PLANT'S GEOMETRIC CHUCK. PART I.

(For Illustration see Supplement.)

THE geometric chuck is an instrument or machine so complicated in its details that only very few workmen have achieved the construction of a complete chuck. The intricate nature of the mechanism, and the absolute accuracy of fittings necessary to produce a satisfactory result, are such that only first-rate hands can succeed. Only a few such chucks are now in use. Their employment is limited, and their prime cost great. By some the term geometric chuck is applied to chucks of comparatively simple design, and only capable of producing mere ellipses and circles in various positions.

The definition of the instrument, as given by a dictionary, is: A chuck having a radial slider, to which the work is attached; this slider, oscillating in a plane at right angles to the axis of rotation, produces curved lines in various patterns. By means of toothed wheels the sliding and circular motions are made to act simultaneously in different ratios. The introduction of several sliders adds to the complexity of the patterns that may be produced. By these motions the patterns may be waved or interlaced lines of great intricacy, and which cannot be counterfeited.

It appears that the geometric chuck was first devised, or, at any rate, first constructed, some sixty to seventy years ago. The merit of the invention is claimed by John Holt Ibbetson, who, in 1833, published a small book, entitled, "A Brief Account of Ibbetson's Geometric Chuck, manufactured by Holtzapffel and Co." The author states that the object of his book was to bring under the notice of the public—particularly that of the amateur turner and of those who take pleasure in the investigation of the organical description of curves—the powers and capabilities of the instrument alluded to in the title-page. He says further that he contrived the instrument and constructed it with his own hands, even to every screw, from the raw materials of brass and steel.

These remarks appear to have been brought out in consequence of some statements made in "The Mechanic's Magazine," which cast some suspicion on the originality of Mr. Ibbetson's invention. In continuation he writes:—When I first made my chuck I called it "The Geometric Chuck," and certainly no other chuck had been so called. In "The Mechanic's Magazine" of the 26th September, 1829, there is a letter in which the writer says that he has "possessed geometric chucks, and compound geometric chucks, but that the idea of them came so easily, and must have occurred to so many others besides himself, that they did not appear to be worth communicating." The powers of my chuck have appeared before the public in various ways from the year 1817 to the present time. In 1820 I presented a book to the Society of Arts on the subject of preventing the forgery of bank-notes, which contained a large assortment of engravings executed with this chuck. The fact of its being an instrument that accomplishes its work in the most finished style, and in the greatest imaginable degree of correctness, symmetry, and beauty, has been further established by my publishing various other specimens, and by many presents to friends of the work done by it on ivory, wood, metals, and even on glass.

Ibbetson explains that he did not get any part of his idea of a geometric chuck from the "Machine Epicycloïde," which is described in Bergeron's "Manual du Tourneur," published in 1792. He states that at the time he constructed his first geometric chuck he had never seen or ever heard of Bergeron's book, which was then little known in England, and which is now out of print. He acknowledges a certain amount of indebtedness to a description of Suardi's geometric pen which he had seen, and some of the principles of which he applied.

In his description of the instrument, Ibbetson says:—I divide the geometric chuck, with reference to its powers, into three divisions or parts. The first part is made separately, and forms a chuck of itself. The second part can be added to the first, and the two combined possess the power of placing all the lines and curves that could be obtained from the first part alone in every conceivable direction and eccentricity, and of combining them in all sorts of ways. The third part consists in a further extension of the powers of the chuck, and gives it the property of dividing the ellipsis and any other curves into any even number of equal parts, and this principle of equal division of the ellipsis is the foundation also of many very various figures and curves.

In 1829 Mr. Ibbetson gave Messrs. Holtzapffel and Co. permission, and the necessary particulars, to manufacture his chuck, and that firm now continues to supply it—that is to say, they profess to be able to make the chucks, if orders are received, but they have not been favoured with orders for some years it appears.

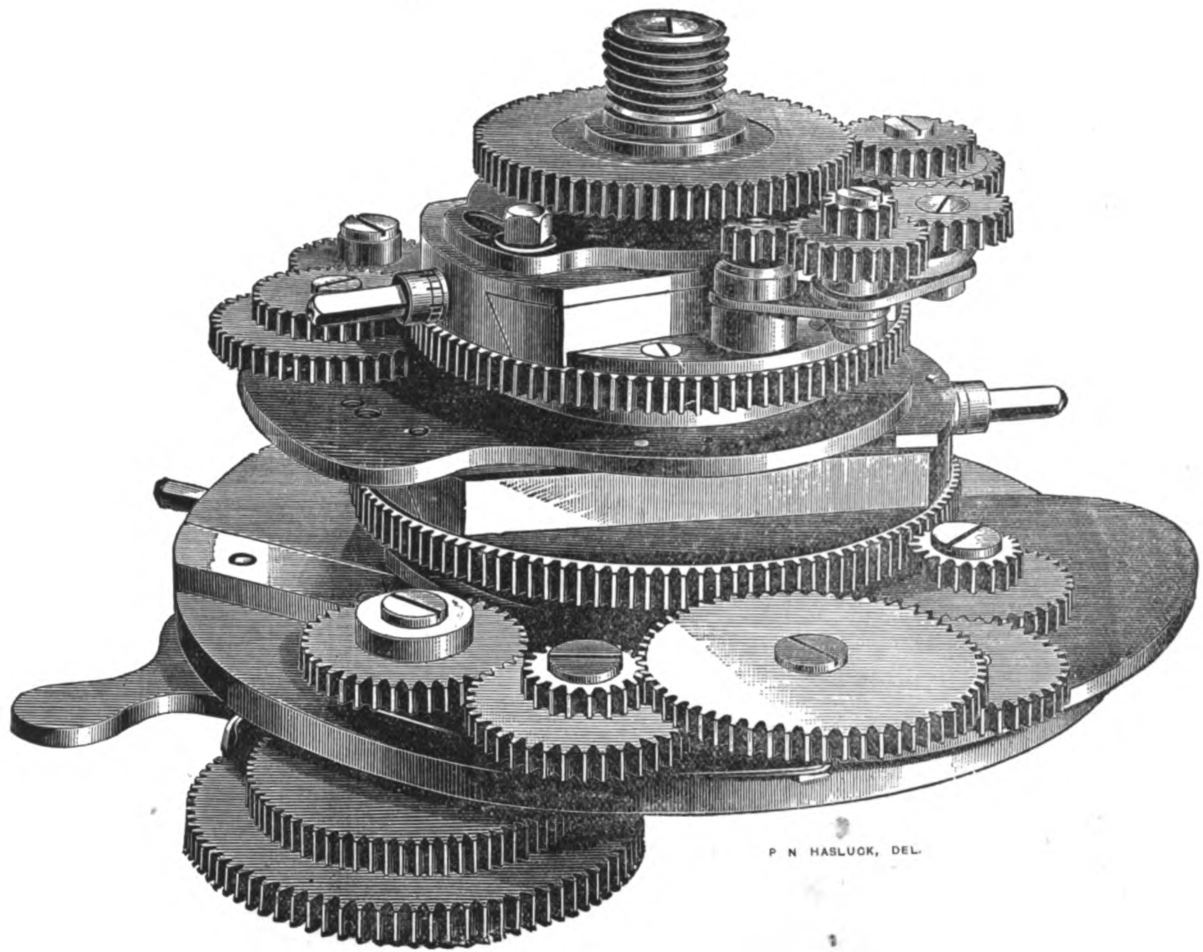
In 1875 the Rev. T. S. Bazley, M.A., published a valuable book, entitled, "An Index to the Goemetric Chuck." This work has an immense number of lithographic illustrations, showing the capabilities of the chuck. The instrument used for producing the figures was Ibbetson's chuck, made by Holtzapffel. Only a hundred and fifty copies of the book were printed.

The instrument which is herewith illustrated by a perspective elevation of the complete chuck, and which is hereafter to be described, is that manufactured by Messrs. Plant, of Birmingham. It has been greatly improved by this firm, and now claims precedence over the original construction. The writer is indebted to Messrs. Plant for the loan of the instrument which is to be described, and as the detail drawings for the illustrations have all been made from the chuck itself, and will be printed by photo-lithography, their accuracy may be thoroughly relied upon.

The accompanying illustration, drawn by the author, is borrowed from "Design and Work."

(To be continued.)

Solder.—The fusibility of soft solder is increased by adding bismuth to the composition. An alloy of lead 4 parts, tin 4 parts, and bismuth 1 part is easily melted; but this alloy may itself be soldered with an alloy of lead 2 parts, bismuth 2 parts, and tin 1 part. By adding mercury a still more fusible solder can be made. Equal parts of lead, bismuth, and mercury, with two parts of tin, will make a composition which melts at 122 Fahr.; or an alloy of tin 5 parts, lead 3 parts, and busmuth 3 parts will melt in boiling water. In mixing these solders melt the least fusible metal first in an iron ladle, then add the others in accordance with their infusibility. To cast strips of solder, pour the molten metal on a flat surface of stone or metal, drawing the ladle along the while to leave a thread of metal of the desired substance.



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PLANT'S GEOMETRIC CHUCK.—PERSPECTIVE ELEVATION.

PLANT'S GEOMETRIC CHUCK.

PART II.

(For Illustrations, see Lithograph Supplement.)

A BOOK on geometric turning, written by the late Rev. H. S. Savory, was published in 1873, in which Plant's geometric chuck is described, and about five hundred and seventy blocks illustrating some of the capabilities of the chuck are printed. This book contains much valuable information on the method of using the chuck, but no attempt is made to describe the construction of the instrument. In fact the author disclaims any intention of giving any account of the chuck, except so far as it is used for producing certain patterns.

The Rev. H. S. Savory cut the whole of the patterns used to illustrate his book, and the blocks printed herewith are borrowed from his work. The writer is also indebted to him for some of the information which is now given on the use of the geometric chuck. As to the force required for working the chuck, the motion of the lathe is so easy when using high numbers that when all arrangements have been made the motion can be kept up by a slight pressure of the foot. When using low numbers, the mandrel turns very stiffly and slow motion is necessary. When the chuck is put together the parts should be screwed up to slide stiffly, as the slightest amount of play will spoil patterns. When the chuck is used simply to face up a block of wood, and has to be revolved fast, the whole of the mechanism must be very carefully balanced. By this simple precaution the vibration is eliminated. It is easy to effect an equipoise by shifting the position of the two upper slides till the eccentric weight balances the overhanging wheels and radius plate of the lower slide.

A horizontal position is more suited to the action of a geometric chuck, and it is often arranged to work in that manner. A special table with a vertical mandrel and an arrangement for holding a pencil or writing tool is all that is required. The chuck is turned by hand, something like a lapidary's wheel, by means of a winch-handle and a band.

An idea of the complicated nature of the patterns that can be produced by this instrument can be formed from Mr. Savory's statement. There is hardly a curve that it is incapable of producing. The field in which, very probably, the forms of greatest beauty lie is that in which the first and second parts of the chuck are used to produce the pattern, and the slide of the third part is used to dispose the patterns in different relations to one another. There is also a very wide field laid open in the use of all the three parts with the low numbers, say from ellipse up to six loops on each part. With the first part you can make from ellipse to seventy-two loops, with the second from ellipse to thirty-six loops, and the same with the third; and each of these can be made internal or external. Each part has a slide, which can be moved eccentrically from zero to 2in. The tool for the cutting may be placed at any distance from the mandrel centre. With these combinations there is enough variety to satisfy the most comprehensive mind.

If the chuck was arranged for all its loops, it would produce 93,312, and 15 hours would be required to complete the pattern with the mandrel running 100 revolutions a minute. Such a combination has probably not been attempted, but it is interesting to consider what the chuck can do.

It might be an exceedingly interesting subject for a scientific person to give an account of the principles on which the chuck works, but it would be of very little or no assistance whatever to the person who aims at using it only for practical purposes. The scientific knowledge required to understand a three-part chuck would be so great that I doubt, says Mr. Savory, if there is a person existing who could describe the course of a line that would be produced by the chuck when all parts are arranged for low numbers. There are four axes, the axis of the lathe, and an axis to each of the three parts; each of these latter may be revolved either way. The epicyclic axis of one part becomes the deferent axis of another part, and it is quite certain that if we have to wait for a scientific knowledge of the chuck before we commenced using it, we shall have to wait a very long time indeed.

The geometric chuck consists of one, two, or three parts. Each part consists of a slide similar to that of the eccentric chuck, but carries a large toothed wheel, which is rotated by a train of wheels; thus each part is nothing more than a self-acting eccentric chuck. The large wheel of the first part of the chuck (*h*, fig. 2) has its motion imparted to it by a toothed wheel (*m*) on the boss of the chuck. This wheel (*m*) is held still by a pointer, that takes into a hole in it (*m*, fig. 5) and holds it fast to the headstock. This wheel gears into another wheel (*o*, fig. 2) and so drives the pinion (*q*). This pinion (*p*, fig. 4) gives motion to the train of wheels which drive the large wheel of the first part. When the first part only is used, every rotation of the lathe mandrel produces one loop. If the detent was not in the hole (*m*, fig. 5) a circle would be produced, the radius of which would be the distance of the cutting point from the true centre. When the detent is in, and the train of wheels are in motion, the first part of the chuck is moved round a certain distance, according to the number of loops arranged, at the same time that the lathe mandrel revolves once. The second part of the chuck is set in motion much in the same way, and the third part is precisely similar to the second. In describing the perspective elevation we will commence at the top, where the nose is, and proceed to the bottom, where there are two wheels shown behind the foundation plate. Where possible, I shall make cross reference to the parts which will be described separately.

Commencing at the nose, we have fig. 18 in perspective. The nose thread is precisely like that on the nose of the mandrel. The wheel, forming the base of the nose, is driven through a series of four change wheels by the small planet wheel projecting from a cannon screwed to the face of the main wheel. This cannon and planet wheel is shown in full size section at fig. 21. Links connect the planet wheel to the radius plate of the top slide (fig. 7). The radius plate is shown fixed to the slide by a square-headed clamp screw. The slide is shown in section at fig. 18, and the screw, which projects from the lower part of it, is shown in full size at fig. 10. The graduated collet shown on the square near the slide is for the purpose of showing the amount that the screw is moved.

The large wheel, concentric with the lathe nose, which forms the base of the first slide, is shown by *b* in fig. 16. The planet wheel, which drives the train shown on the second radius plate, is on the rear side of the chuck, and consequently is not shown. The radius plate is fig. 6. The screw holes shown in it are made to take screws which form the axes of the change wheels. These holes are spaced so as to suit wheels of various sizes.

The slide just beneath this second radius plate is fig. 16. The square end of the screw which actuates it is shown on the right-hand side. This screw is precisely like the one used for the first slide, and shown at fig. 10. Though no marks are shown on the collar of this screw, yet it is graduated in the same manner as the other one. The first and second slides are reversed in position so that the train of wheels which are fixed to the second radius plate are hidden, and, therefore, do not complicate matters unnecessarily. It must be understood that the rear side of the second slide is fitted with the planet arbor and cannon shown at fig. 20, in a similar manner to that illustrated at the right of the first slide.

The wheel which carries the second slide has been shown full size at fig. 14, where it is marked *b*. The sliding piece to which it is fixed is not very conspicuous in the large illustration, but a portion of it may be seen just above the square end of the leading screw shown at the left-hand part of the base plate. One of the strips which form the guides for the sliding piece is shown partly.

The screw, of which only a small piece of the square head is seen at the left-hand part of the drawing, is shown full size at fig. 9. The lower radius plate which projects above the base plate is not illustrated elsewhere, but in form it is like figs. 6 and 7; the size is of course larger. The position of this radius plate is shown at *c*, in fig. 14.

A train of wheels, eight in number, connect the back to front gear with the base wheel of the lower side. Only seven of the wheels are shown, one being covered by another, the largest of the series.

The two wheels in the foreground under the base plate are those marked *c* and *b* in fig. 12. The upper one is a ratchet wheel, and the lower one is driven from a wheel fitted to the centre of the chuck and held by a stop fixed to the front of the head-stock. In fig. 2 these wheels are marked *o* and *p*. The ear projecting on the left from below the foundation plate is part of the plate for the reversing wheels, and shown full size at fig. 8.

The whole of the illustrations numbered from 9 to 20 inclusive, represent parts of the chuck which is shown complete in the perspective elevation. Complete particulars will be found in the descriptive matter specially referring to the particular parts. All these parts have been drawn from the chuck itself, and they are shown full size, so that any one who contemplates making a geometric chuck will find it easy to arrive at correct dimensions, as has been previously mentioned. Messrs. George Plant and Son, of Birmingham, supply the necessary castings, and these may be had in the rough or partially finished.

With a first-class lathe as a foundation, a good workman should be able to construct a geometric chuck from the particulars to be given. It would be mere waste of time to make such a costly and complicated instrument to any but a first-class lathe. In fact, probably the better plan would be to mount the chuck on a specially-contrived vertical spindle, arranged so that the ornamental slide rest could be brought into position for operating.

Every chuck must be made on the particular lathe for which it is intended, in order that it shall perform accurately. The base plate after being screwed to fit the nose of the lathe, is turned up true on the mandrel. It is not possible to get chucks to fit two mandrels and run equally true on both. When the foundation plate is perfectly true, the lower slide is fitted on it, and the ring on which the wheel *b*, fig. 14, fits, is then turned perfectly true. In the same manner the rings on the sliding pieces which receive the main wheels must each be turned on the lathe itself, or their absolute truth cannot be depended upon. The main wheels may be recessed out to receive the rings, and have the teeth cut in the periphery concentric with the recess, without any special precautions for a particular chuck. The dovetail slides may also be made irrespective of their applications. All that is necessary to insure every centre of motion acting truly, is that the projecting ring on the slides must be turned on the lathe itself.

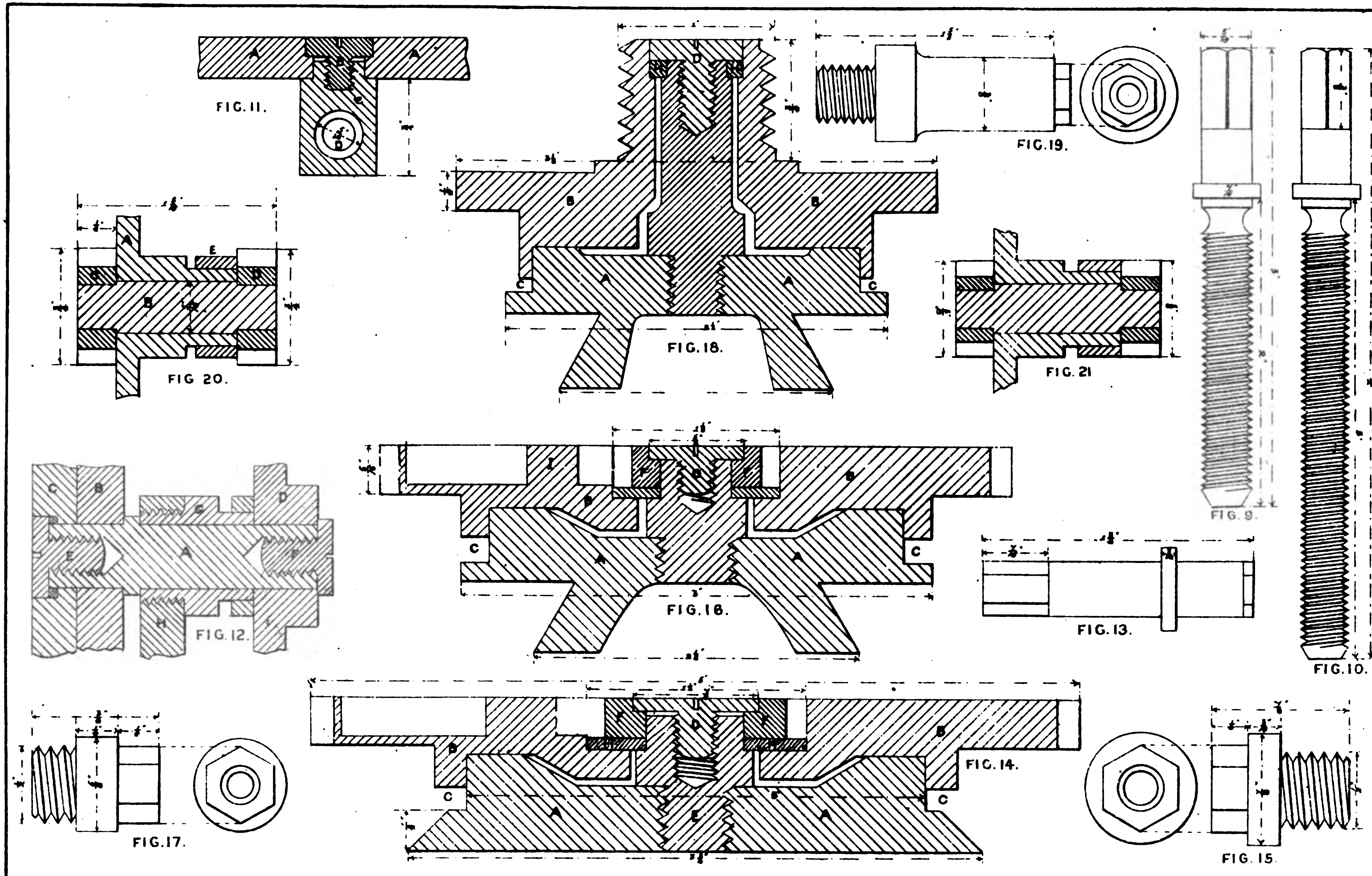
When the sliding piece has been adjusted to fit accurately between the side strips it should be placed as nearly central as possible, and a hole drilled through both the sliding piece and base on which it slides. This hole is carefully broached out to a slight taper, and a pin fitted accurately to it. This pin is used to hold the slide whilst the ring is turned, and subsequently any particular slide, or all of them, may be made to run dead true. This is an important consideration, and must not be neglected when making the chuck, or it will be difficult to rectify the omission. When work is mounted on the chuck for turning, though it is generally fashioned roughly to shape, yet a finishing cut is invariably necessary. This is always taken with the slides all at centre, and to insure this the taper pins are both easy and efficacious to use. To adjust the position of the slides by means of the leading screws is a tedious and unsatisfactory operation compared with the taper pin method.

The practical application of the chuck for cutting various patterns can only be learned by experiment. Savory's "Geometric Turning" contains much useful information, a sample of which I have transcribed. It is, however, difficult to follow the meaning of the author without having a chuck beside one to put the instructions into practice. Some elementary information as to the figures formed by each motion, and the effect of combining various motions would be very acceptable to any one desirous of studying the action of the chuck. These have yet to be furnished by someone.

The construction of the chuck I have endeavoured to make clear, and the few hints that I have given on its application may suffice for the present. The foregoing particulars, together with the drawings which they describe, will enable any one to attempt the construction of the chuck with a fair chance of succeeding.

Elegant Little Tables are now covered in deep crimson plush, and the bordering, instead of being equal all round, is in panels, some long, some oval, and others short and square. Upon the surface of the table a design in flowers is worked in fine ribbons, while leaves and tendrils are in arasene. Each panel is finished off with tassels of different colour, to match the design, and they depend from brass ornaments in the shape of a crescent. These brass crescents are very much in favour for ornamenting lambrequins, bracket hangings, and the many decorative objects to which needlework is devoted. They make a very pretty finish to fringes, etc.

Velocities of Wood-working Tools.—The velocities required for wood-working machinery are as follows:—Circular saws at periphery, 6,000 to 7,000 feet per minute; band saws, 2,500 feet; gang saws, 20in. stroke, 120 strokes per minute; planing machine cutters at periphery, 4,000 to 6,000 feet. Work under planing machine $\frac{1}{16}$in. for each cut. Molding machine cutters, 3,500 to 4,000 feet; squaring up machine cutters, 7,000 to 8,000 feet; wood-carving drills, 5,000 revolutions; machine augers, $1\frac{1}{2}$in. diameter, 900 revolutions; ditto, $\frac{3}{4}$in. diameter, 1,200 revolutions; gang saws require for 45 superficial feet of pine per hour, 1 horse-power. Circular saws require 75 superficial feet per hour, 1 horse-power. In oak or hard wood three-fourths of the above quantity require 1 horse-power. Sharpening angles of machine cutters—adzing soft wood across the grain, 30°; planing machines, ordinary soft wood, 30°; gauges and ploughing machines, 40°; hard-wood tool cutters, 50° to 55°.



Whiteman & Bass Photo Litho London

PLANT'S GEOMETRIC CHUCK — DETAILS IN SECTION.

mathematical rules for forming curves such as this, the hand and eye can produce them, without difficulty, to please cultivated taste.

If a turner was given a detailed drawing of a piece of work such as this, and told to work exactly to it, he would make a reverse or template from the drawing; he could then produce any number of exactly the same pattern. In like manner the stone cutter making round balusters by hand would work with a reverse mould, thus making them all alike in outline.

Now, the amateur, in practising on a bit of work of this kind will do well to train the eye, in working the body of his baluster. It is worked down to near the finishing size with the gouge, beginning at the largest diameter and working down on the right to fillet 4, and on the left to the astragal—where the body is finished same diameter as the neck.

It is a fixed rule that in order to cut the wood with the grain every projecting member must be cut away from its *centre* right and left, and every hollow or reversed member cut from its *sides* and finishing in its centre. To make this more clear, I refer you to figs. 11 and 12. In fig. 11 *a*, *b*, *c* is a torus bead on a plain cylinder. This would be formed by working from the crown at *a* towards *b* on the left, and from *a* again towards *c* on the right. In fig. 12, which shows a hollow in a cylinder, the cut is made from either side and finishing at the bottom. At the beginning of the cut at *a* and *b* the gouge is turned on its side and is gradually turned till on reaching *c* it has its hollow side up. To turn out a hollow like this, with the gouge always on its back, would be to tear out the wood, making a very rough job and leaving ragged edges at *a* and *b*, so there is all the difference in the world between cutting and scraping—cutting is turning, scraping is not—and with reference to our baluster, the more cutting in the process of manipulation the easier will it be to finish with sandpaper. A good turner would make it so smooth and clean cut with the tools that a very light sandpapering would suffice to finish it. A bad turner would labour with various grades of paper, trying in vain to make a smooth job, and succeeding only in rubbing off all the clean, sharp angles which always mark the finest and best specimens of turned work.

In addition to the foregoing, I have to show three different specimens of the very simplest of turned objects. Figs. 5 and 6 are ball feet. Ball feet are used on numerous articles, such as dressing glasses, foot stools, fern-cases, bird cages, &c. Fig. 13 is the simplest of all ball feet, and is found upon small boxes, caddies, and the like. It may be an inch in diameter as for a caddie, and 2½in. or 3in. as for a dressing glass. It is cut from the wood plankways with a bow saw, a hole is bored in the centre, and it is fixed on a screw chuck for turning in the lathe. This screw chuck is a very simple affair. It is simply a small block of wood fixed to the ordinary face-plate, and turned up true. In the centre of the face a common wood screw is secured, having about ½in. of its point projecting. If this is properly done, the screw will run true. The face of the chuck may be reduced to about an inch diameter; on this the circular pieces for ball feet are fixed, and as it is only the edge or periphery that is turned, you get readily round it on account of the narrow-faced chuck. In turning ball feet, the tools must be very sharp—as the wood running plankways presents, when revolving, two sides of side wood and two of end wood to every revolution. So in turning it is more of a scraping process. The rest is raised somewhat above the centre, and the chisel lies flat on the rest, with the handle somewhat lowered. With a blunt tool the wood, particularly on two sides, is only torn up, and will never paper smooth. These ball feet are fixed on to their destined places with screws passing through them.

Fig. 14 is a ball foot, with a fillet on the underside. This is an improvement when a somewhat high ball is wanted. It is fixed on in the same way as fig. 5.

Fig. 15 is another foot which is much used for chests of drawers, chests, and boxes. It is composed of a torus, an astragal, a hollow, and three fillets. It is hardly ever less than 4in. or 5in. diameter, and about the same height. It has a tenon for fixing to its purpose, and, unlike the ball feet, its grain runs lengthways, consequently it is turned between centres. The tenon is usually an inch or more in diameter. To gauge the tenon, a centre-bit is selected, a hole bored with it in a bit of wood, the hole is callipered, and the callipers used to gauge all the tenons of one diameter, so as they will make a good fit when glued in.

The operation of turning these three last objects is precisely the same as that given for the turning of the baluster.

PLANT'S GEOMETRIC CHUCK.

PART III.

(For Illustrations, see Lithograph Supplement.)

THE lithograph published herewith shows sectional details of various parts of the three-part chuck. The drawings are made to scale, and are full size.

The screws which actuate the sliding pieces are shown full size in figs. 9 and 10. They are precisely alike in all respects, except length. The one used to actuate the sliding piece on the foundation plate, marked *j* in the back view fig. 5, is shortest. It measures 3in. from end to end. The collar which confines the lateral motion leaves 2in. of threaded part. The other screw shows the size of those used in the other slides. Two are required in the three-part chuck, but only one in the two-part chuck. The square ends of these screws are shown in the side view of the latter chuck. (See fig. 2.)

The following measurements apply to all the leading screws:—Diameter of collar $\frac{7}{16}$in.; diameter of thread and shoulder part to where squared, $\frac{5}{16}$in.; thread, 20 to an inch, cut deep, as is usual in apparatus used for ornamental turning. This rate (20) is useful as affording an easy means of adjusting the eccentricity of the slides to decimal parts of an inch. It is also just double the rate of the usual slide-rest screw. The square end of the screw is as large as the metal will allow; it is ⅝in. long. A collet about ⅛in. thick is fitted on this square, and its edge is divided to form an index when altering their slides. The method by which these screws are held in position is this: A cannon is made to fit on the shoulder, its exterior diameter being the same as that of the collar. The lower part of the collar bears against the casting, which is bored out to receive it. The cannon is held by a pin passing through the casting, the hole for which is drilled at the diametrical line. The cap bearing shown screwed on the foundation plate may be recessed out to receive the collar, and so save the trouble of fitting the cannon. In the illustration, fig. 2, a plate secured by two screws is shown holding the leading screw. Either plan for confining the end motion of the screws may be adopted.

The nut for the leading screw of the lower slide, which is shown by *l*, fig. 5, is shown full size by fig. 11. The sliding plate of the lower slide *j*, fig. 2, is marked *a*. The nut *c* is held against it by the screw *b*, and *d* is the hole for the leading screw. The nut itself is a piece of gun-metal, about ½in. square, and ¾in. long over all. A short length is turned circular, to fit in the hole through the plate under the head of the screw *b*. It is not necessary to fix these nuts by screws; and the other two, those in the two upper slides, are simply fitted into holes as in the illustration, the screw being omitted, and the circular part made longer, so as to get a better hold.

Fig. 12 is a full-size sectional view of the gearing which conveys the motion from the back to the front of the foundation plate. Fig. 3 shows the position of the part where the arbor is marked, *t*. In fig. 12 this is *a*, and it is also shown full size in elevation at fig. 13. This arbor is 1¾in. long, ⅜in. diameter, having a collar ½in. diameter and about 3/32in. wide. At one end it is squared for a distance of 1/16in., and at the other it is shaped hexagonal a length of 7/16in. The hexagon is about 5/16in. across its faces. Referring to fig. 12, *a* is the arbor already described. Tapped into the two ends are the screws *e* and *f*, which secure the wheels *c* and *d* respectively. The wheel *b* is fixed on the arbor against the shoulder. It is a ratchet wheel, and has 72 teeth. The wheel *c*, marked *q* in fig. 3, turns on the arbor *a*, and is held by the click on its face, which catches in the wheel *b*. A reference to fig. 3 shows this arrangement at *q r s*. *D* is a change wheel. (*Q*, fig. 2.) It has a hexagonal hole, which fits the arbor, and it is held by the screw *f*. Wheels of various diameters are put in the place of *d*, according to the patterns which are to be traced.

The foundation plate is marked *h*, and into it the cannon *g* is screwed. This cannon is made of steel, and turned to the shape shown. It screws firmly into the foundation plate against the shoulder, and at its lower end forms a bearing for the collar of the arbor. Its front end is turned down to receive a washer *i*, and on the space between this washer and *g* the link to carry the change wheels is fitted. The front side of *i* is level with the end of *g*, and these form a shoulder for *d*, so that the end motion of the arbor *a* is confined. *I* fits tightly on *g*, and is adjusted by hammering when the arbor is removed. The link, though free to move, should be tight between *i* and the shoulder *g*.

Fig. 13 shows, in elevation, the arbor marked *a* in fig. 12.

A section of the lower sliding piece, and the wheel which revolves on it, is shown at fig. 14. The drawing is taken from the centre of the entire mechanism. The sliding piece is marked *a*. This is marked *b* in the two part chuck, shown at fig. 2. The section being full size, measurements can be taken from it. The plate is ¼in. thick, with the edges bevelled off to fit the dovetail slides. The extreme width is 3¾in. Solid with the plate is a projecting ring 3in. in diameter. This ring is in the centre of the sliding plate. Its periphery is turned true to receive the wheel *b*, which fits it accurately and turns on it smoothly, without shake, when actuated by the first series of change wheels. This wheel *b* is 5in. in diameter, and 5/16in. thick on the edge. It has 120 teeth, of the same pitch as the change wheels. It is fitted on the outer edge of the ring on the slide, and on its top surface. (See illustration.) The central part is quite clear, and no attempt must be made to fit any other parts but those named, as it would only end in failure.

The space below the ring on *b* is to allow the radius plate, fig. 6, to swing. This is confined sufficiently to prevent absolute shake, but on no account must the bearing of *a* against *b* be prevented by the thickness of the radius plate. The plate itself is held by clamp screws, as explained in the description of fig. 6. The wheel *b* is held against the face of *a* by the screw in the centre. This screw *d* is tapped with a stud, which is screwed into *a*, and forms the centre of the whole arrangement. This stud is shown in elevation by fig. 15, where its top view is also given. It will be seen by a glance at this last figure that the stud consists of a threaded part which screws into *a*. It has a round shoulder about 3/16in. thick, and a hexagonal part ¼in. high.

Turning back to fig. 14, *e* is this stud in section. The round part is shown quite free from contact with the wheel *b*, as it must be. The hexagonal part serves to receive the wheel *f*. This is 1½in. in diameter, and has 36 teeth. Under it is a steel washer marked *h*. This is fitted carefully on to the hexagon, and bears against the recessed part of *b*. The washer thus forms the bearing which keeps *b* in contact with *c*. The wheel *f* is recessed out to receive the head of the screw *d*. By adjusting this, the amount of freedom of *b* on *a* can be regulated.

The wheel *f* is the centre of the sun-and-planet motion, and the semi-circular recess shown in the left-hand side of the wheel represents the hole sunk into *f* to receive the wheel marked *w* in fig. 3, and shown full size in fig. 12. The solid sectional part, a pin, is left solid on the wheel *b*, and having a groove sunk all round it to contain an idle wheel, which revolves on the pin, and conveys motion from *f* to the planet wheel. The recesses are shown ¼in. deep to clear wheels of that thickness, the central wheel being a trifle thicker for additional strength, and under it the washer is seen. The centre of the wheel *b* is considerably thicker than its edge, so that the extra depth of the recess containing *f* and *h* will not weaken the wheel. This completes the description of fig. 14.

The stud, fig. 15, is ⅞in. high. The thread is ½in. diameter, its length being governed by the thickness of the central part of the sliding piece into which it screws. (See section, fig. 14.) The round part forming the shoulder is ¾in. in diameter. The hexagon measures about 1 1/16in. across the flats. The screw (*d* in the section) is 5/16in. in diameter, with a head ⅞in. This stud is marked *f* in fig. 3, and *e* in fig. 14.

The second slide is shown at fig. 16. In its general principles it is precisely like the one last described. The measurements, of course, differ. The sliding piece *a* is fitted in dovetails, but it has a flat plate on the top, which projects. The width of the plate is 3in., and the web cast solid with it is 2⅜in. wide at the widest part, tapering to 1½in. at the narrowest; the height of the dovetail is ½in. In fitting this slide it should be made to bear on the tops of the strips, which afford a much better surface than the lower part of the web. In every way the first-mentioned method of fitting this form of slide is best. It gives a larger bearing surface and supports the slide at its weakest part. It is somewhat surprising that some makers of slides have failed to understand this fact, or at all events some do not fit in the correct manner. The wheel *b* is similar to the one described in fig. 14. It is 4⅛in. in diameter, and has 96 teeth. The thickness is 5/16in. The space for the radius plate, fig. 7, is shown at *c*. *D* is the screw which holds the wheel *b* on its place. *E* is stud, shown by elevation and front end at fig. 17. The wheel fitted on to the hexagonal part of this stud marked *f* has 24 teeth, and is 1⅛in. in diameter. The washer *hh* serves the same purpose as the one in fig. 14. The pin has also been described. The slide *a* is represented by *h* in fig. 3, but the wheel *b* has no counterpart in the two-part chuck.

The stud, fig. 17, has a thread ½in. diameter. The plain part is ⅜in. diameter, and the hexagon about 7/16in. across the face. The total length is ¾in., the thread, plain part, and hexagon each taking an equal share, the thread being perhaps a trifle longer according to the thickness of the casting in which it is screwed. This short stud is replaced by the long one illustrated by fig. 19 in the two-part chuck. The latter stud is marked *l* in fig. 3.

The top slide is figured No. 18. *A* is the slide. It is 2½in. wide. The dovetail is 1¾in. wide at the lowest part, and tapers like the last figure. This slide is fitted in the same manner with the bearing on the tops of the strips. The wheel *b* is solid with the nose-piece on which the chucks screw. The wheel is 3⅜in. in diameter, and has 72 teeth. It is ¼in. full in thickness. The ring on *a*, to which the wheel is fitted, is 2⅛in. in diameter. *Cc* show the space for the radius plate. *D* is the screw tapped into the stud *e*. This is shown in elevation at fig. 19. *H* is the washer fitted on the hexagonal part of the stud.

The stud, fig. 19, is 1⅜in. long; but its length will be determined by that of the nose screw, which is a duplicate of the one on the nose of the mandrel. A ⅜in. thread will hold the stud in the casting; the shoulder may be ⅝in., and the plain part from ⅜in. to ½in., according to the diameter of the nose. An end view of the stud is shown together with it at fig. 19. The screw in the end is ¼in. in diameter, and the hexagonal part nearly ⅜in. This stud is *l* in fig. 3, where it is much longer, through the nose having a ratchet wheel extra.

Fig. 20 is a full-size section of the planet arbor and wheels of the second slide. It serves the same purpose as fig. 12. *A* is a metal casting, with a cannon on it, through which the arbor *b* passes. *A* is secured on the face of the wheel *h* by two screws through the flange. This flange is shaped to the same form as the wheel itself. The two wheels on the arbor *b*, marked *c* and *d*, are fixed by feathers and keyways, or by octagonal fitting, or in some such manner. They are alike in size, having 16 teeth each, and are about ¾in. diameter. A collar or washer *e* fits on the cannon of *a* to hold the link, which goes on at the bottom of *e*, where the space for it is shown. The arbor *b* is $\frac{5}{16}$in. diameter, and $1\frac{5}{32}$in. long. The wheels *c* and *d* are ¼in. thick. The other measurements are for the most part arbitrary, but a general idea of the proportion will be gleaned by inspecting the illustration. This planet gear is shown in fig. 3, where *y* is the arbor and *w* and *x* the wheels *c* and *d*. Screws are shown in the arbor at fig. 3, but they are not necessary, and not shown in fig. 20.

Fig. 21 is the planet wheel of the third slide. It is in every respect the same as the one last described, excepting inasmuch as the difference of measurements. In this the wheels at the ends of the axis are the only essential smaller parts. The cannon and the arbor may be the same size, but the wheels have 12 teeth only, and measure about ⅜in. in diameter. It will not be necessary to letter and describe each part of this drawing, as it is but a duplicate of fig. 20 in all respects but the one named, and will therefore require no further explanation. This mechanism does not exist in the two-part chuck.

The two-part geometric chuck will be illustrated and described in the next article.

Oil for quick-running Machinery.—A correspondent writes:—"I will say that I have used sperm oil and mineral oil mixed, ⅓ sperm to ⅔ mineral, and have obtained better results than when I have used either alone. Of course the proportion may be varied, but the mineral oil has a heavier body than sperm, and one is too light while the other is too heavy, and a mixture of the two will give the best results."

CAPT. R. PUDSEY DAWSON'S SLIDE-REST FOR CUTTING GEOMETRIC FIGURES.

(For Illustrations, see Lithograph Supplement.)

THE rest is made on the same principle as the ordinary slide-rest for ornamental turning, only it has two slides; the upper slide carries the tool holder for the fixed tool, eccentric, drill, and other cutters, all of which can be used with the apparatus. The top slide has a screw to traverse the tool carriage; the lower slide has a spiral spring in the place of a screw, which is fastened to the right-hand end of the top slide by a steel pin; the other end of the spring passes through a small hole at the end of slide, and is kept in position by a nut and washer that screws on to the end of the steel spring. When the upper slide is pressed against the spring, it oscillates from the elasticity of the spring. At the back of the tool carriage there is a steel arm firmly screwed on to the end of slide, and at the end of this arm is fixed a small steel rubber, which acts against the cams. On the left-hand of the lower slide is a transverse slide, which moves along the slide as required, and is fixed with a set screw underneath; this slide carries a spindle, and the end nearest the lathe head has a screw cut on it and fitted with nut and washers, and carries any of the change wheels of the spiral apparatus.

Motion is given to the spindle by a tangent wheel and screw when the revolving cutters are used, but when a fixed tool is used motion is given by a winch handle that fits on to the square end of spindle, the tangent screw being then thrown out of gear. On this end of spindle a boss is fitted that carries the various cams.

To actuate the apparatus you first set the tool—say a fixed one—at centre, then push the slide that carries the cam forwards till the rubber on the tool slide presses against the cam—the spring is now extended; fix the slide by the binding screws underneath the slide.

Put a 72-wheel on the end of spindle, and 144-wheel on spiral chuck, an intermediate wheel on the radial arm to complete the connection; advance the cutting tool and regulate the depth of cut; turn the winch handle at the end of spindle, and the apparatus is put in motion, and the result will be a six-looped figure if you have an oval cam on shaft, the tool being moved 12 turns out from centre.

The patterns that can be cut from one cam by altering the change of wheels are endless.

When you use the revolving cutters in place of the fixed tool you actuate the apparatus by the tangent wheel, and regulate the fineness or coarseness of the pattern by the divisions of the micrometor screw, moving two or one or half a turn for each cut. Now withdraw the tool, move one turn and cut again, and so continue till the pattern is completed. There is no difficulty in working the apparatus, and after you have once arranged it you can cut the most intricate geometric figures in a few minutes. Should you make a mistake all you have to do is to take out the revolving cutter, put a round nose tool in tool slide and face up the material without disarranging the apparatus further than throwing the wheels out of gear; replace the revolving cutter, and you are ready to start again. This is a very great saving of time.

The illustrations show some specimens of the work done with this rest. When I cut the patterns I did not take a note of the settings, consequently cannot tell for certain what eccentricity was given to the

TOUCHING UP REPAIR WORK.

A CORRESPONDENT to "The Blacksmith and Wheelwright" writes:—Blacksmiths and woodworkers have occasion quite often to touch up their repair work with paint, when there is not time for the job to be finished in the paint shop. Some men have paint dishes in the shop to use themselves as may be necessary, while in other shops the painters attend to these things. Very often this takes a painter away from something he can't leave very well, while some of the other hands could have done it while he was coming downstairs. But blacksmiths and woodworkers generally daub up and do more damage than good in their attempts at painting. We have a spoke or two that must be used immediately; if it is black we generally put on black varnish, but paint, dark lead or something heavy would be much better. Black varnish will come off gradually and won't keep the grain from raising; of course it has a little shine, but you can't get one coat on very well without making it look streaked. So take it on the whole it doesn't look very well, and it is in no shape to paint up again.

But whatever is put on should be applied properly; if you have a large brush and the paint or varnish is old and sticky, and you daub all over, it looks bad, besides making lots of work for the painter when the job comes to be painted. You can't get this stuff off, or a spat of it when it gets dry without the use of a sharp knife, and you can hardly ever succeed in preventing a spot that will show always. The paint should be mixed with oil, japan and turpentine in equal parts, or keg lead mixed with japan and turpentine. It should be mixed up once a week, so to be fresh, and dry quickly and well. Have an inch and a half bristle brush, not an old stick of a thing, but a good brush, and keep it soft in the paint or water. A spoke is about the worst thing to get around without touching the hub or other spokes, but take a brush part full of paint and put down as near the hub as possible, then tip up the brush a little and work crosswise of the spoke and you will touch all bare wood without getting on the old paint. If you should, why wipe off with a rag or finger. Go around the butt of the spoke in this way, then at the felloe to the same, cutting close, and then fill in between hub and felloe and smooth up nicely. This will perhaps take a moment longer on a spoke, but it will be enough better to pay.

When a smith heats an iron that has been painted, and dosen't heat the whole of it, the paint will fry up back a little way, and cinders will stick. These should be filed or sand-papered off, and dusted or rubbed off with the hand before the paint is applied. If you will only take a little pains and work slow around these places at first you will soon get so you can do it about as quick as if you were merely daubing. One should take as much pains in patching up a job as he would in making a new article, but there are not many who do. When taking off clips on irons on a painted job the paint is liable to break up away from the clip. Now if you will take a knife with a sharp point and cut around the clip it will come and go right back, and will not need to be touched up. When hammering or pounding on a painted iron or surface, take a piece of harness leather and hold under the hammer; remember that an ounce of prevention is worth a pound of cure.

Black Wax.—Add one ounce of beeswax to half an ounce of Burgundy pitch; melt them together, and add one ounce and a half of ivory-black, ground very fine, and dried.

PLANT'S GEOMETRIC CHUCK.

PART IV.

(For Illustrations, see Lithograph Supplement.)

REFERRING to fig. 2, *a* is the nose screw, cut to precisely match the thread on the mandrel. On this the work is mounted for turning. *B* is the shoulder, against which the chucks are screwed, and it should match the shoulder on the mandrel. *C* is the ratchet wheel, having 96 teeth, marked *m* in the sectional drawing. *A b* and *c* is a solid casting, the wheel being about 3in. in diameter. *D* is the wheel revolved on the slide *f* by gear wheels from the wheel *r*. *D* is shown in section at *k*. The smaller radius plate is seen on edge at *e*. The portion marked *f* is the sliding piece, actuated by the screw with the square end. This slides between the strips *gg*, screwed on the wheel *h*. The section of the slide *f* is shown by *h* in fig. 3.

The wheel *h* is shown in section by *e*. Immediately behind it is the larger radius plate. *J* is the sliding piece, fitted between the strips *kk*. It is marked *b* in the sectional view, and is actuated by the screw shown at the back of the foundation plate *l*. *M* is the wheel fitted on the boss of the chuck, to which it is secured by the ring nut *n*. This wheel is held stationary by a spring catch whilst the chuck is revolved. *O* is driven by *n* through wheels shown in fig. 5, but not shown in this cut, these forming a reversing motion, driving either backwards or forwards as may be required. *P* is the ratchet wheel, allowing any adjustment of *o*, and carrying the spindle, having at its other end *q*, shown by *s* in the section. *R* is the wheel which receives motion from the centre of *h* and communicates it to the wheel *d*. *R* is shown in section by *s*.

These two figures should be referred to together, as they will thus be the more readily understood. The various small fittings, which are of a complicated nature, have been shown on an enlarged scale, and have a more extended description where specially shown as belonging to the three-part chuck. The mode of fitting up this chuck is precisely similar, and it only differs inasmuch that one of the sliding pieces and the gearing and other parts incidental to it are omitted. This saves a corresponding amount of labour in the making, and for this reason a two-part chuck would probably be made in preference to the three-part chuck. The additional slide could be fitted to the two-part chuck when desired.

A reference to the sectional illustration, fig. 3, will enable the reader to recognise the various parts as lettered, and which we now proceed to describe, and give dimensions of. *A* is the foundation plate on which the entire chuck is constructed. It is a circular disc $\frac{5}{16}$ of an inch thick and 8 inches in diameter. Cast iron answers the purpose, but brass or gun-metal looks better, and is easier to work. The extra cost of this latter material is scarcely worth considering when the value of the entire chuck is reckoned. On the back of the disc and solid with it is the boss, into which the lathe nose screws. This should be long enough to prevent the possibility of the nose projecting beyond the level of the front surface, but otherwise the shorter the better. In every case a chuck should be kept as near to the lathe nose as possible, and this ruling applies with even more force to such chucks as this one, which must necessarily be prolonged to a considerable distance beyond the lathe nose. When making a geometric chuck the foundation plate *a* is the first part to be finished.

The first sliding piece on the chuck is marked *b*. This is a plate 8 inches long and 3¾ inches wide. Its edges are dovetailed to slide between strips fixed on to the face of *a*. A quarter of an inch is sufficient thickness for this sliding plate *b*, and its ends are turned concentric with the foundation plate. In the centre of *b* a projecting ring is cast on solid, around which the wheel *h*, fig. 2, revolves. The exterior diameter of this ring is 3 inches, and it projects from the surface of the slide ⅜ of an inch. The central part is hollowed out, as shown in the illustration, leaving a thickness of about ⅜ of an inch in the centre to hold the stud marked *f*. A full size illustration of this stud will be found in the description of the three-part chuck.

The strips which hold the slide are marked *cc*. They are bevelled off to match the slide, and are each held by three screws to the foundation plate. These are shown marked *n* in the back view fig. 5. The screws may be tapped either into the strips or into the plate, but they are generally put through from the back. Steady pins at each end of the two strips are the best means of securing them, perfectly parallel, with the certainty of replacing them precisely as before, when the chuck is taken apart for any purpose. None of the slides require any means of adjustment, as they are not much used. The strips are about ¾ of an inch wide, and the same thickness as the slide, viz., ¼ of an inch.

A radius plate is shown at *d*. This plate fits on the projecting ring of the slide *b*. It is secured by clamping screws, slots for which are shown in the figure just named. The plate is nearly $\frac{3}{16}$ inch thick. It is made of brass or gun-metal usually.

The wheel *e* is fitted on to the ring on *b* to revolve smoothly without any shake. It is held down by the screw *g*, tapped into the stud *f*. The wheel is 5 inches in diameter, and has 120 teeth. It is $\frac{5}{16}$ inch thick on the edge, the projecting piece, which fits on to *b*, being about $\frac{3}{32}$in. above the back surface. The front carries the two strips *ii*, which are secured by two screws each. The surface is recessed out to allow the wheels *v w* and *o* to be contained in it below the surface. These wheels are more fully explained in another figure, which should be referred to. (See sectional drawing of lower sliding piece in the three-part chuck.)

The strips *ii* form bearings for the sliding piece *h*, which is similar to *b* already described. The slide *h* is 5 inches long and about 1¾ inch wide between the dovetails. The part above the slides is extended to 3 inches, and thus allows a projecting ring 2⅜ inch in diameter. On this the radius plate *j* is fitted.

The wheel *k* revolves freely on *h*, as *e* does on *b*. The central stud *l*, screwed into *h*, forms the axis on which *m* turns. It will be seen that *m* is a wheel having a projecting stud cut to match the nose of the mandrel, and on this any work to be treated on the geometric chuck is screwed. The edge of *m* is cut with ratchet teeth, usually 96, and a click fixed on the face of *k* allows the work to be turned round independently of the chuck and set to any required position with respect to former patterns. Fig. 4 shows these details as seen from the face.

The stud *l* is screwed into *h* tightly. Its front end is made hexagonal, to take the washer shown beneath the screw *n*. It is necessary that this washer be fitted to the stud, or when the wheel *m* is moved it will be apt to turn the washer with it, and tighten or slacken the screw *n*. A full size illustration of this stud has been given in the plate illustrating the details.

Referring back to the other side of the chuck, *o* is a wheel fitted on to the boss on the foundation plate. It is secured in its place by the nut *p*, which is a plain ring, screwed on to the boss against a shoulder, as seen in the drawing. The wheel *o* turns freely on the boss, and is precisely like the wheel *q* —that is, each is 3½ inches diameter, and has 84 teeth. These wheels are about $\frac{3}{32}$ inch thick. *O* has a hole drilled into it, by which it may be held with a catch whilst the chuck is revolved. This is shown in another illustration, fig. 5, where all these details are shown more clearly.

The spindle *t* is fitted to revolve freely in a cannon screwed into the base plate near its edge. The wheel *r* is fixed on to this spindle. This is a ratchet wheel with 96 teeth, and the face of the wheel *q* carries the click. The click and ratchet wheel afford the means of adjusting the position of the patterns to be cut in the same way that *m* is used. *Q* is held against *r* by the screw, as shown, which has a washer, fitting the square end of *t*, beneath its head.

The small wheel *s* is fitted on to a hexagonal part of *t*, and secured with a screw. Thus *s* is always revolved together with *r*, and it is through *t*, the axes of these two, that motion is conveyed to the wheel *e*.

The cannon which carries *t* forms a centre, on which the link carrying the gear wheels from *s* to *e* turns. The radius plate *d* also carries the last wheel, which gears into *e*.

In the centre of *e* is the wheel *o*. This wheel is fitted on to the stud *f* hexagonally, and turns with it irrespective of the motion of the wheel *e*. The wheel *o* forms a bearing for *e*, and keeps that wheel close against the surface of the ring on *b*. The screw *g* secures the wheel *o* on the stud. A steel washer is usually put between *o* and *e*. The illustration, showing an enlarged view of the stud *f*, makes the details more plain.

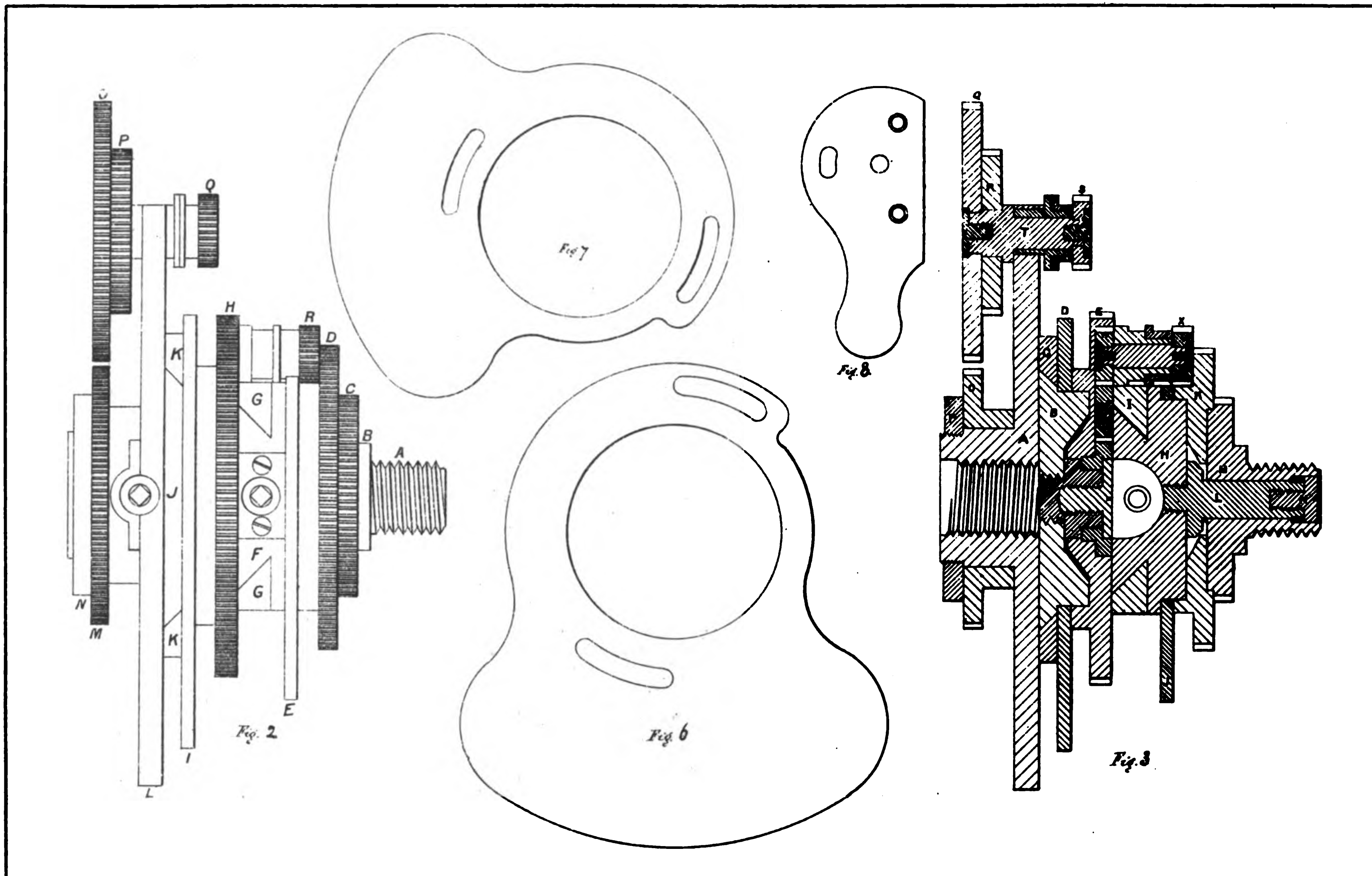
The wheel *o* is about 1⅜ inch diameter, and has 32 teeth. It is about ¼ inch thick, but should be as thick as possible, compatible with leaving sufficient substance behind the wheel *v*. The central stud on which this wheel turns is solid with *e*, though by an error it is not shown so in the engraving.

The wheel *v* is simply an idle wheel, which conveys motion from *o* to *w*. It is 1⅛in. in diameter, and has 24 teeth. The stud on which it turns is solid with the wheel *e*. Though the wheel is shown secured to the stud by a small screw, this is not necessary, as the strip *i* prevents the wheel coming off, which is all that is required, as the wheel *v* has no force moving it sideways.

The wheel *w* is secured to the spindle *y* by riveting. It is ¾in. in diameter, and has 16 teeth. The recess in the face of *e* is turned or bored out of the solid metal sufficiently large to admit the wheel. The spindle is fitted in the cannon held on the face of *e* by the screws. The wheel *x* is put on to the other end of *y* by a hexagonal fitting. It is held by a screw as shown. The spindle *y* and its fittings are shown in detail in a subsequent fig. The screw shown in fig. 3, as holding *w* on *y*, is unnecessary if the wheel is riveted as stated above.

The wheel *x* conveys the motion from *o* to the wheel *k* through wheels fixed on a link frame, centred on the cannon containing *y*, and reaching the radius plate *j*, which is shown at fig.

The foregoing description will explain the construction of the chuck figured in section in fig. 3. The same is shown in elevation by fig. 2, and to this I have referred. Each part will be recognised from the description given of fig. 3, this being the sectional elevation.



Whiteman & Bass Photo-Litho, London

PLANT'S GEOMETRIC CHUCK: SECTION AND ELEVATION OF TWO PART CHUCK, &c.

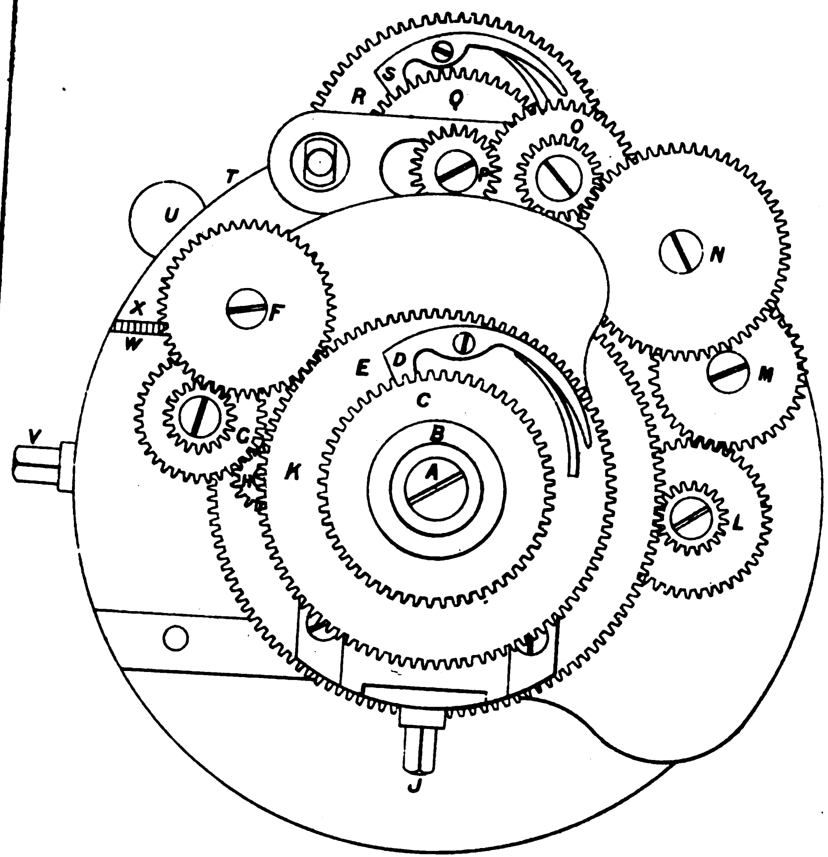


FIG. 4.

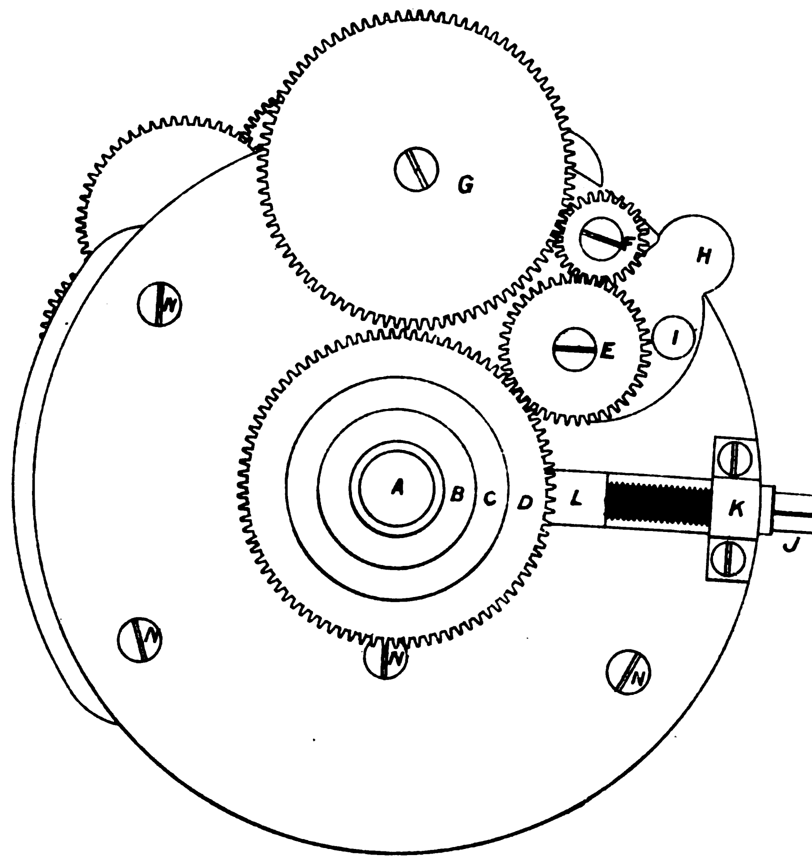


FIG. 5.

Whiteman & Bass Photo-Litho. London

PLANT'S GEOMETRIC CHUCK: FRONT & BACK OF TWO PART CHUCK.

PLANT'S GEOMETRIC CHUCK.

PART V.

(For Illustrations, see Lithograph Supplement.)

IN continuation we now give other illustrations of the complete two-part chuck, showing the back and front.

Fig. 4 is a front view of the two-part chuck. It is the reverse side of fig. 5, the circle representing the foundation plate. *A*, *b*, and *c* show the nose, the shoulder, and the ratchet wheel respectively, and correspond with the same letters on fig. 2. These parts have been already minutely described. *D* is a click, which engages in the teeth of *c*. It is shown fitting two spaces, thus distributing the pressure on two teeth. Perhaps this is unnecessary, more especially if the wheel *c* is a thick one. The wheel *e* is shown by *d* in fig. 2, and needs no further description. *F* is an idle wheel, which is fixed on the radius plate, and transmits motion from *g* to *e*. *G* is a wheel, solid, with the pinion seen below it, and driven by *h*. *H* is the planet arbor of the sun-and-planet motion of the second slide. It is marked *r* in fig. 2. The sliding piece which carries the wheel *e* is marked *i*. It is actuated by the screw *j*, a full size drawing of which is given at fig. 10. This sliding piece is shown better in fig. 2, where it is marked *f*. *K* is the wheel on which the strips of this sliding piece are fixed. It is marked *h* in fig. 2. *L* is a wheel and pinion, screwed to the radius plate, which drives *k*, the motion being derived from *p*, through the train of wheels *m*, *n*, *o*. *P* is the wheel fixed on the arbor, shown by fig. 13, and marked *t* in fig. 3. *Q* is the ratchet wheel fixed to the same shaft and against the face of the wheel *r*, to which the click *s* is fixed. This click engages in the teeth of *q*. The small portion of the wheel marked *t* is shown by *f*, fig. 5. *U* is the plate which takes the reversing wheels, only a small piece, just enough to take hold of, projecting. The leading screw of the first slide is marked *v*. (See fig. 10 for full-size drawing.) *W* is an engraved scale, by which the amount of eccentricity of the first slide can be read against the strip *x*. The other illustrations, figs. 2 and 3, should be referred to together to identify the parts more readily. A side view, section, and back view, are given in figs. 2, 3 and 5, respectively.

Fig. 5 is a back view of the chuck. The large circle is the base plate. *A* is the thread by which the chuck is attached to the mandrel nose, *b* being the shoulder. A reference to the elevation of the two-part chuck (fig. 2) will render an explanation of the details easier. *C*, fig. 5, is the screw collet *n*, fig. 2, the wheel *m* being marked *d* in the back view. The reversing motion, by means of which the wheels *d* and *g* may be made to revolve in the same or in opposite directions, is shown by the plate *h*, illustrated full size by fig. 8, the wheels *e* and *f* acting as intermediary runners, which merely transmit the motion. When in the position shown, the wheels *d* and *g* turn in the same direction. By shifting the plate *h*, the wheel *f* is drawn away from *g*, and at the same time *e* is put into gear with *g*, and still remaining in gear with *d* it (the wheel *e*) transmits motion from *d* to *g* direct, and causes the latter to turn in the opposite direction to the former. The plate *h* is more fully described by fig. 8. The dotted circle under *e* is the pin on which the plate turns, and the clamping screw which fixes the plate is shown by *i*. The leading screw *j* is shown full size by fig. 10; *k* is the bearing screwed on the foundation plate, and *l* is the nut, shown full size by fig. 11, which is screwed on to the first sliding piece *j*, in fig. 2. *M* is a hole through the wheel *d*, by means of which it is held stationary, whilst the chuck revolves, and so forms the well-known sun-and-planet gearing. The screw heads, marked *n*, five of which are shown, the sixth being covered by the reversing gear plate *h*, show the screws which secure the strips *k*, fig. 2, to the foundation plate. The wheel *g* is more fully described by *o*, fig. 2, and is shown in section at *c*. *Q*, fig. 3, represents the same wheel, and *r*, fig. 4, likewise. It is fitted to the shaft illustrated by fig. 13, on which it is free to revolve, and is held in the desired position by the click, as shown in fig. 4.

Figs. 6 and 7 show the two radius plates shown in section at fig. 3, where they are marked *d* and *j*. These illustrations are precisely half-size. The large circles are turned out to fit on the projecting rings of the first and second sliding pieces respectively. The dimensions of these are given elsewhere. The curvilinear slots are to allow the clamping screws to pass and give angular motion to the plates. These clamping screws are not seen in the perspective drawing, they being hidden beneath other parts. They are screwed into the sliding pieces, and have flat square heads, by which they may be tightened or slackened by means of a spanner. Half a turn of these clamping screws is all that is required when adjusting the radius plates. The portion shown solid is tapped with a number of holes at various distances, to suit different sized change wheels, so that these may be fixed as required by a screw on which they revolve freely.

Fig. 8 is the plate which carries the reversing wheels as shown by *h*, fig. 5, the back view of the complete chuck. It is here shown full size. A piece of flat iron will serve for material, and a trifle over an eighth of an inch in thickness will suffice. The hole in the centre fits on a pin driven into the base plate, and the curvilinear slot concentric with it is for the clamping screw, which holds the plate in the desired position. The two holes shown by double circles, representing screw threads, are to take the screws which form the studs on which the reversing wheels revolve. These are bored so that the wheels are at the correct distance apart to gear properly. The tail at the upper end is shaped to any form that may be fancied, so that it can be moved easily with the fingers. The illustration, fig. 8, is not precisely like the plate *h* in fig. 5, although there is but little difference between them.

Having described the construction of the two-part geometric chuck, we proceed to the three-part chuck. It will be unnecessary to repeat the large figures, viz., 2, 3, 4 and 5, with the modifications applied to the three-part chuck. In each figure it will be easy to add mentally the extra slide, and so arrive at an approximate idea of the construction of the three-part instrument. A perspective view of the complete three-part chuck has been given, and this will further elucidate the construction.

For the most part the particulars of the first and second slides, numbering from the mandrel nose, are equally applicable to both two and three-part chucks. In the illustrations it will be noticed that the two-part chuck has a ratchet wheel and click at the base of the nose, which allow the work to be adjusted circularly, without rotating the lathe. These are not seen on the three-part chuck; they may be added, and are equally useful on it. To an extent, this adjustment is only a refinement, which may be dispensed with.

The lower sliding piece, fig. 14, is precisely like the parts marked *b* and *e* in fig. 3, excepting, of course, the difference of the form of slides, which has been pointed out. The sliding piece shown at fig. 16 is like *h* in fig. 3. Instead of the wheel *b*, and all its belongings, the stud, fig. 19, is screwed into the slide *a*, fig. 16, and the wheel *b*, fig. 18, is mounted on it. The planet motion, fig. 21, is also not used in the two-part chuck.

The two radius plates, shown by figs. 6 and 7, belong to the slides, figs. 14 and 16 respectively. The former figures are half size and the latter full size. By measuring the holes in the plates, it will be seen that they fit on at the spaces marked *cc*, *cc*, in figs. 14 and 16. Another radius plate will be wanted for the three-part chuck, to fit on at *cc*, fig. 18. This is not shown, as it differs only in size from figs. 6 and 7.

The various screws used to hold the parts of the chuck together are not illustrated separately. Their size and form may be judged in most cases from the sectional and plan views.

The three slides and their fittings are shown separately in section. They are full size for the three-part chuck, and a glance at the half-size section of the complete two-part chuck will show the position of each. The material for the slides may be cast iron, though good brass or gun-metal castings are perhaps on the whole preferable. The strips between which they slide should be steel, though wrought and cast iron are sometimes used for the purpose. These strips are not illustrated, as their forms and positions are sufficiently obvious. The three-part chuck is fitted in plain dovetails.

The various illustrations referred to in this series of articles are shown on four lithograph supplements, the last of which is issued herewith.

We hope shortly to give an exhaustive treatise on another geometric chuck, and to show specimens of the work done by it.

Casing an Oil-stone.—About the first job an apprentice gets with his tools is to put a case on his oil-stone. The stone is bought in the tool shops without a cover; but it should not remain long without one, as it must be kept free from dust, and besides, in the event of falling off the bench, the cover protects it from breaking, so we will now give a description of how to case the stone. Supposing the stone to be 9in. long, 2in. broad, and 1in. thick, get two pieces of mahogany or other clean, straight, hard wood, each an inch longer, and an inch wider than the stone, and each ⅞in. thick. Plane one side of each piece so that they will lie closely together, and taking one of the pieces place the stone upon it, keeping the side of the stone that you mean to use upmost, and with a draw-point draw all round the wood close to the stone, when you will have a margin outside the line all round of ½in. Now with the brace and a ⅝in. or ¾in. centre bit, bore all over the portion within the line for ½in. deep, then with a sharp ⅞in. or 1in. chisel, you cut down to the draw-point line all round, clearing out all within to ½in. deep, and making the bottom level throughout. If it is pared square down at the edges, the stone will slip into it, taking care to put it in the same way as you previously drew it. When it is bottomed, ½in. will project above the wood, and this part is to receive the top or cover. The stone is placed upon the second piece of wood, which is to make the cover, and marked in the same way; and this piece is also to be bored and dug out to fully ½in. deep, and must have a smoother finish inside than the under piece It must be pared a little beyond the draw-point line, so that the cover will slip on to the stone easily, but without shaking. The stone being within, the case is to be planed on the edges and ends. This is best effected by catching it in the bench lug, when the corners may be rounded as well as the edge round the cover, and a ⅛in. bead may be run round where it joins the under part.

HOW TO HARDEN AND TEMPER STEEL.

By Joshua Rose.

PART I.

NO practical subject possesses more interest to the mechanic than that of hardening and tempering of steel. And for this reason: that the steel of which all cutting tools are made depends more for its real value upon the degree of its temper than the quality of the steel itself. A piece of untempered steel, even the finest grade, will, under ordinary conditions, not cut at all; while a piece of steel of inferior quality may be made to cut well if judiciously hardened and tempered.

While the capacity of steel to cut is mainly due to the temper, the durability of the cutting edge is determined by the quality of the steel and its adaptability to the kind of work upon which it is employed. Hence it is that for cutting tools the best of cast steel is employed. The degree of temper is varied to accommodate the nature of the duty. The cost of steel of which a tool is made is of very little importance compared to its efficiency, because this cost is very little in comparison with that of performing the duty. For example, a steel turning tool weighing but two or three pounds will cut off many thousand pounds of iron, the operation lasting perhaps several weeks. The speed at which this tool will cut—or, in other words, the time it will take to cut off a given amount of iron—will vary 30 or 40 per cent. from a very slight difference in the quality of the steel of which the tool is made. The cost of the operator's time is so much greater than that of the steel used up in a given time as to render it, even in the case of cheap labour, always economical to employ the best of steel. With a given quality, however, the efficiency depends upon the skill employed in the forging, hardening, and tempering of the tool, as well as upon its shape. To the skilful performance of these operations we must look for the difference in the quantity of work performed by different workmen, even when using the same grade of steel for similar duty.

The art of hardening and tempering steel as applied to cutting tools is much more simple than when the same operations are resorted to, to give steel elasticity as well as durability of form, or to give durability to pieces of slight and irregular form sufficient hardness to withstand abrasion. The reason of this is that for tool purposes a special and uniform grade of steel is readily obtainable, which is known as tool steel. Special sizes and grades are made to suit the manufacture of any of the ordinary forms of tools. The steel purchased under the cognomen of steel, whether crucible or otherwise, and though of the same make and brand, may vary so much as to seriously affect the degree of hardness or temper obtained by any specific process. Most of the difficulties met with are in obtaining a uniform degree of temper or in tempering without loss from water cracks, etc. These defects may arise from rigidly adhering to some special process of hardening recommended by others, and can be overcome by varying the method to suit the quality of the steel. Very few steels are as yet sufficiently uniform to render it practicable to employ an unchangeable method of tempering, and to this fact is largely due the use of particular brands of steel. Manufacturers of special tools, such as saws for example, find that they must either manufacture their own steel or else use some well-known brand, and this is the case of most articles manufactured that require a fine and

CORRESPONDENCE.

Readers are invited to avail themselves of this section for the interchange of information of any kind within the scope of the Magazine.
All communications, whether on Editorial or Publishing matters, or intended for publication in our columns, should be addressed to PAUL N. HASLUCK, Jeffrey's Road, Clapham, S.W.
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Be brief, write only on one side of the paper, send drawings on separate slips, and keep each subject distinct.
We cannot undertake to return manuscript or drawings, unless stamped and addressed envelopes are enclosed for the purpose.
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GEOMETRIC CHUCKS.

Sir,—In No. 5 of your journal (which, by accident, came under my notice the other day) I observed an article on "Plant's Geometric Chuck," and, having some knowledge of that gentleman's antecedents, I read the article through very carefully, and found, as I surmised might be the case, that the so-called "Plant's Geometric Chuck" therein described was no other than the chuck of an old and valued friend of mine, Mr. William Hartley, of Higher Broughton, near Manchester.

I know the whole history of that machine, having seen the greater part of it built up, and having also printed hundreds of specimens cut by it as far back as the year 1848. I remember, also, that Mr. Hartley sold that identical chuck to Mr. Plant, who at that time was residing at Alsager, Cheshire. This, I believe, was the first compound geometric chuck that gentleman had seen.

In justice, therefore, to my *two old friends* (the chuck and its maker), I could not silently pass by what appeared to me to be an attempt to appropriate the honour of its construction; and I am sorry to have to add that this is not the first time I have deemed it necessary thus publicly to dispute Mr. Plant's claim to be considered in any way the originator of the chuck in question.

In the lithograph supplement appended to the article, and showing the working details of the machine, I observe *one* alteration from the arrangement adopted by Mr. Hartley in the original chuck—viz., the fitting of the wheels upon the rim of the slides. In the hands of a really competent workman, I venture to assert that such an arrangement would be entirely unnecessary. The manner of its execution, moreover, is such as to render the chuck incapable of producing really accurate geometric figures, or of cutting delicate lines of an even depth. This plan may probably have been adopted in order to avoid the difficulty of fitting the recess in the underside of the wheel upon the rim of the slide.

I am, Sir, yours faithfully,

WM. S. BARLOW.

[We have some letters from Mr. Hartley, which we purpose publishing.]

APPRENTICES.

Sir,—If we examine a boy on entering a workshop, we shall find that in nine cases out of ten he knows next to nothing of what he will have to do at first. He thinks that if he is made to sweep up, and keep the tools and such like in their proper places, he is very badly used. I should like to give such youths a few words of advice: I will suppose that a boy is on the point of leaving school, and that he has decided to be a wood turner. He enters a turner's shop as an apprentice. They (the foreman, or a leading hand) start him, we will say, with stacking wood that has been sawn into lengths. At the end of the week he is told to sweep up, and make things a little tidy, and when Monday comes he is told to move this lot of wood to such and such a lathe. Well, he is at this sort of work for some months very likely, week after week it is the same. At last another boy enters the shop as an apprentice and takes his place: he is then, perhaps, put to a small circular saw. Of course he has seen this saw at work from the first day he came into the shop, and knows something about it, or he should do if he has kept his eyes open. He works at the saw for several months, and then is put to a lathe, where the most simple and plain work is done, and he remains there also for some length of time, and then put to a lathe where a better class of work is done, and after that put to a better lathe still, where undercut work has to be done. He now finds himself a good distance up the tree, but allow me to tell him he has much to learn before he gains the top. He has been at lathes where the same class of work is done over and over again, but let let us see how he gets on at the odd-job lathe; he gets a piece of work given him to do that stumps him at once. He now begins to see how little he knows about the trade he has chosen to get his livelihood by, but do not let him be disheartened by this; if he watches and takes notice how his better workmen do their work, and does not try to know too much, he will live, prosper, and learn, and when his apprenticeship is up will be a good workman. His stock of tools when he first enters the shop should not be many, or he may brag, and say his tools are better than Bill's or Jack's, and his fellow apprentices will quite expect him to teach them something, but when it comes to the push they will teach him something, although their tools only consist of a pair of inside and a pair of outside callipers, two gouges, two chisels, a parting tool, a hand saw, and a two-foot rule. Apprentices, always keep your tools in good order; you cannot do work well unless your tools are well sharpened.

Buy your tools as you require them, and have them of first-class make; do not upon any account buy cheap tools.

GEO. F. JACKSON,
Mechanical Engineering Instructor, All Saints' School, Bloxham.

MANDREL NOSES AND CHUCKS.

Sir,—Much has been said at various times, and in various places, about the intolerable nuisance of sending away one's mandrel or headstock when one wants a chuck fitting to it. It is undoubtedly a nuisance and an expense. One of your correspondents, "Graham," mentions an ingenious way out of the difficulty. I can see only one drawback to his plan, viz., that it tends to throw the work further away from the mandrel nose, which is undesirable when turning or boring articles held by the chuck only. Now, I am but a humble amateur at the best, and any opinion I form I am almost afraid to put forward lest it be erroneous or impracticable. I venture to suggest that every buyer of a lathe gets a *duplicate* of his mandrel nose from the maker. It may be made from wrought iron, and I think would not cost much. This, of course, applies only to those buying new lathes. But those who possess screw-cutting lathes ought to be able to make one for themselves. This duplicate mandrel nose could then be sent away instead of the original.

If you, sir, think this suggestion worth inserting in the columns of "Amateur Mechanics" I shall be glad; and remain yours, &c., J. W.

ON MISCELLANEOUS ITEMS.

Dear Sir,—I am in sad tribulation! Some fine boxwood that I had cut down last winter has cracked in all directions, and will, I fear, be next to useless.

Can you recommend any plan which will obviate this disappointment and loss, for the future? I have also some fine cherry and yew, which, I fear, will go wrong unless something is done. What is the best chuck for holding small pieces of ivory? would not a four jaw American answer well?

Could you not descend to something easier in your magazine than the ivory work, requiring expensive lathes and chucks, which none but a wealthy man is likely to have? A few simple suggestions as to turning ivory studs, ring stands, &c., would, I believe, be very welcome to many of your readers. A short list of useful and ornamental articles, in various materials, requiring only an ordinary lathe, with back-gear and a slide rest, would be of immense use to me and probably to others; with hints on turning particular form, also on polishing, staining, &c.

Forgive my presumption in suggesting anything to you, Mr. Editor, but if we do not make known our wants how can you supply them?

Yours very truly, J. C. E.

[NOTE.—Owing to the non-completion of engravings some of the serial papers are discontinued in the present issue. They will be resumed next month.—ED.]