Since its function is to induce magnetism in the soft iron pole-pieces, the permeability of the latter should be as high as possible, and seriously affects the efficiency of the receiver.

(Letter 319, p. 294.) The number of turns do not vary as the resistance. Let l_1 and l_2 = the length (d_1 and d_2 = diam.) (n_1 and n_2 = number of turns) (x_1 and x_2 = res. of windings on similar bobbins). Then—

$$\frac{l_1}{l_2} = \frac{d_2^2}{d_1^2};$$

and the number of turns is $\propto$ length of wire, therefore—

$$\frac{n_1}{n_2} = \frac{d_2^2}{d_1^2}, \text{ but } \frac{x_1}{x_2} = \frac{d_2^4}{d_1^4}, \therefore \frac{x_1}{x_2} = \frac{n^2}{n_2^2},$$

or the resistance is directly $\propto$ square of the number of turns, hence the number of turns is—

$$\propto \sqrt{\text{resistance of winding.}}$$

In the case given by "Pericles"—

$$\frac{C_1}{C_2} = \frac{\text{current in 4.000-ohm phone}}{\text{current in 100-ohm phone}} = \frac{1}{40},$$

Therefore—

$$\frac{C_1 n_1}{C_2 n_2} = \frac{1 \times \sqrt{4.000}}{40 \times \sqrt{100}} = \frac{1 \times 63.2}{40 \times 10} = \frac{63.2}{400} \text{ approx.}$$

If any prescribed number of amp.-turns are to be given, the winding must be such as to have the resistance per turn of a definite value, independent of the actual number of turns. It must also be remembered with wireless receiver design, we are dealing with alternating currents, or discharges of very high frequency, so that continuous-current calculations will not apply with any accuracy.

With regard to regulation of diaphragm, I have had good results with the following method:—The diaphragm is let into the earpiece, and fixed with a metal ring, a fine thread being chased on receiver-case and earpiece. Regulation of diaphragm being obtained by rotating earpiece, a grub-screw being used for fixing earpiece when the best position has been found. H. E. T.

THE HOLTZAPFFEL THREAD: 9.45 PER INCH.

[507.]—Need I repeat once more that, as shown in my first letter bearing on this subject, I took no notice of, nor interest in, the thread so long known as "9.45 per inch" in its *business* relations with British workmanship, confining my attention, as I did, entirely to its equivalence in Strasburg measures. To others is due the introduction of the name of that widely-known British firm on whose precision work it has so long appeared. I refer to Holtzapffel.

Now, strangely enough, we are to learn from the quotation of the writer of 414 (see p. 360) that the above number does *not* represent a Holtzapffel thread at all, and that the screw in question has really 9.434 per inch, very closely.

Like most people whether to pure science or to *commercial* information inclined, I have ever, when any possible doubt existed, and, indeed, whenever at all possible, gone directly to the *original source* for the required information—in the present instance to the published statements of J. J. Holtzapffel *himself*, who kindly permitted Mr. P. Hasluck to insert in his booklet on screw-threads in general two tables of the "Holtzapffel threads." These two tables differ only in very small details—the first one being that used by his father, I take it; the second being slightly different in the gears set down as those to be used in cutting these threads on the screwing-lathe, and in this second table, as in the first, the thread "9.45" *stands unaltered*. It is also there clearly shown that in cutting this thread, with *precision*, no out-of-the-way wheels are needed—neither 53 nor other equally "odd"; all the wheels are present in the common five-step sets, as I mentioned before.

It must, however, be stated that two wheels not usually found in common sets are there introduced (though *not for the* 9.45); these are 47 and 48. Wherefore all this cry about the necessity for a 53-wheel, when Holtzapffel's own table shows it is not needed?—as anyone may easily discover by use of his pencil. Being at present a tramp in the wilderness, I cannot quote the number given for the wheels; but, as said before, I have cut it with precision by use of other wheels than those of the table quoted, and these equally simple ones.

Next, as to the measurement of a screw supposed to be 9.45 per inch, but which turns out to be 9.434, or about it, instead. Concerning procedures of this kind I have a tale to tell. Considering such measurements to be more or less easy to anyone used to handling tools, rules, etc., five individuals of no small workshop experience, and all with no small opinion of their manual skill, were given portions cut off from a very fine and beautifully-cut screw (lathe-cut), which, having been made slightly too small, was rejected. Only one of these gave the true measurement—approximately close, as far as means permitted; some of the others were terribly out. Men are not all equally good at one thing!

But, after all, are we not chasing a shadow? Are we not placing the notes found in the notebook of someone of happy memory against the actual statements of the *maker himself?* And are we not ignoring the undoubted results of what the use of the very wheels he tabulates for this very thread when we take up the dicta of one of any degree of happy memory in contradiction of the very plain facts of the case? "This ought to set the question at rest."

(For "Barton," col. 2 at p. 359, read "Barlow.") H.

LATHE MATTERS.

[508.]—In reply to Mr. Shield (475, page 407), I may say that most turners on small accurate work, tool makers, etc., that I have come in contact with seem to prefer to turn their work dry, and I have always found myself when turning work to accurate sizes, especially if it is slender, that when taking very light cuts, the tools seem more manageable if they are dry. Of course, reducing the clearance angle to the smallest possible amount is very well; but it may be carried too far, and I think this is perhaps what Mr. Shield is doing, as he says his tools will not cut unless they are perfectly sharp.

A little later on in my articles I will describe how I use lubricants for work like crankshaft turning, that cannot be finished by any other method. This, I think, is the proper use for lubricant in small work. I have never found anything better than Bessemer for small work, unless it is carbon steel for something special. The drill guide Mr. Shields describes is very good, especially for an amateur, who, as a rule, only does one piece of a kind at a time. The advantage of the hand-drill that I described is that for a run of work it does not have to be put in the tool-holder each time it is used.

Owen Linley.

THE UNDULATOR: TO MR. A. S. ROGERS.

[509.]—Your undulator as described on pages 346-7-8 of the "E.M.," May 16, has given me the greatest pleasure. Unfortunately, I am not good at understanding drawings, and I cannot see through Fig. 6, which you say shows cam-wheel axle, and sizes being collar ¼in. thick and 1½in. diam, fitting banjo plate, 1in. filed down to ¾in. to fit slot in plate. There is no slot noted as being ¾in., and cam-wheel axle is, I understand, fitted on connecting arm. To one who is not good at reading drawings, a photo. of appliance all put together would have been a great help, as my lathe is a large one with plenty of room on rear end of spindle. Will Mr. Rogers kindly say if in making one I may reverse the ratchet-wheel and lever, keeping the face of wheel to front, and putting ratchet above in place of below the wheel? My fine set of gunmetal wheels are 20-pitch, a wheel of 120 teeth being 6in. diam. and comparatively light. As I read of no bearing for outer end of connecting arm carrying wheel and cam, I am wondering if this is an omission.

Scotland.

CLEARING METHYLATED SPIRIT WHEN DILUTED WITH WATER.

[510.]—Some few weeks ago you published a letter from me about the clearing of methylated spirit when diluted with water. The following week a letter appeared, in which the writer stated that ordinary methylated spirit diluted with water may be cleared by simply letting it stand for a month. I showed the letter to an interested friend, who said the statement was not true: the mixture would never clear itself, however long it stood. I determined to try it, and have had now two samples of methylated spirit with an equal quantity of distilled water added, standing, without being disturbed, during the last five weeks, and the mixture is not cleared yet.

My friend, above mentioned, told me that he had cleared the mixture pretty well by shaking up with white of egg, but the result, after filtering off, was not perfectly clear. Now I am writing, I may as well say that my method, which gives a mixture perfectly clear, is to add to the mixture of spirit and water a small quantity of ordinary benzoline, such as is used in the costers' lamps, and shake well. It will not clear immediately, but takes some days, and longer in cold weather. The mixture should be shaken every day till it clears. The benzoline rises to the top, and the clear liquid may be siphoned off. A. P. W.

POTASSIUM PERMANGANATE AS A GERMICIDE.

[511.]—I notice a statement in a recent reply to the effect that potassium permanganate is useless as a germicide. Considering that permanganate is used largely in the average household as a deodorant and disinfectant, I think it would be desirable if your correspondent would give some authority for stating that it has no germicidal properties. As far as "killing" goes, there is no question as to its operation in this respect. A solution of the strength commonly used in households will kill low forms, such as protozoa, infusoria, etc., practically instantaneously. Chætonotus larus succumbs in a few seconds; Vaginicola likewise. Even large entomostracans like Daphnia and Cyclops live only a few minutes in a very dilute solution, and a full-grown larva of Corethra (plumicornis) in the same dilute solution straightened out inside of five minutes. Bolles Lee states that permanganate is unequalled as a killing agent—even by 2 per cent. osmic—and Dr. Sims Woodhead, in his manual on Bacteriology, states that a 1 per cent. solution of permanganate will kill the bacillus of glanders "within two minutes."

My object in writing is to prevent a useful household safeguard being dethroned without sufficient reason.

Sidmouth, S. Devon. G. T. Harris.

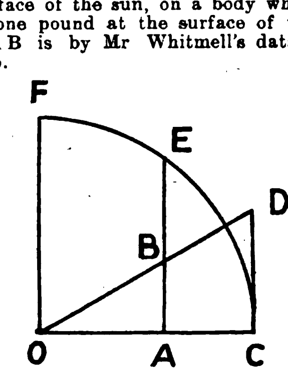
REPLIES TO QUERIES.

*** *In their answers Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[454.]—PEROXIDE DUST IN LECLANCHE CELLS.—About 14 months ago, when in a large town where I could not get any granular peroxide, I washed some batteries out well, and replaced the carbon, sprinkling in powdered peroxide. The batteries have worked well, but I notice the powder works its way through the porous-pot into the salammoniac solution.

M.M.I.Sc.S.

[561.]—EARTH, SUN, AND MOON.—In solving Mr. Whitmell's problem, the geometrical method is the most convincing. In Fig. 1, let O be the centre of the sun, O A its radius, A B at right angles to O A, the force of attraction at the surface of the sun, on a body which would weigh one pound at the surface of the earth. Then A B is by Mr Whitmell's data, 890/32.2 = 27.6lb.



The triangle B A O is the indicator diagram of the fall down the radial well: its area in foot-pounds is ½ × 433,200 × 5,280 × 27.6 = M. This is the vis viva of the body when it reaches the centre, starting from rest at A. Its vis viva, when it arrives at A with a velocity of 380 miles per second, is $380^2 \times 5{,}280^2/64.4$ = N. Produce O A and O B to the ordinate C D, such that the area A C D B = N: that is area D C O = M + N. This is easy, for O A² : O C² :: M : M + N, by similar triangle. Now conceive the velocity of 380 miles a second at A to have been produced in the body, by moving from rest at C to A under a force which is C D at A, and which varies directly as the distance from O. Then the motion from C to O is a harmonic one, with diagram D C O, and takes place in the same time as the harmonic motion A to O, commencing from rest at A, with diagram B A O. I the picture plane at any height be correctly represented by two lines separated by 6in.

If the picture plane be shown in the elevation at a distance of 1ft. from the observer, the plank would be represented by parallel lines 3in. apart; in fact, the scale of the perspective drawing depends on the proportionate distance of the picture plane from the observer and the object.

In my "Tracks of the Sun and Stars," recently advertised in this journal, I described my system, "The Perspective of Points," which enables anyone who understands mechanical drawing to make perspective drawings from plans and elevations which are obviously right, and does not require him to remember the usual rules of perspective.

June 7. T. E. Heath.

WIRELESS CHATTER, ETC.

[534.]—This seems very curious, and rather inexplicable. I would like to know if Mr. Eades has tried if he gets this result with different detectors.

Twickenham. W. J. Shaw.

WIRELESS MATTERS.

[535.]—With reference to letters 466 and 504, re tuning-coil diagram, I cannot quite understand Mr. W. J. Shaw's remarks. He says "the aerial circuit cannot be tuned independently of the receiver circuit." Now, this is just what I do, the necessary extra inductance being afterwards put into the receiver circuit by means of the other slider. In the diagram referred to by Mr. S., there seems to be a lot of unnecessary damping of the aerial circuit, and a good-sized variable condenser is absolutely necessary to work his diagram, whereas in mine the variable condenser is very little used, and can be dispensed with if wished.

I have repeatedly changed from one connection to the other, and, apart from any other consideration, find signals very much stronger with mine, the aerial circuit acting inductively upon receiving circuit in a more efficient manner. My remarks are based upon experience upon my own aerial only, and it would be instructive if others would try the experiment and report results. W. X.

[536.]—Mr. Landor recently asked for my experience of different capacities of blocking condenser in receiving circuits. I noticed a long while ago that the use of a large capacity gave signals a dull, muffled sound. Recently I have paid more attention to this particular matter.

The inductance of the telephone windings and the capacity of the fixed condenser form a closed oscillatory circuit, having a natural period of its own. The capacity of the condenser should be such that the natural period of this circuit should agree with one of the multiples, or harmonics, of the spark-frequency of the transmitter. The last detail is now considered of such importance that one of the newer systems—the "Lodge-Chambers"—have devised means of tuning this circuit independently of the detector circuit. It consists of a "jigger," which couples this circuit to the detector circuit, and a variable condenser.

The circuit is tuned to a frequency which is some multiple of the spark-frequency, and also near the natural vibration-frequency of the diaphragm of the 'phone. This "harmonic selector" provides means of discriminating between a number of stations transmitting on the same wave.

W. Malling. H. J. Lucas.

DOUBLE-THROW SWITCH.

[537.]—I do not like Mr. Pulling's suggestion, and am afraid it would be risky when putting much current into the aerial at a very high tension. Most Marconi stations are fitted with the Magnetic detector, which is not affected adversely; but I imagine that with Mr. Pulling's suggestion, unless in the case of very small power, the detector would want readjustment every time after transmitting, and there would be a severe strain on the insulation of the primary or receiving primary of receiving coupler.

Twickenham. W. J. Shaw.

USEFUL TABLE FOR WATER-SUPPLY QUESTIONS.

[538.]—The following table for pipes of diameters from ½in. to 24in. should be useful to those dealing with questions on water supply, etc. The figures in column 3 are also the cross-sectional areas in square feet of the pipes they refer to, and those in column 4 are obtained by multiplying the square of the diameter in inches by .034. This implies that the water is at a mean temperature. Column 7 contains the square root of the hydraulic mean radius (R) in feet. R, in the case of pipes, is always equal to one-fourth of the diameter, and $\sqrt{R}$ is required in all formulæ of the Chezy type for finding the velocity of the water in pipes running full or half-full, in which it is assumed that the velocity varies as $\sqrt{R}$. To ascertain quantities (columns 3 to 6) for larger diameters, look out the figure for half the diameter, and multiply it by 4. To find $\sqrt{R}$ for a larger diameter, look out for one-fourth of the diameter, and multiply the figure by 2, ignoring a possible difference of .001. Cosmo.

Diameter of Pipe.		Contents in a Length of One Foot.		Discharge per Minute when Velocity=1ft. per Second.		$\sqrt{R}$
Inches.	Feet.	Cubic feet.	Gallons.	Cubic feet.	Gallons.	R. in feet.
½	.0417	.0014	.0085	.084	.51	.102
¾	.0625	.0031	.019	.186	1.15	.125
1	.0833	.0055	.034	.333	2.04	.144
1¼	.1042	.0085	.053	.510	3.18	.161
1½	.1250	.0123	.077	.738	4.59	.177
1¾	.1458	.0167	.104	1.00	6.25	.191
2	.1667	.0218	.136	1.31	8.16	.204
2½	.2083	.0341	213	2.05	12.75	.228
3	.2500	.0491	.306	2.95	18.36	.250
3½	.2917	.0668	.417	4.01	24.99	.270
4	.3333	.0873	.544	5.24	32.64	.289
5	.4167	.1363	.850	8.18	51.00	.323
6	.5000	.1964	1.224	11.78	73.44	.354
7	.5833	.2673	1.666	16.04	99.96	.382
8	.6667	.3491	2.176	20.95	130.6	.408
9	.7500	.4418	2.754	26.51	165.2	.433
10	.8333	.5454	3.400	32.72	204.0	.456
11	.9167	.6600	4.114	39.60	246.8	.479
12	1.000	.7854	4.896	47.12	293.8	.500
13	1.083	.9218	5.746	55.31	344.8	.520
14	1.167	1.069	6.664	64.14	399.8	.540
15	1.250	1.227	7.650	73.62	459.0	.559
16	1.333	1.396	8.704	83.78	522.2	.577
17	1.417	1.576	9.826	94.56	589.6	.595
18	1.500	1.767	11.016	106.0	661.0	.612
19	1.583	1.969	12.274	118.1	736.4	.629
20	1.667	2.182	13.600	130.9	816.0	.646
21	1.750	2.404	14.994	144.3	899.6	.662
22	1·833	2.640	16.456	158.4	987.4	.677
23	1.917	2.885	17.986	173.1	1079.2	.692
24	2.000	3.142	19.584	188.5	1175.0	.707

THE HORSE-POWER OF STEAM LOCOMOTIVES.

[539.]—Although the locomotive which refused to go appears to be a freak, it would be interesting to learn what the mechanical difficulty was which prevented it from working.

"Locomotive" appears to have been unfortunate in his experience. I feel sure that a firm of locomotive builders would guarantee to turn out of their shops batches of locomotives which would do equal work with one another. I quite agree that it is possible for every connection in one engine to be loose and in the other tight. This is, of course, possible with every steam-engine. I cannot conceive that any railway engineer would allow engines to work under such conditions. Locomotive builders deliver engines in perfect working order, the connections being neither too loose nor too tight, and there is no difficulty whatever in keeping engines in good working condition. Regarding a 25 per cent. cut-off, I have travelled many thousands of miles on the foot-plates of locomotives, and invariably found that drivers linked up to 25—30 per cent. cut-off; such drivers were, moreover, at the top of the list in coal-consumption.

I also agree with "Locomotive" that indicator diagrams do not tell much regarding the condition of machinery. I hope he will admit that the M.E.P. in the cylinders is one of the main factors of the formula from which the actual horse-power developed by an engine is calculated. In this connection I have frequently advocated the desirability of locomotive builders taking brake tests from one of each type of engine built, which might lead to improvement in future designs. This method of arriving at the actual horse-power a locomotive can develop may appeal to "Locomotive."

When comparison is made between the work done by a locomotive and other steam-engines, advocates of the former have always the excuse that the conditions under which they work are different—in my opinion, a very unpractical one. My contention for very many years has been that it is quite possible to design a locomotive engine which will fulfil any condition of work, no matter how variable. That such is practicable I can vouch for, as I have travelled on the foot-plate of a locomotive the lever of which was linked up to 25 per cent. cut-off in the high-pressure cylinders after the engine had moved forward the length of itself, although attached to a train the maximum weight of which equalled the adhesive limit of the engine, the acceleration and speed of the train throughout the run being controlled by using the regulator. Were all engines similarly designed, not only would all drivers be able to work their engines under equal conditions, but any train could be worked, no matter how light or how heavy, at all times using up steam to a lower terminal pressure than at present practicable.

John Riekie.

THE UNDULATOR.

[540.]—I will do my best to explain any difficulties which readers may experience in following the description before given. Referring to the cam-wheel axle (Fig. 6, p. 347), the various "members"—as one would say of a moulding—are as follows, commencing at the left hand:—(1) Steel pin for spiral reaction spring; (2) 5-16in. thread and nut; (3) washer; (4) parallel part of axle; (5) collar; (6) narrow groove 1-16in. wide, which is a common trick for saving the trouble of getting out the corners when filing the two flats upon the next part; (7) a circular portion which is first turned 1in. diameter, and then has two flats filed on opposite sides until it will pass into the slot of the swing frame for the gear-wheels or "banjo-plate," which slot I assumed to be ¾in. wide. Last of all, part 8 is the screw for the large nut by which the axle is fixed in position.

It will be seen, therefore, that the axle (Fig. 6) is carried in the banjo plate, just the same as the revolving double axle of the spiral apparatus which it replaces, and that the cam-wheel upon it is one of the train of wheels by which the cam is revolved when the handle of the slide-rest screw is turned. The parts of the apparatus which are carried upon this axle go on in the following order:—First, the sleeve (Fig. 5), the collar being to the right hand; upon the sleeve the 120 cam-wheel is placed, and the cam is then screwed to the boss of the wheel by the two 3-16in. countersunk-head screws; next, the sliding boss (Fig. 5) fits on the axle close up to the cam, the reduced part of the sliding boss being to the left hand. Upon this reduced part the slot of the connecting arm (Fig. 7) is placed, and the gunmetal washer shown in Fig. 11 is then screwed on the boss. The washer and 5-16in. nut keep all in place, but must allow all the parts freedom to move easily. The truck or roller upon the connecting arm now rests upon the edge of the cam; and as the latter revolves, so the arm rides up and down upon the sliding boss and actuates the radial lever upon the lathe mandrel.

In answer to the question about reversing the ratchet-wheel and lever, the ratchet should be on the opposite side to the slot, or otherwise it would come in the way of the fixing-nut of Fig. 3 when at its nearest point to the lathe mandrel. The ratchet-wheel is also in the best position when fixed with the flat side to the right hand, because the wheel may be figured on this side and easily read while the operator stands facing the lathe.

If desired, however, the radial lever may hang downwards from the mandrel, instead of standing above it; but in the former case it means that the teeth of the ratchet-wheel must be cut the reverse way, and the ratchet also be reversed. The effect of thus reversing the lever is merely to reverse the pattern upon the work, the upward rise of the cam causing the work to turn forwards, instead of backwards, as it does when the radial lever stands above the mandrel. In my own lathe the radial lever is not fixed upon the mandrel itself, but upon a supplementary axle which is part of a reversing gear. This enables the pattern to be reversed in a moment by the movement of a lever handle, and although this is a complication, it is a great convenience in working.

A. S. Rogers.

POTASSIUM PERMANGANATE AS A GERMICIDE—CLEARING METHYLATED SPIRIT.

[541.]—In reply to "A. P. W." (510), all I can say is that it cleared for me. I think "A. P. W." may have put too much water in his spirits; I only added 20 to 25 per cent. Probably just enough to precipitate all the naphtha would work best. In my case the naphtha rose slowly and collected in droplets on the surface, leaving the liquid quite clear.

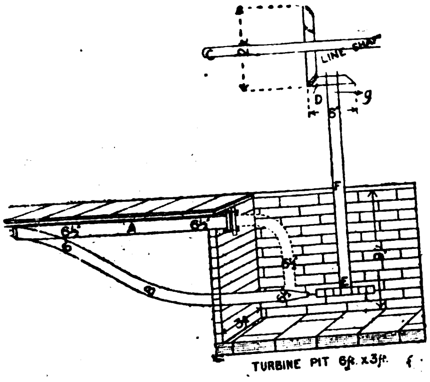
My authority for stating that potassium permanganate is not a germicide is Professor J. Emerson Reynolds. I attended his lectures and worked in his laboratory when a student, and I have his books on Experimental Chemistry. He states that it has no disinfectant action beyond that due to the oxygen it contains, and is only effective, so far as it is effective, in solution and in quantity. It oxidises the products of decay, but does not stop decay. Forms of life such as Mr. Harris mentions would very likely be killed by it, but they are not germs. The only instance to the point quoted in his letter is that of the bacillus of glanders. I know nothing of this bacillus, nor whether it is highly resistant or not. Speaking generally, a non-poisonous disinfectant is a contradiction in terms, for to kill such stubborn things as most disease germs are needs a substance which is poisonous, and strongly so. I have used pot. permanganate as a mouth-wash to prevent decay of the teeth, but quickly abandoned it on finding it had no preservative effect whatever; if anything, the reverse. A few drops of carbolic acid in half a pint of water is very effective for this purpose.

Wm. F. A. Ellison.

REPLIES TO QUERIES.

**** In their answers Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[613.]—TURBINE.—To "Jack of All Trades."—I should be obliged if you would kindly give a full sketch of turbine suitable for our job.



Could I make same out of steel plating, or should I make some patterns and get castings for same? We are well up in angle and Tee work, and have lathes for large and small work. I enclose rough sketch. A is the present position of pipe. Would it improve things a little if we alter pipe-line as B? This will be a big job, as it is under the foundation of building. How far should we go back to get on to pipe-line, which is about 7ft. down at turbine? C is the line-shaft fitted as old turbine with 2ft. cog-wheel. D is the small pinion which worked off old turbine spindle 6in. Could we speed line-shaft about 150 r.p.m., or by what size turbine to gear up with the 2ft. cog-wheel to get the greatest power on to line-shaft, as this is fitted with 2ft. pulleys, and our chaff-cutter 20in. pulley is wanted to speed at 120, and over, if possible, if we can keep turbine up to this when working. Would it be right to hang turbine by putting bearing at E, also F, also G? We could fit H joist to carry at E, and not have a centre bearing in the water, as that means trouble in oiling. Will this turbine work without a cover round same? Is turbine to be fitted above water-level?

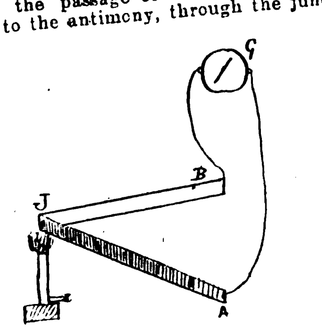
Miller.

[705.]—VERTICAL SUNDIAL—ANOTHER SUNDIAL.—Mr. E. C. Middleton finds fault with my sundial diagram; but when the gnomon is of appreciable thickness, it becomes necessary to allow for same, as I have done. The left of the vertical lines is not the twelve o'clock line, but merely a constructional line to facilitate the drawing of the others. It is true, however, as Mr. Middleton points out, that all the hour-lines in the diagram are not required. This is a case where mathematics not only answers the question we ask, but provides still further information. Are these extra lines not the identical ones that would require to be drawn if the northern side of the same plane were to be converted into a sundial? Of course, if "Vertical Sundial" has any doubt of the correctness of the angle through which his wall is turned from the south towards the east (its declination, as Mr. Middleton will have it so), he must first make certain on that point, and have the angle carefully measured. This could be accomplished by a little calculation, provided the inquirer gives the following data: (a) the time, and kind of time (i.e., whether Greenwich Mean Time or otherwise), as correctly as possible, together with the date, when the sun is observed to be perpendicular to the wall; and (b) the latitude and longitude of the observer taken from a good map. (a) Can be ascertained as follows:—Make a vertical line on the dial-face with the help of a plumb-line. On this line hold the edge of, say, a piece of stiff flat cardboard supported at the side by a set-square at right angles to it, so that the plane of the card shall be vertical and perpendicular to the wall. Now, when the shadow of the card is smallest and falls upon the line, the sun at that moment must be perpendicular to the wall. Then note the time. It would be better to give two or three sets of observations made on different days, to insure further accuracy.

"X." (487, p. 426) describes a simple circular sundial. I have seen a diagram and description of this form of dial in "Encyclopædia Britannica" in the article on Dialling; it is called an "equatorial dial," I think. But both sides of the disc require to be graduated, and one would have to look underneath for the time for that part of the year when the sun is south of the Equator.

Maldart.

[752.]—HEAT — ELECTRICITY.—In 1882, Seebeck discovered that if the point of contact of two dissimilar metals was heated, or cooled, a difference of potential or E.M.F. was found to exist between the two pieces of metal, and if the ends were joined by a wire, a current would flow through the circuit. Suppose we take the two metals antimony and bismuth. When the junction (J) is heated, the galvanometer (G) indicates the passage of a current from the bismuth to the antimony, through the junction.



If J is cooled, the current flows in the reverse direction. You can easily remember the direction by the letters A B C—i.e., the current flows from antimony to bismuth through the cooled junction. Later, Peltier noticed that if a current was passed through the junction, it was cooled or heated acording to the direction of the current. You must notice that here the A B C rule does not hold; a current passing from A to B heats the junction. On the Seebeck effect depends the action of the thermophile, which has been of great use in experiments on heat radiation. There are several other peculiar effects, such as "thermo-electric inversion," but space is limited. The whole subject is exceedingly interesting, and it would well repay "J. W. W." to read up the subject in some textbook on electricity.

Syphax.

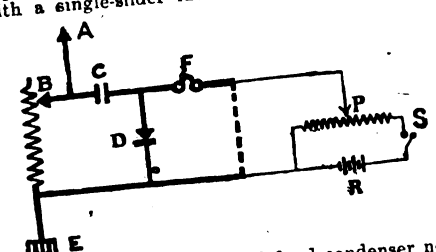
[764.]—RAIN-GAUGE.—The multiplier mentioned in reply on page 409 should be .886, and not .866, as printed.

Cosmo.

[778.] — TRANSFORMING DIRECT CURRENT.—In the issue of May 30 Mr. Bottone says: "With regard to the statement that an induction-coil gives an alternating current, it is, I fear, not quite true—unless, of course, it is fed by an alternating current to its primary." Surely Mr. Bottone must realise that this statement is incorrect, for when, at make, we thrust a number of magnetic lines into the secondary, an E.M.F. is induced which must be in the opposite direction to that produced by the withdrawal of those magnetic lines—i.e., by breaking the primary. In the ordinary coil, fitted with a condenser, the discharges, of course, are very unequal, for at make the supply of energy is divided between the iron core and the condenser as magnetic and electrostatic energy respectively. At break the whole of the energy is released in, perhaps, a few thousandths of a second, so that a very high voltage is induced in the secondary. In your next issue (June 6) Mr. Whitmell realises the truth of the above; but he says: "In ordinary conditions the current from the poles of the secondary coil is unidirectional." This, again, is not necessarily true, for by adjusting my spark-gap I can make my discharge either alternating or unidirectional. For the further study of this interesting subject, I would recommend both the gentlemen above mentioned to look up an article by W. Duddell which appeared in Vol. XXI. of the Proceedings of the Physical Society, and also in the "Philosophical Magazine" of August, 1908. In this article appear some beautiful curves showing the exact nature of these discharges. These curves were traced photographically by that most ingenious of all electrical instruments, the oscillograph.

Alexander Riddle.

[797.]—WIRELESS CONDENSER.—I presume your difficulty is in knowing which terminals to connect to the respective parts, and Mr. W. J. Shaw, in referring you, in company with many others, to his recent articles, has not noticed that he has not given that information in so many words. Refer to page 25, col. 1; also Fig. 28, page 2, and Fig. 23, page 562. Connect the aerial to O, the earth to 25, and the terminal which is connected to the centre finger-stud to the variable condenser, the point of detector, and to one lead of phones. Connect the remaining lead of phones to the crystal of the detector, and also to one side of fixed condenser. Connect remaining side of F. condenser to remaining side of variable condenser, and also to the stud No. 25 on the inductance-coil. You will then be connected as Fig. 23, page 562. Some readers say this works well; but I have found the following coupling-up (which I believe has not appeared in "E.M." before) works much better with a single-slider inductance-coil.



A, aerial; B, slide; C, small fixed condenser not larger than 4 or 5 sheets of tinfoil 2in. by 2½in., interleaved with waxed paper (with stud contact inductance a variable condenser must be used connected from B to E); D, detector; E, earth; F, phones; P, potentiometer; R, 3-cell battery; S, switch.

For crystal detectors complete to the thick lines. For electrolytic detectors, also include the thin lines, and omit the dotted thick line.

J. J. Shaw.

Sunnyside, West Bromwich.

[816.]—CLEMENTS DRIVER.—Mr. Andrews overlooks a point about this. There should be a special carrier for this, with a boss at each end, as I described in my letter of a week or two ago, so that the driver does not engage the set-screw as he shows. The heavy cuts used on modern lathes would make short work of set-screws.

Owen Linley.

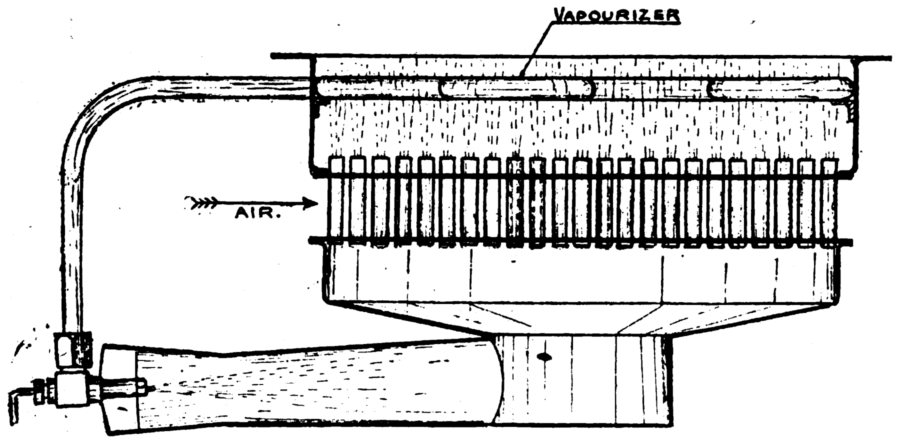
[821.]—NEBULA.—The Spiral nebula in Canes Venatici is just visible in a 2in. refractor. I have seen it with a 2in. Cooke ×60. I cannot say as to the Crab nebula in Taurus. A 3in. shows it certainly. Most of Jupiter's satellite phenomena are visible with a 2in. when the planet is favourably placed. Cassini's Division is beyond that aperture in the ordinary way, bu obtaining finer tuning. There may be some additional damping, due to several turns being "shorted" with the heavy contact, as final tuning with variable condenser did not clear up the signals as the lighter contact did. In reply to Mr. Shaw, the results were the same with different detectors.

I am fitting a small round-head rivet to the contact-springs of my slider-coils, which I anticipate will remove the trouble. I find bornite-zincite the most effective all-round detector (I have not yet tried the electrolytic); but the pressure needs to be carefully varied with the actual signals coming in to find the best pressure. It is not much use regulating it with the "buzzer." For this reason I found it necessary to replace my brass head of pressure-screw with ebonite. When adjusting with the brass head, the hand dulled the signals, and the best position could not be easily found.

It may be of interest to fellow-amateurs to hear that I am receiving Paris quite clear with my aerial under the slates of my house; inductive coupler to Mr. Shaw's instructions (or even primary only), and 'phones of about 160 to 180 ohms each. I also get occasionally Poldhu and Norddeich under favourable atmospheric conditions. Rhobeta.

STEAM-CAR BURNER.

[562.]—I enclose a sketch of a steam-car burner I have been experimenting with. It is an induction-burner of the usual pan type; but instead of the mixture burning at slots or holes



in the top of the pan, it passes through a large number of small tubes, which are fixed in two plates, between which air circulates, keeping the burner-plate and the tubes cool, to prevent lighting-back through the plate getting red-hot.

The burner certainly works excellently in practice; but I should be glad to have the opinion of some of your readers who have more experience with induction burners than I have as to whether sufficient advantage is likely to be obtained from the air-cooling arrangement to be worth the extra space required and the trouble in making. E. D. Suggate.

20, Upper Gloucester-place, London, N.W.

WATER IN PNEUMATIC TIRES.

[563.]—For several years I have put before "Our" readers the advantages to be obtained by injecting a little water into the inner tubes of motor-car tires, but have not yet seen any statements from any readers that might have tried it. It does not eliminate punctures, or save bursts due to weakness of the outer cover; but it does save bursts due to overpressure in hot weather, perishing of the tubes in the cover, and the sticking of the valve-jumpers. It does not interfere with any repairs, or do any harm, the inner tubes retaining the silky new feeling for very long periods. I have some in use now over three years old—one, a Dunlop, has never been touched except pumping and renewal of the water supply for over two and a half years, yet I am sure that I shall find the tube quite soft and flexible when taken out.

David J. Smith.

DOUBLE-THROW SWITCH.

[564.]—Thanks to Mr. Shaw for his criticism of my suggestion. The magneto detector used by the Marconi Co. certainly has the advantage of being totally unaffected by the transmitter, but I have always found that crystal detectors lose their adjustment during transmission, whether a double-throw switch is used or not. Using a spark-gap instead of a switch, I have found the difficulty completely overcome, in the case of small powers, by shorting the detector *close up*. The detector would be no less short-circuited when a large coil is in use, and I see no reason why the short-circuiting switch should not perform its function with equal success. I have not yet had an opportunity of trying the device with a large coil. If any reader has tried it—using the shorting switch across the detector—I should like to hear the result. It is absolutely necessary that the switch does not form with the detector an oscillating circuit; it must, therefore, be very near it.

I usually adjust the shorting gap during "reception." I screw up the electrodes until signals vanish, then open until they just reappear. The gap is then as small as possible.

Reigate. E. L. Pulling.

THE UNDULATOR—TO MR. A. S. ROGERS.

[565.]—With many thanks for Mr. Rogers's reply, I may state not only I. but a good many more in Scotland, considered No. 2 of his drawings to be the banjo referred to in that article.

What he calls a "banjo plate" is, I presume, what is called in this quarter a quadrant: hence partly my not quite understanding the drawings and their assembling. Perhaps it is too much to ask Mr. Rogers to send to the Editor a photo. of the appliance as put together on his lathe?

I know a few in the North that will be very thankful to Mr. Rogers, and will also consider it a great favour if the Editor will kindly grant space for same in "Ours." Scotland.

BINOCULAR—APERTOMETER—SCREW-GAUGE—LATHE MATTERS.

[566.]—"Alfred's" letter (527) seems to indicate that I did not make the conditions of employment of binocular quite clear, which omission I duly regret. The assumption was that high-power, long or short tube objectives were to be usable under the best conditions, while any sacrifice was to be entirely on the part of the low-power binocular vision. Such a binocular as he describes was my usual working instrument twenty years ago, and for long after, and did good service in much physiological and bacteriological work; but it is not adapted to the best use of modern objectives of varying tube-length, and was intentionally omitted. I should be glad of further porticulars of the Tolles eyepiece, which seems to have received much commendation from authorities at that time, but of which I have no personal knowledge. Personally, I much prefer objective changers to nosepieces. Incidentally, it may be worth mentioning that the Leitz type lend themselves to the insertion of stops to limit aperture, a set of which I have made for the purpose, which are frequently useful. They come in to cut down a fine 24mm. Zeiss apo. from .30 to .25 or .20 N.A. for pond-life objects, or a P. and L. 1-12th for dark-ground illumination with paraboloid. And here I should like to ask Mr. Nelson why a Beck-Cheshire apertometer, which gives apparently correct results with all other objectives from 2in. to 1-12in., is hopelessly out with an old Ross 3in., to which it ascribes an absurdly large N.A.?

Some of our old readers may feel a pang of regretful interest on hearing that at the sale of the contents of Dr. Edmunds's workshop on Tuesday last, his fine old Kennan lathe, including a spherical slide-rest and numerous accessories, found a fortunate purchaser at 12½ guineas, while the few competitors for other ornamental lathe apparatus had good reason to depart satisfied.

Re Screws.—The usual screw-gauge, with its numerous blades, is not the handiest instrument for counting threads, and a small tool that will at once show threads per inch or millimetre is handy for such purposes as sorting mixed screws, measuring those of a mechanism that is being taken down, or the like. It is made on the precise model of the type of caliper known as a "douzième-gauge," with measuring-jaws—or, rather, rounded divider-points—about 1in. long, the other arms on the opposite side of pivot being 5in. or more long, one having a brass arc on which the other reads, which is graduated—empirically—in threads per inch and per millimetre. All that is necessary is to push the points into adjacent grooves of the thread, and pitch is read off on arc. It does not pretend to micrometrical accuracy, but within its limits is a most handy tool, as whoever makes one will find. A sketch is hardly necessary.

Has any reader tried any of the newer alloy steels, as nickel-chrome or nickel-vanadium, for lathe-mandrels? If so, ideas as to the best alloy for this purpose would be interesting. Old traversing-mandrel lathes, with mandrels of "best cast steel," are often none too strong for the work their owners now want them to do, and to alter the dimensions would mean an excessive amount of redesigning and disturbance of accessory appliances; but to put in a new mandrel of one of these steels, some of which have most remarkable elastic and tensile limits, would be comparatively simple. But what steel to select, and the treatment of it as regards hardening bearing-surfaces, are points needing discussion. R. W. B.

A PERSPECTIVE PROBLEM.

[567.]—I am obliged to Mr. F. W. Shaw and other correspondents for their replies to my letter; but, while correcting my diagram, they do not quite clear up the problem.

If a vertical sheet of glass represents a picture plane, and we trace on it the image of a tall column of bricks behind, it would seem as if the top brick, being more distant, would have to be drawn smaller than the brick opposite the eye; and if so, the sides of the column would have to converge, which is not admitted in the rules of perspective.

On reflection, my own theory of the explanation is that, the top part of the picture-plane being also furthest from the eye, the bricks need not be drawn smaller, but if made the same size will appear smaller to the eye, just as much as the real bricks do. Perhaps this is only another way of expressing what Mr. T. E. Heath says?

Colchester, June 16. Charles E. Benham.

TIMEKEEPING RECORDS.

[568.]—Under the above title, Mr. Cory, of Leeds, gives in the *Daily Mail* for June 12, 1913, the fine performance of his watch, and asks if anybody can beat that record.

"Sir,—Can anyone among your multitude of readers beat the following record of a pocket watch, compensated and adjusted?—

"April 12, 1913, set Greenwich Mean Time. April 19, one second fast. April 26, two seconds fast. May 3, four seconds fast. May 17, four seconds slow. May 24, the same. June 2, two seconds fast. June 9, the same. The position errors are practically almost nothing, and the watch has been exposed during the above time to very varying conditions of temperature.

"Leeds. F. W. Cory."

The following is also a remarkable performance:—Lever watch, fully jewelled, with adjusted compensated balance, purchased 1877. This watch was worn for 25 years, never cleaned, and did not stop unless on rare occasions its winding up had been forgotten. At night it was placed under my pillow, and once it fell out of bed on to the floor. After that the watch went irregularly, and stopped in 1902. It was then cleaned for the first time. The watchmaker said that the watch was in first-rate condition, the only injury being that the top of the balance staff had been bruised by the fall. The watch after being cleaned went very well again, was worn daily, and at night placed upon a dressing-table. In the beginning of this year it went irregularly, so it was cleaned a second time. Rates are as follows:—April 12, slow, 29 seconds; May 19, slow, 37 seconds; June 13, slow, 35½ seconds. Therefore its greatest alteration in about two months is only eight seconds, which shows that there is not much wrong with it, although it is 36 years old, and has only been twice cleaned.

Now for a record of a different kind. A cheap (less than 20s.) machine-made watch has been kept on a watch-stand for about a couple of years. This watch has gone for one or two months at a time to 1 minute. No rate has been kept, but an error of 1 minute would have (krupios = hidden) the only difference between that and Synura being a mucilaginous investment. The remaining genus is called Uroglena (Uro = a tail, glene = eyeball). The mucilage in this case is in the centre of the colony.

I call attention to these three colonial organisms because they are pretty objects; because they are fairly abundant at this time of the year, especially in rainwater pools, and because I hope the mention of them will appease the chronic "wanting to know" state of mind of the zealous pond-hunter. "N. E. B." has contributed this week some very helpful notes. May I tell him that my remarks on diamond-beetles were submitted to my entomological friend, who is in charge of the natural history side of our local museum, and he carefully verified the names. This constant changing of nomenclature is tiresome; but I suppose new works must be made to sell.

P.S.—After forwarding above, I received following on a postcard from my friend:—"In the 'Encyclopédie d'Histoire Naturelle,' by Dr. Chenu, the Diamond-beetle is given as Curculio or Entimus imperialis. The Rev. Fowler, in his work, 'The British Coleoptera,' gives the British pine-weevil as Curculio abietis (Hylobius)."

J. B. G.

APERTOMETER.

[585.]—The error in querist's reading was probably due to the hole in the diaphragm being too large. It should not be more than 1.5mm. in diameter. E. M. Nelson.

CLIMACOSPHENIA.

[586.]—"N. E. B.'s" excellent drawings of Climacosphenia show the diatom just as I see it on Möller's Typen-Platte. The 20,000 lines to the inch, for the inside band, is a misprint for 29,000, which are, of course, too fine for an inch objective; but they can be easily seen by a low-angled $\frac{1}{8}$ of .36 N.A.

The side-view, Fig. 4, page 474, should show the corkscrew pipe joining the cells. See Journal Quekett Microscopical Club, Vol. VII. pl. 10. Fig. 11, p. 162 (1899).

No stop or slot was used with the Wenham-Ross $\frac{1}{8}$ when stopped down to .52 N.A. on P. angulatum. E. M. Nelson.

TURNING SPIRAL TABLE-LEGS—WATER IN TIRE-TUBES.

[587.]—Can any of your readers help me with the following? I wish to turn some spiral table-legs in oak, as seen in Jacobean furniture, and thought of doing it by means of revolving cutters, carried by slide-rest of screw-cutting lathe, and driven by an overhead. Is this the best way of doing it, and, if so, what rake and clearance would be best for the cutters, and what speed? Would four cutters, fixed by set-screws to the sides of a square spindle, do?

I notice Mr. D. J. Smith asks for readers' experiences with regard to water in inner tubes of tires. Acting on his suggestion—for which I am very grateful—I inserted some water in a pair of bicycle-tires, and noticed a marked improvement in the length of time they remained inflated without pumping. The improvement was not noticed at first, but was progressive in character, the period between two successive inflations gradually increasing from a few days to three weeks. I have remarked no ill-effects, but, on the contrary, find that the tubes, now five years old, are quite soft and elastic, and that the patches, whose name is legion, seem to give very little trouble by coming loose. In conclusion, may I express my great indebtedness to Mr. Smith, whose letters I have read for years with the greatest interest and profit?

Tailstock.

TAPER-TURNING.

[588.]—My object in writing is to supply my brother-mechanics with a method of setting the slide-rest for "taper-turning" that, in my opinion, is simpler and quicker in operatoin than anything that has been suggested up to now. Mr. Linley's method is nearly the same as mine—not quite so.

The first thing to be done is to get the top slide absolutely parallel with the lathe-bed; and to do this, a piece of iron or steel a little longer than the top slide should be placed in the lathe centres and turned true for about an inch from the end, then at a distance from the end equal to the length of the slide, another length of about an inch should be turned exactly equal in diameter to the first turned part. The tool should now be run in until it just touches the turned part, in such a way that the metal bar can just feel the contact between the tool and the work when turned round by hand. Whilst in that position a fine line should be drawn across the handle of the *cross*-slide and the bearing adjoining it. The tool can now be backed off and run to the turned part at the other end, run up to the bar as before, and if the line on the cross-slide handle and its bearing coincide, the slide is in its central position; if not, the rest must be moved round until the lines coincide, when the tool is tried at both ends. The rest being right, a fine but deep line should now be scribed across the *base* of the top rest and the adjoining part of the cross-slide. This is the line from which all measurements must be taken when setting the rest for any particular taper. To get the distance that the rest must be moved round for any taper, the following rule gives accurate results. Multiply one-half the taper required by the *radius* of the base of the slide-rest; divide the product by the full length of the taper part; the answer is the distance the rest must be moved round from its central position. In turning or boring tapers, the cutting edge of the tool should always be same height as the lathe-centre, or the work will not be a dead straight taper.

Example.—A piston-rod and requires turning for cross-head. Length of taper part, 8in.; the two diameters $2\frac{1}{2}$ and 3in.—that is, $\frac{1}{2}$in. taper; radius of base of rest, 6in.

$$\frac{1}{4} \times \frac{6}{1} = \frac{6}{4} \div \frac{1}{8} = \frac{6}{32} \text{ or } \frac{3}{16} \text{ to move the rest.}$$

An Owd Mechanic.

[589.]—Re Mr. O. Linley in his example of taper-turning and fitting, Fig. 75, I suggest a better way; but I am only a wood-spoiler, and do not profess to know much about metal, so let me off lightly. Having to do a small job like that shown, I cast about to do it easily, especially as my lathe was a bit rocky, and I wanted to do away with setting that top slide twice, as I knew I should have rare trouble to get two settings alike, and the less fitting done the better.

This is how it was done: The rod was turned, as in Fig. 75, with taper towards poppet, then plate was fixed to face-plate, and with drill held in poppet, the plate was bored nearly to size. Now bring up slide-rest, and put tool in upside down; wind over bottom slide, and bore on the back side of hole. By this means you can do the job exactly, and it must fit. You can also see what is going on with no trouble. I think that a lot of jobs could be turned out with a better finish if users of small lathes could set tools at back instead of front, as you get no chatters through loose bearings, etc. I find this answers well when job is on face-plate.

H. E. Brown.

LATHE MATTERS.

[590.]—About two years ago I saw an automatic put through a show job, making a $\frac{5}{8}$in. bolt about 3in. under head, with $1\frac{1}{4}$in. round head from $1\frac{3}{8}$in. reeled stock, in, I think, 1m. 9s., reducing from $1\frac{3}{8}$in. to $\frac{5}{8}$in. at one deep cut. (I could never get a satisfactory answer to the question why it did not use hexagon stock, and so produce a finished bolt.) It was using about 4H.P., and obviously no man on an ordinary or "engine" lathe could compete with it for speed of production on this particular job; but the shape of the tool, the form of cut, and several of the features of this class of capstan or semi-automatic lathes of this class appeared to offer suggestions which might with advantage be studied in relation to the ordinary lathe, and more particularly to the use of the ordinary lathe for jobs which would more properly belong to the capstan or turret-lathe, if the latter were available. For example: Bolts, studs, nuts, 2, 4, or 6 to a set—not standard sizes, that can be got from stores; and other pieces which can be got in lots of two or more, that may be wanted in building a single engine or machine, or on repairs. I shortly afterwards found, in a characteristically American book, issued by a firm who had been pioneers in capstan and turret-lathes, a strong statement of the economic advantages of reduced clearance and acute cutting angles. On these materials I have worked, as far as limited time and appliances would allow, and with some satisfaction, in relation to the rapid production of work of sufficient accuracy for the purpose for which it is intended. Naturally, I have welcomed Mr. Linley's articles as a description of the present British practice, on which little appears to have been written for many years.

The points to which I venture to draw attention as deserving of discussion are: To what extent, if at all, production on the ordinary or engine lathe can be expedited or economised by the adoption of methods now wholly or principally confined to capstan turret or other semi-automatic lathes. Whether any, and if so, what modifications can, with advantage, be made in the ordinary lathe to render it easier to adopt such methods. To give one very simple illustration: Take the making of four to six medium-sized capstan-headed screws, in a lathe fitted with a concentric chuck, but without a hole through the mandrel. The stock, in the absence of this hole, must be sawn or parted into lengths for two screws; and, mounting a die in the tail-stock, the pieces can then be turned to diameter with a knife-tool, and screwed without changing the tool, and without calipering, except for the first, if the cross-slide has a stop. The tool has then to be changed for a parting-tool, and the pieces of two screws each parted off. This obviously suggests the usefulness of a simple form of revolving tool-holder, which would present two or more tools in succession, and enable turning and parting to be done alternately without shifting tools. If the tool-holder will present four tools, it is possible to turn round or chamfer corners, knurl, and part without loss of time; but to have such a tool-holder in its simplest form, without special tools, involves some sacrifice in the building of the slide-rest, the top table of which must be about $\frac{1}{2}$in. lower than usual, to permit of the tool-holder having a bottom, and carrying the tools round with it. The great extension of mechanical means of transport and of mechanical appliances for domestic and similar purposes renders any improvement in the equipment of the single-handed repairer one of considerable interest, and the apparent origin of many of the most important features of modern machine-tool in the appliances used by the amateur ornamental turner renders it probable that the opinions and experience of amateurs as well as tradesmen may afford valuable material for the lathe of the future.

A. H. Shield.

THE UNDULATOR.

[591.]—In reply to "Scotland's" request (letter 565), the apparatus has been photographed to-day, and, if successful, I will send print in the course of the week.

A. S. Rogers.

SURFACE GRINDERS.

[592.]—The only drawback to that very valuable tool, the surface grinder, is the trouble of affixing the discs. Even the makers of the machines and the emery-discs do not seem able to supply a cement or adhesive that is satisfactory. I should like to know, from readers of the "E.M." who use these tools, what they use for fixing on the discs, and if it is satisfactory. So far, there are drawbacks to every adhesive that I have tried. Some of the compositions sold especially for the purpose can only be "meant humorous." David J. Smith.

WIRELESS LICENSE.

[593.]—I have always understood that a wireless license costs nothing. I know of two amateurs who have applied for same, and have been told in a typewritten letter from the G.P.O. it will cost £1 1s. for office expenses, inspecting station, etc.

Besides this, it is required to know whether you are a qualified person for experimenting. If this is so, my set will have to go, including two others, I know, as we are not going to pay. Any advice will be gladly received as to getting over the difficulty. Also, I am told, you may be summoned for erecting a pole on the roof. Is this so? Laws.

WIRELESS CLUB FOR BARROW—MOMENTUM — RELATIVITY — ANGULAR DIVISION.

[594.]—Following the example of other towns, Barrow-in-Furness is to have a wireless club, and intending members are requested to communicate with the undersigned.

Having failed to attract replies to the above-subjects through your query department, and having an insatiable desire to know something about them, in common probably with many others of your readers, I venture to ask your permission to transfer them to the region of your correspondence. The authoress of the "A B C Guide to Astronomy," speaking of momentum, says: "No system was started without it," but advances no explanation for the vast disparity existing in different quarters of the universe. How can we account for the fact, for example, that endowment bestowed upon our Solar System is two thousand times less than that of some others?

My query re Relativity was as to its claim to be called a discovery. That the principle involved can be employed to carry scientific theories to the point of paradox, I fully peranywhere on the circumference, a little extra pressure applied there in grinding will remove the excess.

Perhaps the greatest difficulty experienced was flexure. The 5in., though not extremely thin, was on the thin side, and, of course, the alterations reduced the thickness a little further. The crown-lens was a puzzle: how to support it all over, or nearly so, and yet avoid flexure. To cement a disc of glass with pitch to a wood support as large, or nearly as large, as the glass, is to invite flexure, even in the case of the thick discs used in mirror work. As a matter of fact, the crown-lens *was* flexured in grinding, and part of the fine-grinding had to be done over again to restore the figure. But this regrinding was done *face down*, the lens being only held in the centre. An empty cotton-reel, $1\frac{1}{4}$in. dia., served as a handle, avoiding any strain. As only the very finest stage of the grinding was re-done, no appreciable flattening of the curve took place. The polishing of the two altered surfaces calls for no detailed remarks. The figure of the concave was under control all the time by the shadow test, and was left slightly hyperbolic. That of the convex, in the absence of a spherometer, had to take care of itself. It was merely judged from the uniformity with which the polish came, that no serious alteration of the curve had taken place. Owing to the necessity of avoiding pressure, the polishing took much longer than a mirror would require: over twelve hours being taken by each surface. In addition, the third surface was also polished, as its polishing had been left in very imperfect condition by the original maker.

Now came the critical moment of trial on a star. The lens was assembled, and placed in its cell, and its star images tested. Arcturus was the object. Result, spherical aberration strongly in evidence, under-corrected. Central 3in. of the lens appeared to focus $\frac{1}{4}$in. to $\frac{3}{8}$in. further from the lens than its marginal portions. In addition, the extreme edge had an extra short focus, throwing quite a big halo of scattered light round the image. As both the concave surfaces were left slightly hyperbolic, and had turned-down edges, it was clear where the trouble was. So the next job was one of figuring. The third surface was a tough proposition, and it required several hours' work on an extra hard pitch-tool, with nearly the whole centre cut away, to bring its figure up to an approximate sphere, and get rid of the imperfect edge. The fourth surface was easier to work. It was brought also on a hard tool, to a very decided oblate spheroid, with a turned-up edge. When tried once more on a star, the result was highly satisfactory. The scattered light is entirely gone. Star images are neat discs, with one or two clean diffraction rings. Judged by the out-of-focus images, there appears to be still a small amount of spherical aberration; but I doubt if it is worth while to remove it. I will certainly not attempt it until after an exhaustive trial of the o.g. on all sorts of objects. I may add that the achromatism is all that could be desired, and there is very little secondary spectrum. The focal length of the o.g. is now 78in., which is fairly normal, and much handier than the former 85in. The job from first to last took about six weeks, working all my spare time, and hard at that: but it was worth it.

Wm. F. A. Ellison.

Fethard-on-Sea, Waterford.

AN IMPROVED INTERNAL-COMBUSTION ENGINE.

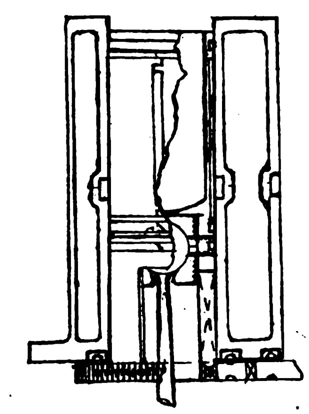
[624.]—I enclose particulars of my invention relating to internal-combustion engines of the four-cycle type. It has for its chief object to produce an engine in which poppet- and sleeve-valves, and the actuating mechanism therefor are entirely dispensed with, and wherein by reduction of friction to a minimum, and simplicity of operating-gear, high efficiency is obtained.

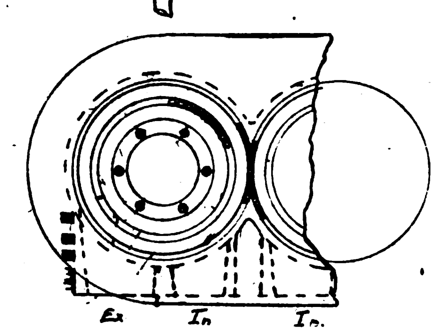
The nature of my invention will be clearly understood by describing it with reference to a single-cylinder engine, though, as will be seen, it is equally applicable to a multi-cylinder engine with much better results. In the following description it is assumed that the cylinder is set vertically.

According to my invention, the piston has, in addition to its reciprocating motion, a continuous rotary movement imparted thereto by suitable gearing, so as to make one complete revolution about its axis for each two revolutions of the crankshaft. On its upper, or combustion, side the piston is formed with an annular wall, or extension, wherein there is cut a vertical oblong port. In the cylinder-wall two oblong ports are cut circumferentially, the length of each being about one quarter the inner circumference of the cylinder, these ports being set as close together as possible, and separated by a space or partition the width of the piston-port. There is a universal joint between the piston and its connecting-rod. As the piston rotates about its axis, its port successively moves over the cylinder-ports, one of which is the induction and the other the exhaust port, so that by the rotation of the piston these ports are successively opened and closed. The piston-port crosses the cylinder-ports at about right angles, the effective port area being, of course, the rectangular aperture produced by the crossing ports, and the length of the piston-port is that of the stroke plus the width of the cylinder-port, so that during the whole of the time the piston-port travels over a cylinder-port there will be open communication between such cylinder-port and the combustion-chamber in the piston extension.

The operation of the cycle is thus as follows:—(1) Suction stroke: The piston-port passes over the inlet-port of cylinder, and the charge is drawn into the combustion-chamber within the piston-head. (2) Compression stroke: The piston-port is now travelling round the non-ported portion of the cylinder-wall, and no ports are therefore in communication. (3) Explosion stroke: Still no ports are in communication. (4) Exhaust stroke: The piston-port now arrives at and travels over the exhaust-port of cylinder.

If desired, the piston-port may be arranged to open the cylinder exhaust-port just before





the completion of the explosion stroke, should this be considered necessary in timing the engine. To prevent leakage during the compression and explosion strokes between the piston and cylinder, I groove the outside of the piston extension, or head, to take a spring ring of greater width than the length of the piston-port, and in this ring form a port corresponding and registering with the piston-port, the ring being preferably pegged in two places, and when closely fitted to bottom of recess, also ends, and sprung tight, closing cuts, prevents any leakage of gas, also compensating for any wear. Above and below this wide ring, ordinary spring piston-rings, which also must be pegged, are provided.

The piston-rotating gear would preferably be constructed and arranged as follows:—The under-side of the piston is provided with an annular wall, or extension, which passes through a ring having gear-teeth round its outer periphery, this ring rotating on ball bearings, whereof the races may be fitted, one in the cylinder base, and the other in a suitable frame bolted to and within the crank-casing. Anti-friction ball fittings recessed in the inner periphery of the gear-ring engage with vertical grooves in the dog-clutch cut, piston-wall, or downward annular extension aforesaid, so that when the gear-ring is rotated it rotates the piston through the medium of these balls, which reduce to a minimum the sliding friction between the gear-ring and the piston extension or flange. The gear-ring is driven off the crankshaft by a half-speed bevel-gear drive.

In the case of a multi-cylinder engine, no additional mechanism would be needed for rotating the other pistons, since the gear-rings of the several pistons may be arranged to intermesh. The top end of the connecting-rod may be spherical, preferably solid-turned, with rod, but hollowed out for lightness, this top end working in two spherically-bored half-bearings which screw into the lower extension, or flange, of the piston, which is internally screw-threaded at its upper end to receive them. Gudgeon-pins and blocks are thus dispensed with, enabling the engine to be more accurately balanced. The lower half-bearing would be divided vertically to enable it to be fitted over a solid-turned rod. The half-bearings may be held in place by grub-screws, and these latter locked by an annular-spring locking-ring surrounding the piston extension and engaging notches in the screw-heads. The crank-pin and the connecting-rod are made hollow or with oil-passages therein, and oil-passages in the crankshaft and cranks lead from the crankshaft bearings to the crank-pin passages. Thus oil under pressure from a crank-case pump or the like flows to the lower bearings of the connecting-rod, and through the passages in the crank-pin and connecting-rod to the top end of the latter, and thence through a passage to the external wall of the piston. The crank-case would have side doors to make the interior accessible without having to dismount anything.

Fig. 1 shows half-section of piston, with wide and small rings, and the unique top end of the connecting-rod. Fig. 2 shows plan of cylinder base and the rotary driving-piston gear-wheels, also the ports from cylinder. The six balls show the arrangement of the clutch of wheel and piston, and piston-wall through the anti-friction balls.

Mr. Herbert Sturmey, F.R.P.S., F.I.I., the first living authority on the British motor industry, in a letter dated April 12, 1913, writes me: "The idea is a very interesting one, and you appear to have some novelty in your particular arrangement of the ports—although, of course, the idea of a rotating piston opening ports as it proceeds is not new. I do not see any reason why it should not work satisfactorily, and the only objection I can see to it is the necessity for adding to the height of the cylinders, and this would consequently add also to the weight."

I should be glad to hear from any likely to be commercially interested, with a view to putting the engine on the market: or communications may be addressed to my patent agents, Messrs. E. P. Alexander and Son, 306, High Holborn, W.C.

James W. Reeves.

70, Liverpool-street, Walworth, S.E.

A NEW OIL-ENGINE—STEAM-CAR BURNERS.

[625.]—In your description on page 491 of the remarkable new oil-engine there is a rather curious point which is perhaps worth mentioning. It says: "In addition to all this, the flywheel—for the first time in the history of the petrol-engine—is abolished," and then, later on: "Another feature is the embodiment in the design of the engine—and not as an afterthought—of a pneumatic self-starter." Surely, if the engine is capable of working without a flywheel to overcome the dead centre, it also will be self-starting, as are locomotives, marine engines, and steam automobiles.

I have been much interested in the letters on steam-car burners appearing in your last two issues. For some time past I have been designing a burner capable of starting from cold without the use of methylated spirits, and by the mere turning of a small handle some half-dozen times. I am applying for patent rights, and on hearing from the Patent Office as to the acceptance of my application (which should be in the course of a day or two), I shall be very pleased to let you have a drawing and description, if you think it would be of sufficient interest to your readers.

Vanon.

[Certainly.—Ed. "E.M."]

THE UNDULATOR.

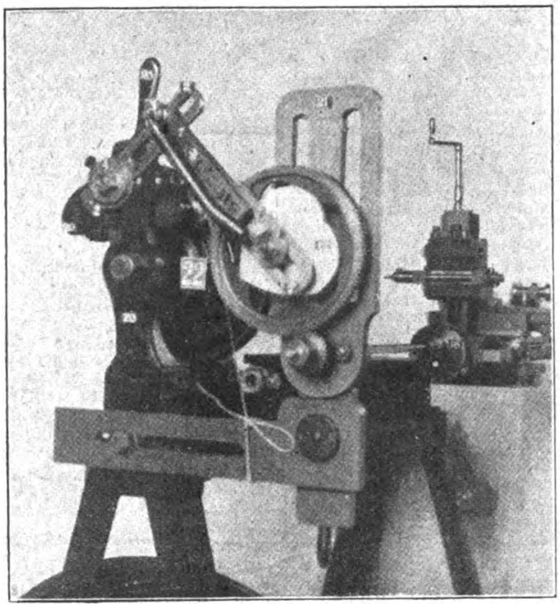
[626.]—I enclose photo as promised. The numbers up to 16 upon the parts agree with the figures given on pp. 346-8. I hope they will be clear enough to reproduce in print.

No. 2 is the radial lever, and is fixed upon the revolving stud of the reversing-gear, the parts of which are numbered 20—20—20. This revolving stud is geared up on the other side of the reversing-lever with a wheel (numbered 22) which is fixed to the cone pulley upon the lathe-mandrel. If there is no reversing-gear or stud, the radial lever will be placed upon the end of the mandrel itself.

No. 4 is the washer which retains the radial lever upon the stud. No. 3 is the axle which is moved in the slot of the radial lever when the depth of the wave is to be increased or diminished. No. 7 is the connecting arm, which rides up and down upon the sliding boss (No. 11) when the cam is revolved. No 9 is the stop-plate. The spiral spring obscured the view of the stop-plate: hence it has been tied back by the piece of string showing in the photo. No. 12 is the cam. No. 16 is the adjustable coupling between the leading screw and the extension rod or shaft. No. 21 is the part with many names—"quadrant," "radial arm," "swing frame for change wheels," or "banjo plate," and I daresay several others.

In the photo, only two wheels are in use (apart from the reversing-gear) 20 teeth on the leading-screw extension, and 120 teeth for the cam wheel. This gives a short wave only, but longer ones are produced by the use of an additional axle and pair of wheels working in double tier. The wheels shown are 20 pitch.

A. S. Rogers.



LATHE MATTERS.

[627.]—I think the following is a simpler method of taper-turning than the one described by "Owd Mechanic," as it does not require the top slide to be set parallel first, or any marking to be made on the screw or figures to be used. Having decided on the length of the taper part, mark this on the rod, and then turn the small end to the required size for a little way, just enough to measure it, and no more. Now set the top slide to what appears to be the required amount of taper, and test it thus: Put a pointer made of a file in the toolholder, with the end of the tang cut off, and the remainder rounded over and smoothed (this is a thing that is often handy about a lathe, by the way). Run this along the taper, and, as the unturned part of the small end prevents the tool coming in contact with the rest of it, use a feeler, which may be any piece of metal of a convenient thickness, say the end of a graver, move the pointer from one end of the taper to the other, and try it with the feeler, and set the top slide until it fits at both ends. I do not say anything against "Owd Mechanic's" method, but it seems to me to be more suited to such work as the example that he gives, and which is of fair size, the taper being 8in. long and 3in. at the big end. I had in mind quite small work, such as would be done in an amateur's lathe.

The method that Mr. Brown (letter 589) described for taper-turning and fitting is very good, and the boring with the tool upside down and working at the opposite side of the hole is largely practised by some turners, especially piece-workers, as they find that by this means they can take heavier cuts without chattering. The tapers will not be exactly alike unless the heads of the lathe are set so that it will both turn and bore parallel, as I described by the three diagrams, Figs. 72, 3, and 4, in No. X. The method that I described is the one most in use in small shops where they make engines a few at a time, and there should be no difficulty about it if the taper is watched and got right before the hole has been bored too large. I can assure Mr. Brown that the lathes in some of these shops are quite as rocky as he describes his to be, and perhaps worse, and it is almost impossible to adjust them so that they can be relied upon, and that is why the method that I described is mostly used, as it is independent of the condition of the lathe.

Mr. Shield (letter 590, p. 497) says that he saw an automatic on a show job turning out work at a remarkable rate, and also that he could not get a satisfactory answer as to why hexagon stock was not used. I think I can throw some light on this. In some cases at shows, these machines are run for the sake of effect on a special steel, that can be worked very fast, but that is practically useless for anything else. I have known a case where one of these machines had been supplied to a firm, and when the makers' expert came to install it, he was provided with some of the above steel, which was sent with it; but when the firm insisted on the use of a different class of steel, that they were compelled to employ in their productions, the output dropped very considerably.

As to converting an engine lathe into a kind of makeshift turret, I have often had to do this, and so have others similarly situated; but I cannot say that these efforts were very successful, for the following reasons: The spindle of the ordinary engine lathe, especially if it has not a large hole through it, is not stiff enough as compared with that of the regular turret lathe, and which makes it difficult to use parting tools at any rate of speed, as they will not cut well; and the work has a tendency to jump over them just as it is being cut through, which causes them to break. The advantages of the reduced clearance and acute cutting angles that Mr. Shield speaks of, are well known to the users of turrets and automatics, but they are not suited to an engine lathe.

The experiments of Mr. Vernon, who is well known in machine-tool circles, and of the lately-deceased Prof. Nicholson, have shown that what is termed a "shattering" action sets in with these tools and destroys the acute edge, unless the machine in which they are used is so rigid that there is practically no vibration.

If work such as Mr. Shield speaks of has to be done in an ordinary engine lathe, it is best to adopt the principle known as the French screw-making machine. This is a very simple and ingenious idea, and is independent of the rigidity of the lathe, and also, to a great extent, its condition. The first persons who started here to make a regular busines of producing metal screws were Frenchmen, who brought these machines with them from Paris, and, as the demand for larger work grew, as well as for turned parts, and these machines were not large enough, they rigged up ordinary engine lathes on the same principle. If our Editor thought it would be of sufficient general interest, I should be happy to give a description of the system as I have seen it used by these men. I have often used it myself on fairly large work with great success.

Owen Linley.

WATER IN PNEUMATIC TIRES.

[628.]—It may interest Mr. D. J. Smith to know that my brother and I acted on his suggestion of putting water into inner tubes of tires. As we had no motors, we had to experiment on cycle-tires. One of the tubes had seen much service, and had had more than its fair share of punctures. In fact, when I pulled it out once, my brother murmured, "The speckled band." I put about an ounce of water in it. As a rule, this tube kept hard about twenty-four hours; but after water treatment it lasted a week! Then the fun began. Every patch that had not been properly put on came off. There was no half and half about it; none of those tiny punctures that are so hard to find. The patches either stuck properly, or came right off, according as they had been carefully or slovenly put on.

However, the other tubes were in good condition, and a few days ago—to be precise it was June 14—I ran over some thorns. Upon examining the tires, I found two places where the water was bubbling right through the outer cover. I resolved not to take the tube out until I was obliged to. To my surprise, the tire did not go down, and it is still hard to-day (June 20). The water has only been in a few months, so I cannot say anything as to its preservative qualities.

Judging by my limited experience, my opinion is, Never put water into old tubes; but it is a good thing in new tubes. I believe Mr. Smith mentioned this in one of his former letters on the subject.

Maidstone. G. A. C.

[629.]—I, for one, very gratefully acknowledge my indebtedness to Mr. D. J. Smith for his advice about keeping water in pneumatic tires, which has saved me much patching and pumping for the last year or two—a wineglassful for a bicycle-tire is enough. Its action has been so beneficial that I have extended the experiment to other rubber articles, and am equally satisfied with the result. Valve-tubes and patches, for instance, seem to keep much better since I immersed them in a stoppered bottle of water, and fishing-waders last a great deal longer, and keep in better condition if the feet are filled with water before being "hung up in a cool, airy place," as recommended by the makers.

Charlton.

[630.]—I was glad to see that "Tailstock" (letter 587) had tried water with advantage in cycle-tubes. I had never thought of it with regard to cycles, as on these the tire question is not so pressing as on motor vehicles. I see no reason why water should not be of equal value in cycle-tubes, and am not surprised at the results "Tailstock" has obtained. I thank "Tailstock" for his kind appreciation of my work—which, however, I do not regard as work, but pleasure.

With regard to "W. E. B." (letter 605) on this subject, I can assure him that the two patches would have come off in any case; the water had nothing to do with it, except, perhaps, to delay the coming off. I have proved the effect of the water by actual trial extending over some years. "W. E. B." can see my letters on the subject in the "E.M." for some years past, so it is not due to chance that the inner tubes are preserved in such a remarkable way when water is used in them. In a previous letter I warned prospective users to always try the effect with a new or sound tube. A tube with two patches simply stuck on cannot answer this description.

A few weeks ago my firm sent to the old-rubber merchant about 15cwt. of inner tubes as scrap rubber. These cost, new, probably some hundreds of pounds, and fetched shillings. None of them were really worn out, but all were perished. The use of water would probably have saved very many, if not all, for a very much longer period of work. Try again, "W. E. B." It costs nothing, can do no harm in any case, and undoubtedly does good.

David J. Smith.

STEAM-CAR BURNERS.

[631.]—I am glad to see that my description of a burner has evoked some interest. The idea of air-cooling was suggested to me by witnessing the failure of an experimental induction-burner; this worked all right in the open, but when under a boiler got red-hot in the centre, and burnt in the mixing-chamber. My burner was constructed for a flash generator, and was actually used on the road for some time on a steam tri-car. Though otherwise satisfactory, it was found to be insufficiently powerful, and has now been scrapped; but I am designing a larger one on similar lines, particulars of which I will forward when I get it going.

The bore of the tubes is $\frac{1}{4}$in.; they do not work well larger. The burner would turn down enough for all practical purposes, and though it could be made to light back, would recover immediately when turned on again. It was fitted with a pilot burner, but this was omitted in the drawing.

If "W. E. B." wants a good method of lighting-up on paraffin, I can recommend him