Nonpareil System of Hand Railing.

THE NONPAREIL SYSTEM

—OF—

HAND RAILING.

ORIGINAL IN CONCEPTION,

SIMPLE IN THEORY, AND

UNIVERSAL IN ITS APPLICATION.

BY JOHN V. H. SECOR,

PRACTICAL STAIR BUILDER.

NEW YORK:

OFFICE PUBLISHING COMPANY.

1889.

INTRODUCTION.

I HAVE been a practical Stair Builder for many years, and in my daily work have come in contact with many of the different systems of Handrailing that are in use. I have thus been able to learn in what repute they are held by the trade. For the most part, they are considered abstruse and difficult of application in practical work. A number of my fellow-workmen, being somewhat familiar with the peculiarities of my own practice, have long desired me to publish a book by which it should be given to the world. They have urged, in support of this request, that the utility of my method would secure for such a volume preference over others which have preceded it. I have, however, hesitated to act upon this suggestion. I began teaching the system as far back as 1863, and in the interval have given instruction to a large number. Meanwhile a book has been published, in which parts of my system are explained. This circumstance would seem to be calculated to leave in the minds of some persons the impression that the author of the book referred to originated the lines he has used, but which, in fact, are mine. In support of this, I have the signatures of a number of those whom I have taught—a precaution taken against just such an infringement of my rights as has occurred. It would now seem that the time has arrived when, in justice to myself, and as the best service I can render to my fellow-workmen, I should publish my system. This I do in the following pages, choosing as a name for the work the "Nonpareil."

In presenting a system of Handrailing, original in its general features, it is necessary to give careful attention to each problem in course. By this means alone can the principles underlying the system be fully defined. Accordingly, my aim in the pages following has been to lead the learner, step by step, from the simplest problems to those of the most complex character, so defining principles and illustrating methods as to make him competent for any emergency that may arise in practical work.

A leading feature of this work is the mode of ascertaining the length of mould. It is a simple method, and the resulting dimension is called the major length. The lengths of tangents are then applied to produce the mould. The minor length is found in the same manner, forming the parallelogram, giving a point from which to set up the various hights and differences in hights and to find the width of the moulds on the minor length.

The system of bevels illustrated herein, I believe, will at once commend itself to the student as being simple as well as universal in application. The use of the trammel in drawing the curves of the moulds, and also the method of finding the length of the trammel rod, it is thought will be found easy, and something to be appreciated by those who desire to acquire efficiency in the art of describing elliptical curves with the trammel. An original mode of locating the minor axis is another point. The "sub-normal," or parallel to normal or minor axis, is also original, and will be found to be an easy mode of locating the minor axis on moulds of other than right angle bases. As will be observed, it does away with many lines which have heretofore been used, but which are, in reality, superfluous.

In order to make the system of easy comprehension, I have first introduced the simplest problems, using the fewest lines for illustration. Following are problems with a gradually increasing number of lines, presented for the purpose of fully illustrating the principles of the work. Following these in turn are problems again decreasing in

the number of lines to the close of the book, finishing with those with as few lines as it is possible to use in Handrailing.

The work is also arranged in such a manner as is believed will make the study of the various problems comparatively easy. The diagrams and letter press are arranged in a way to render reference from one to the other quite convenient.

This book is not intended to teach the art of stair building, but rather to enable anyone in the line of joinery to draw the moulds for any kind of stairs, however unscientifically they may have been constructed. It is no uncommon occurrence to be called upon to put the rail on stairs that have been built by some one that has never given a thought to the rail—how it is to be put on. This work, it is believed, will be of positive help in all such cases.

After the necessary pages devoted to Glossary and Simple Geometrical Problems, there are presented eighteen problems which, in effect, constitute the key to the system. In these problems the portion of cylinder to be covered by a rail, and the tangents in elevation, are given. Following these problems there are a number of others, selected on account of their frequent occurrence in practical work, and which still further illustrate the principles under discussion.

With these introductory remarks, I present to my fellow-workmen the system on its merits, believing that if they will give it careful attention, the most satisfactory results will follow.

JOHN V. H. SECOR.

New York, February, 1889.

Table of Contents.

GLOSSARY.

PITCH.—Rake or hypothenuse, as the inclined side of the pitch board.

NORMAL or LEVEL.—As the minor axis is always level, there being no twist or cant on this line.

SUB-NORMAL.—Parallel to normal, used in this work to direct the minor axis for acute and obtuse angle, ground plan having two pitches.

MAJOR LENGTH.—Greatest length from which the mould is drawn.

MINOR LENGTH.—Crossing major, but not necessarily the shortest; in a full easement over a ground plan of more than a quarter, it is the longest; a term peculiar to this work.

MAJOR AXIS.—Longest or transverse.

MINOR AXIS.—Shortest or conjugate, never changing its length from that of the ground plan, and crossing the major axis at right angles.

STRAIGHT-WOOD.—That portion which is added to a mould or rail outside of the curve and parallel to the tangent.

OVER-WOOD.—The portion of material to remove in the operation of squaring up the twist to form a handrail.

TWIST.—A curved piece of wood used in handrailing. It is formed by applying bevels at the ends, giving the plumb line through the centre to form a twist.

BUTT JOINT.—A square joint to connect handrails to each other, as the centre but joint.

PARALLELOGRAM.—A figure having its opposite sides parallel and of the same length.

RIGHT ANGLE.—Base or ground plan; a quarter cylinder is a right angle base and from this all angles are measured or reckoned.

OBTUSE ANGLE.—Base or ground plan. In this the curve of the cylinder is less than a quarter circle, so the angle is formed obtuse on the line of the tangents and is said to cover less than a quarter circle, while the angle is greater than a right angle.

ACUTE ANGLE.—Base or ground plan. In this the curve of the cylinder passes the right angle or quarter, so that the angle on the line of tangents is acute and is said to be more than a quarter circle, while the angle is less than a quarter or right angle. Thus, if we draw a circle and inclose it within tangents, there will be four right angles; if acute, then three; if obtuse, then an indefinite number.

EASEMENT.—A full cylindrical easement is formed by a level and a pitch tangent. The starting and landing piece would be a full easement.

HALF EASEMENT.—An easement formed when the tangents are of different pitches.

RAMP.—A piece of rail connecting two pitches, forming a curve up and down, while its sides remain straight.

OVER-EASEMENT.—The piece connecting the flight or pitch with the level rails. The top of a platform stairs would be an over-easement, while the starting from the level or from a Newel would be a simple easement.

SIMPLE GEOMETRICAL PROBLEMS AND DEFINITIONS.

The inclination of two lines meeting one another, or the opening between them, is called an angle. Fig. 1 is called an **equilateral triangle,** all sides being of one length, forming three acute angles—A, B and C. This figure is als called a **trigon.**

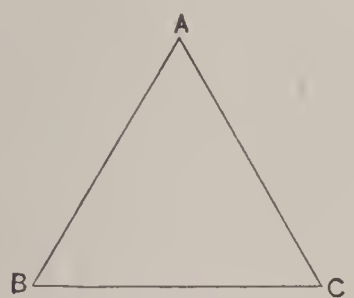


FIG. 1.—EQUILATERAL TRIANGLE.

Fig. 2 is a **right angle triangle,** having three unequal sides, forming one right angle, D, and two **acute angles,** as at E and F. This figure is also called a **scalene triangle.**

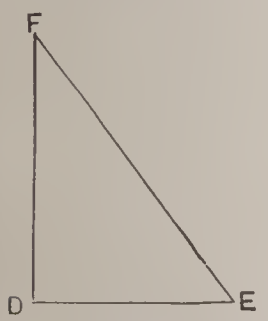


FIG. 2.—RIGHT ANGLE TRIANGLE.

Fig. 3 is an **obtuse angle triangle,** having two of its sides equal, forming an **obtuse angle,** G; also two **acute angles,** H and J.

Lines may be straight or curved, having length without breadth or thickness. A line may be composed of points or dots, or it may be a continuous line, yet its ends will be points. A straight line is the shortest distance between any two points. A vertical line is a plumb line, and at right angles to the horizon. A horizontal line is a level line and parallel to the horizon. A line may be perpendicular to a given line without being in a vertical position.

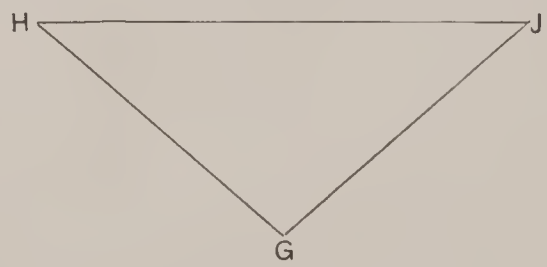


FIG. 3.—OBTUSE ANGLE TRIANGLE.

A point has position without magnitude and is represented by a dot, or by two lines meeting at an angle, or crossing each other. A, B and C, Fig. 1, and A, Fig. 6, are points.

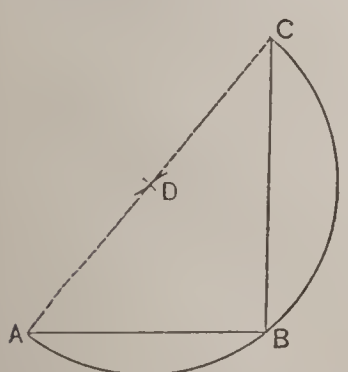


FIG. 4.—TO ERECT A PERPENDICULAR UPON THE END OF A GIVEN LINE.

To draw a perpendicular upon the end of a line. Let A B in Fig. 4 be the given line and B the given end. With radius less than A B, set one foot of the compasses in B and then in A; strike short curves intersecting at D. Then with D

as centre and A B as radius, describe a portion of a circle, A B C, indefinitely. Then from A through D draw a line, cutting the circle at C. Connect C B. Then B C will be the perpendicular sought.

To erect a perpendicular at the end of a given line. Let H J in Fig. 5 be the given line. Set one foot of the compasses in J, and with J H as a radius, describe the arcs H L equal to H J. Draw a line through H L indefinitely; make L M equal H L. Connect M J, which will be the perpendicular sought.

FIG. 5.—ANOTHER METHOD OF ERECTING A PERPENDICULAR AT THE END OF A GIVEN LINE.

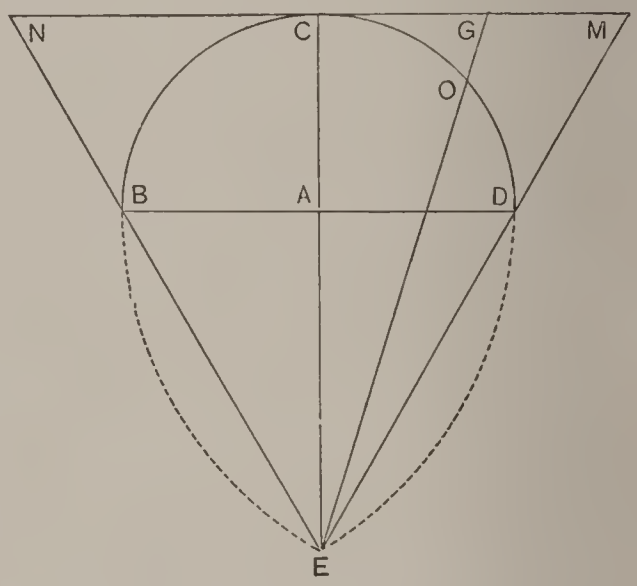


FIG. 6.—FINDING THE STRETCH-OUT OF A SEMI-CIRCLE.

To find the length or stretch-out of a semi-circle. Let A, Fig. 6, be the centre of the semi-circle B C D. Set one foot of the compasses in D, extending the other to B, and describe the arc B E. Then setting one foot in B in the same manner, describe D E. Draw a line from E through D and another from E through B indefinitely. Draw N M parallel to B D, touching the semi-circle at C. Then N M will be the stretch-out of the semi-circle, or so nearly equal to it as to answer all practical uses. We may find the stretch-out of any portion of a circle by the same means. For example, take D O upon the semi-circle as the curve, the stretch-out of which we wish to find. Draw a line from E through O, cutting the line N M at G. Then G M is the length of the curve from O to D and G N equals O C B.

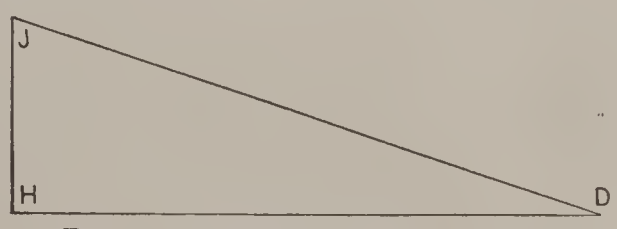


FIG. 7.—ANOTHER METHOD OF DOING THE SAME.

To find the stretch-out of a cylinder in another way. Let H J, Fig. 7, be the radius, or half of the diameter and equal to A C of Fig. 6. Make H D three times the length of H J. Connect D J. Then D J will be the stretch-out or a line in length equal to N M of Fig. 6.

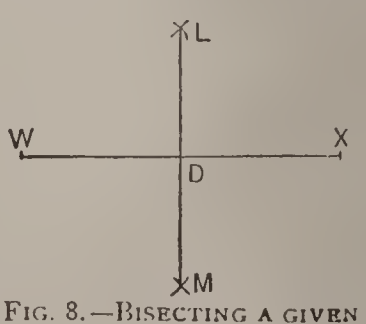


FIG. 8.—BISECTING A GIVEN LINE.

To bisect a line is to divide it in two equal parts. In Fig. 8 the line W X is bisected

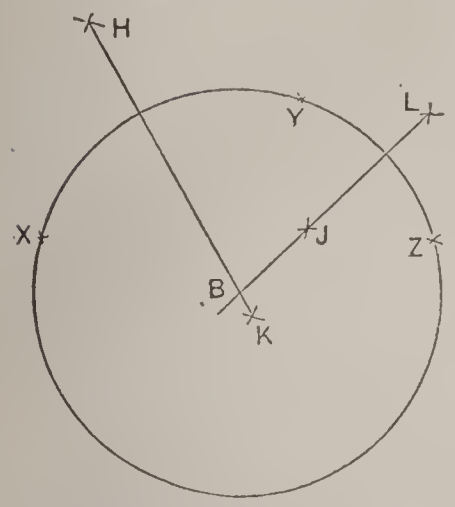


FIG. 9.—DESCRIBING A CIRCLE TO PASS THROUGH ANY THREE GIVEN POINTS.

by L M at right angles to it. Let W X be the given line to bisect. Take any distance greater than X D for a radius and W and X for centres, and describe the arcs intersecting at L and M. Connect L M, which will then bisect W X.

To find the radius to describe the circle which will pass through any three given points not in a straight line, as X Y Z in Fig. 9, proceed as follows: From X and Y as centres with any convenient radius longer than one-half the distance from X to Y, describe short arcs intersecting at H and K. Draw H K. In the same manner describe arcs from Y and Z as centres, intersecting at L and J. Draw L J, and prolong it until it meets H K, thus establishing the point B; then with B as a centre and B X as a radius, describe the circle which will cut X, Y, and Z.

A **circle** may be defined as a round figure, bounded by a single line in every point equally distant from a point which is called the centre. In Fig. 10, C is the centre of the circle.

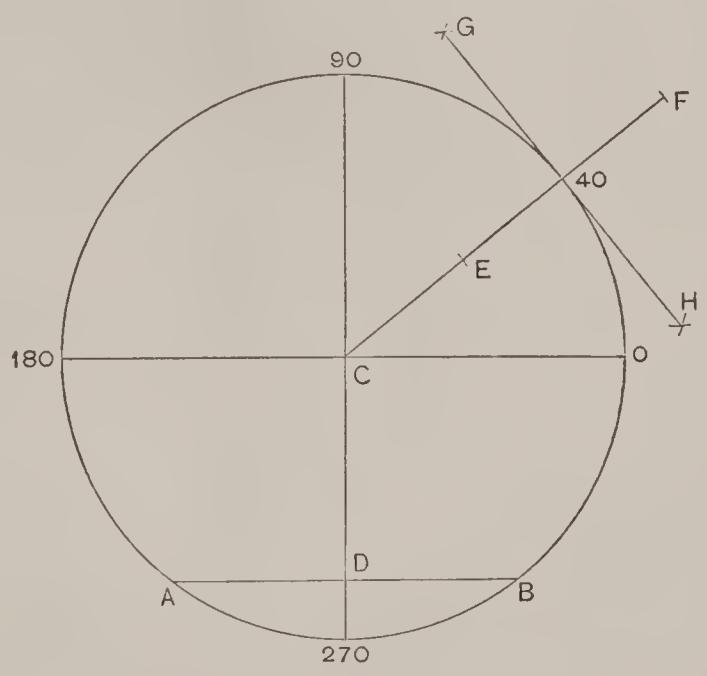


FIG. 10.—SHOWING CIRCUMFERENCE, DIAMETER, RADIUS, CHORD, SEGMENT AND TANGENT.

The **circumference** or **boundary line** of a circle is supposed to be divided into 360 equal parts called degrees; each degree, in turn, is divided into 60 equal parts called minutes, and each minute into 60 equal parts called seconds. A degree is the 360th part of the circumference of any circle, without regard to the size of the circle. The radius of a circle is a line drawn from the centre to the circumference, as C 0, Fig 10. The diameter of a circle is a line drawn through the centre terminating at the circumference, as 0 X 180, Fig 10. A semi-circle is a half circle, as 0 X 90 X 180, Fig 10.

A **chord** is a line crossing a circle, cutting off a portion, as A B, Fig. 10. A segment is the portion cut off by a chord, as A B, 270. The rise

of a segment is the distance from the chord to the circumference; for example, D, 270, Fig 10, is the rise of the segment just described.

A tangent to a circle is a line drawn outside of the circle touching the curve at a single point, as the line G H which touches the circle at the point 40 in Fig. 10.

To find the tangent to a circle, proceed as follows: From C as centre, draw C F, passing through the circle at the point to which the tangent is to be drawn. Take any distance, as F 40 for radius, and with one foot of the compasses in the point 40, set off the points E and F, then with E and F as centres, strike short arcs intersecting, as shown at G and H. Draw G H. Then G H will be the tangent sought. It will also be a line at right angles to the radius produced, touching the circle at the required point.

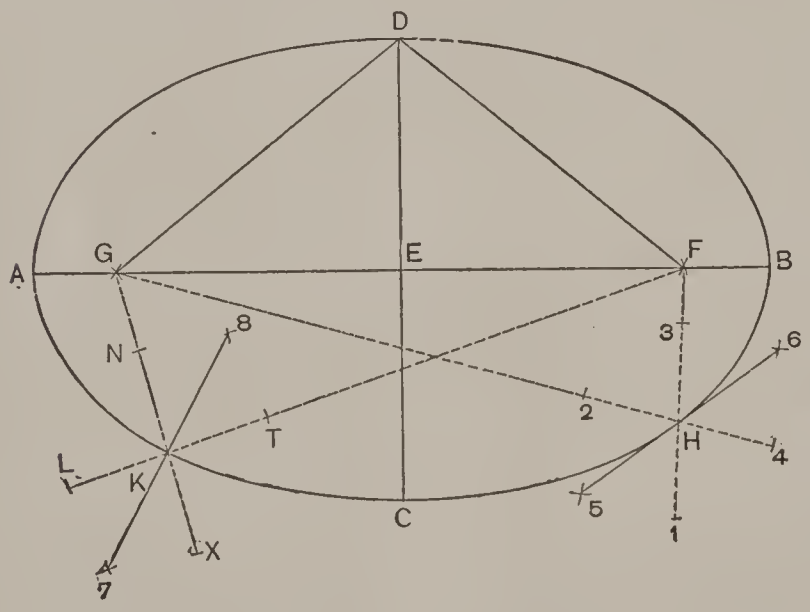


FIG. 11.—DRAWING THE ELLIPSE.

We will next consider the **ellipse**, which may be drawn by a string as shown in Fig. 11. The ellipse is described from points located on lines called the "axes" of the ellipse, and which cross each other at right angles. The line running through the figure lengthwise, as A B, Fig. 11, is known as the major or transverse axis. The shorter one or C D of Fig. 11, is known as the minor or conjugate axis. To draw the ellipse A, D, B, C, with string and pencil, we proceed as follows: Take the length of one-half the major axis, as E B, and with one foot of the compasses in D strike a short arc, cutting the major axis in F, also in G. Then the points F and G, called foci, are the places in which pins are to be placed; also drive a pin at D. Stretch a string around the points F D and G, remove the pin at D and put in place of it a pencil, and keeping the string drawn tight against the pins, F and G, describe the curve A D B C.

To find the tangents to a given ellipse determine, first, at which point a joint is to be made: for example, H, Fig 11. Then draw the dotted lines G H and F I. With one foot of the compasses in H, with any convenient radius, make points on the lines intersecting at H, as indi-

cated by 1, 2, 3 and 4. With same radius, using 1, 2, 4 and 3 as centres, describe short arcs intersecting at 5 and 6. Connect 5 and 6. Then the line 5 6 will be the tangent sought. Make the joint at right angles to the tangents passing through H.

Fig. 11. To find the joint first, and afterward to draw the tangent from the joints, proceed as follows: Let K be the point at which the joint is to be made. From the foci G and F draw lines intersecting at K, as shown. Then with K as centre, with any convenient radius, establish the points L, N, T and X. With L and X as centres, describe short arcs, intersecting at 7, and from N and T as centres, describe short arcs, intersecting at 8. Draw the line 7 8, which will be the joint sought. In this case the tangent may be drawn by erecting a line perpendicular to 7 8, and cutting it in the point K.

A spiral may be defined as a single continuous curved line between two points, as from A to S, Fig. 13. It can be constructed by segments of circles to answer all practical purposes, as laid down in Figs. 12 and 13. A scroll may be defined as formed by two spiral lines, as the outside and inside of a hand-rail. The outside line is called the convex spiral, and the inside line the concave spiral. The two lines completing the scroll terminate at a point called the ball, or the eye. The reader will observe that the two scrolls illustrated in Figs. 12 and 13 are drawn in the same general manner. Fig. 12 may be described as a close scroll, and Fig. 13 as an open scroll.

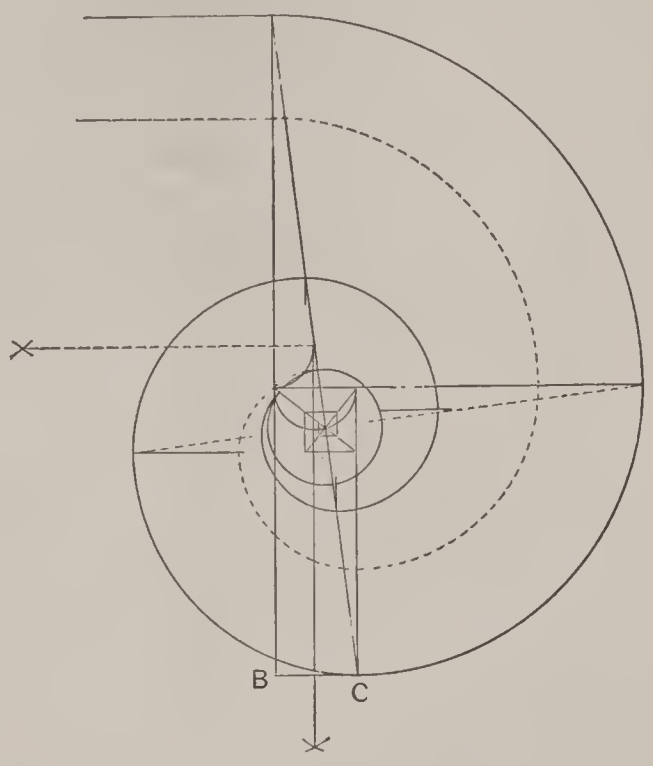


FIG. 12.—SPIRAL AND CLOSE SCROLL.

To construct the scroll shown in Fig. 13, proceed as follows: Determine the size or spread you wish to have the scroll between outside lines, as A B. Draw B C at right angles to A B. Connect A C by the diagonal line, which will pass through the eye. Divide A B into two equal parts. With one foot of the compasses in A and B, with any convenient radius more than half of A B, describe arcs intersecting at D. Perpendicular to A B draw the line D F. Divide B C in a similar manner

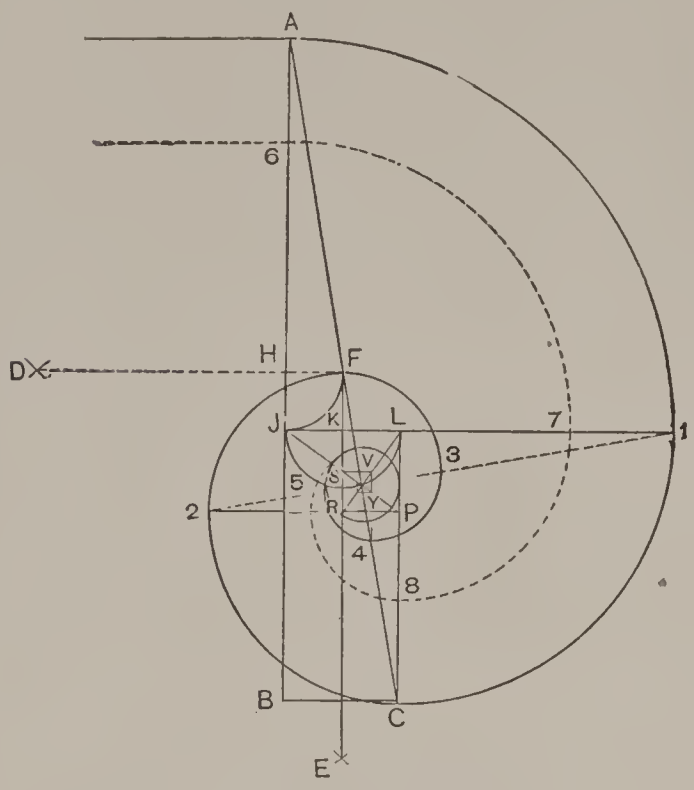


FIG. 13.—SPIRAL AND OPEN SCROLL.

and draw E F parallel to A B, cutting the diagonal line at the point F. From H as centre, with H F as radius, describe the arc F J. Draw J K L at right angles to A B. With K as centre, and K J as radius, describe the semicircle J L, which will pass through the eye. Draw the diagonal line from J, passing through the eye. From L also draw a diagonal line through the eye, as shown, terminating in the point R on the line F E. From L drop the perpendicular L C. Proceed in like manner from the points R, S, V, &c. With this done, to draw the spiral, take J as centre and J A as radius, describing the arc A 1. Then from L as centre, with L 1 as radius, describe the arc 1 C. Then from P as centre, with P C as radius, describe the arc C 2 and proceed in like manner with R S, &c., as centres. For the inside or dotted line, proceed as follows: From J as centre, with J 6 as radius, describe the arc 6 7; and from L as centre, with L 7 as radius, describe the arc 7 8, and so on.

It is to be observed that the line B C in both Figs. 12 and 13 govern the proportions of the scroll. As this line is lengthened the scroll will be made open; if it is shortened the scroll will be closed; compare Figs. 12 and 13. Matters of this kind are always left to the taste of the stair builder.

In Fig. 14 is illustrated the method of describing an ellipse with a trammel and rod. The trammel consists of two pieces of wood or metal crossing each other at right angles, and having a groove running the entire length of each piece. The rod is made to carry a pencil at

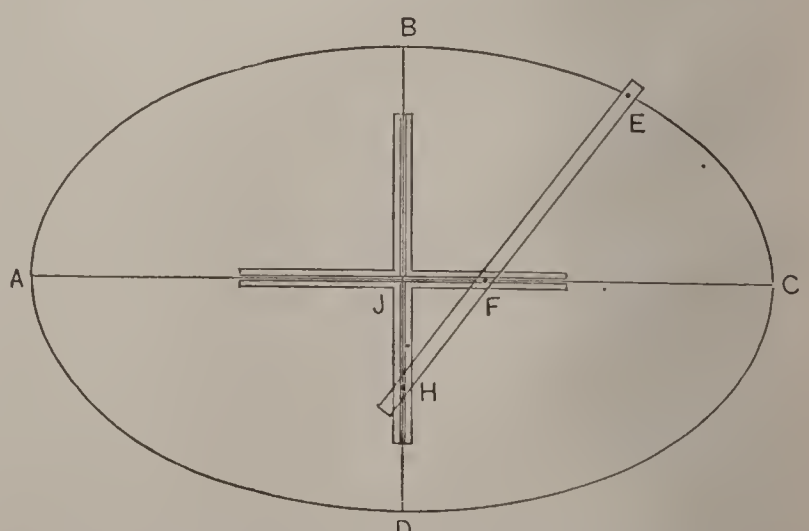


FIG. 14.—ELLIPSE DRAWN WITH TRAMMEL AND ROD.

one end and is provided with two movable heads, with pins on the under side to fit in the grooves so as to slide easily. The trammel is secured in place on lines representing the major and minor axes of the ellipse, as A C and D B. E is the pencil. In setting the trammel make E F equal to B J, and E H equal to A J. Then move the rod, letting the pins slide in the grooves : the result will be an ellipse, as shown.

Fig. 15 illustrates a method of finding the radius by which to describe a segment to a given chord and rise. Let A B be the given chord, and C D the rise. Bisect A B, establishing the points D, and erect the perpendicular D C. Extend C D indefinitely in the direction of O. Bisect A C, establishing a point J. From J as centre, with any convenient radius, longer than J A, strike short arcs intersecting in the points K and H, as shown. Draw K H and produce it until it intersects C D produced in the point O ; then O will be the centre and O C the radius of the arc A C B. In the second case, illustrated in Fig. 15, let A B be the given chord and E D the given rise. Proceed in the same manner as shown, which will establish the centre at L.

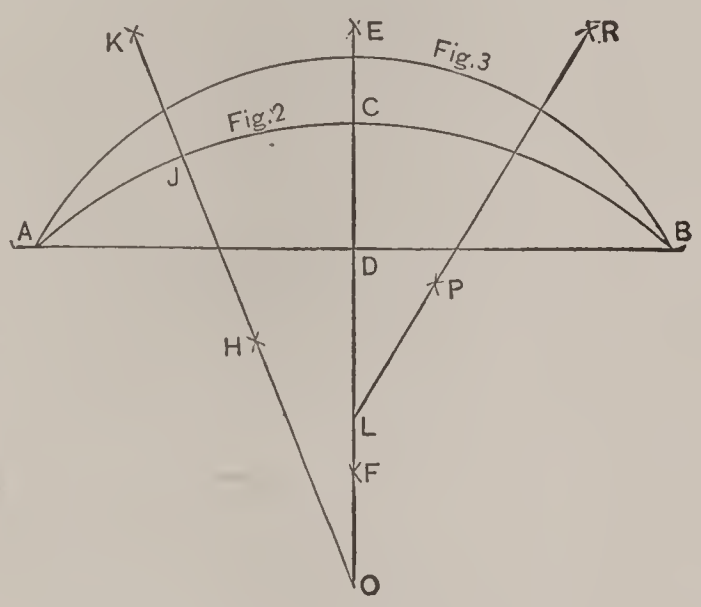


FIG. 15.—FINDING A REQUIRED RADIUS.

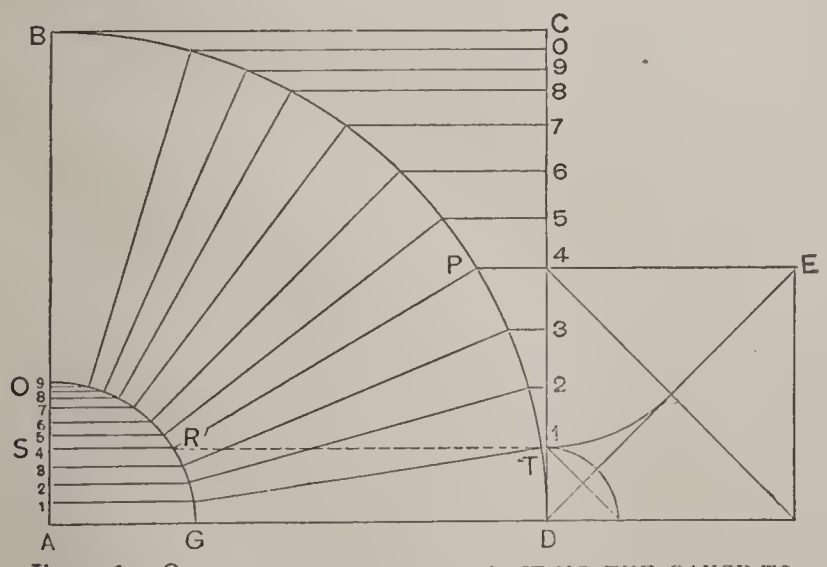


FIG. 16.—ORIGINAL METHOD FOR SETTING THE GAUGE TO EIGHT-SQUARE TIMBER

In Fig. 16 is shown an original method for finding the distance to set a gauge to eight-square any sized timber. Let A B C D be a square of 12 inches. From A as centre, describe the quadrant D B, also the quadrant G O, having the radius A G, which must be 3½ inches in length. Lay down the size of timber to octagon as at 4 E. Extend 4 E, touching the quadrant at P. Then draw from P toward A, cutting the inner circle at

R. Draw R S parallel to A G. Then the required distance to set the gauge is from A to S, as shown by D T at the right.

In like manner any piece may be octagoned from 1 to 24 inches. Example: Using a scale of 3 inches to the foot, for 12 inches the gauge will be A B, or 3½ inches; for 24 inches it will be 7 inches, and so on. The size of material to octagon is on the line D to C, and the gauging is found at A O.

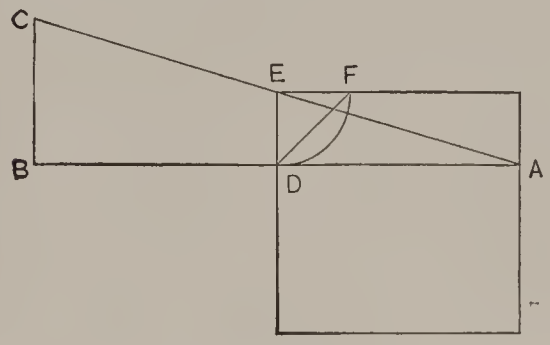


FIG. 17.—ANOTHER METHOD OF EIGHT-SQUARING.

Another way to find the gauging is shown in Fig. 17. Let A B be 24 inches long, and B C 7 inches. Let A D be the size of timber, touching the diagonal line at E. Then E D will be the gauging, as shown at E F D.

Fig. 18. To draw an Octagon from a given side. Let A B be the given side. Draw the square A B C D. With A as a centre, describe the quadrant A B D. Connect A C, and where the diagonal line touches the circle at E will be one angle of the octagon. Extend A D indefinitely and make A L equal to A B. Parallel to A D, make E F equal to E A. Draw E K and F J at right angles to E F. With the compasses set equal to A E, space F G, H J, and K L. Connect them, completing the octagon.

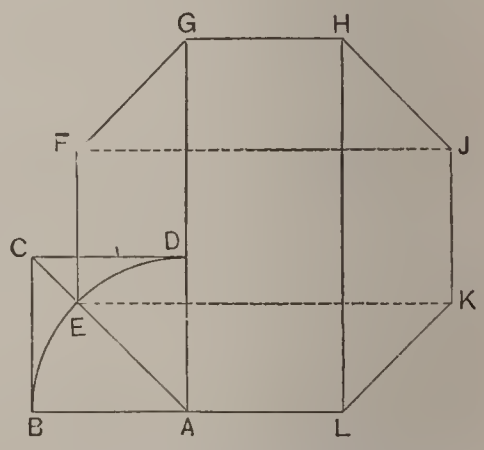


FIG. 18.—TO DRAW AN OCTAGON FROM A GIVEN SIDE.

THE PRINCIPLES OF DRAWING HAND-RAILINGS.

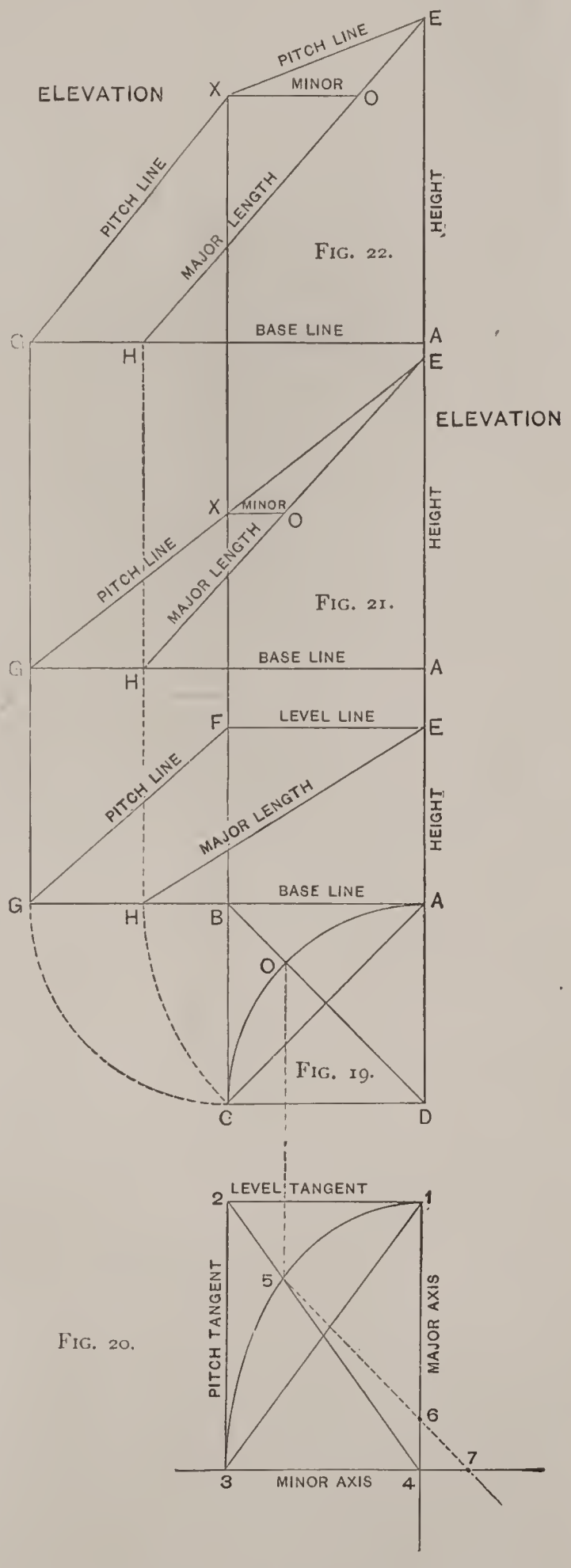
Problems showing the mode of Ascertaining the Length of Mould, the Stretch-out of Tangents, Forming the Mould and Drawing the Curve Line by the use of the Trammel.

Fig. 19. From a quarter circle, ground plan, to draw three moulds. Let A B C D be the ground plan; A B and B C the tangents; D the centre from which the curve is drawn. Extend D A and C B indefinitely. From B as centre, describe the dotted line C G. Extend the line

G G parallell to C B, which is the stretch-out of tangents. From F to G draw the pitch. To find the major length of the mould, take A as the centre and A C as the radius and describe the dotted line C H. Connect H and E, which is the length required from which to draw the mould.

In drawing the mould we will draw tangents and centre curved line only, giving the trammel rod for the curve. The mould completed will be shown further on. As we gradually lead the way, the reader will be able the better to comprehend.

To draw outline of mould from plan and elevation. Draw 1 3, Fig. 20, equal to E H; 1 2 equal to E F, and 2 3 equal to F G. At right angles to 1 2 and 2 3, make 4, which gives the parallelogram, and is also a quarter of an ellipse. Extend 1 4 for the major axis, and extend 3 4, which will be the minor axis. To find the length of trammel rod to draw the curve. Make 5 6 equal to 3 4, and 5 7 equal to 1 4. As the points 6 7 are moved along the lines of axes, the point 5 will describe the curved line as required, and when set up in position will be plumb over ground plan A B C D, 1 5 3 covering A O C.



Figs. 19, 20, 21 and 22.—Showing method of ascertaining length of mould and stretch-out of tangents.

The minor axis is a level line, and is the point at which the bevels change their inclinations. As Fig. 20 requires but one bevel, it is applied at the point 1, as will be explained hereafter.

Fig. 21. Elevation for a mould having tangents of equal pitches to cover the ground plan. From the base line, A H G, set up the hight to E. The major length is found in the same manner as in Fig. 19. The pitch line, E G, is the two tangents, X being the centre. Draw X O parallel to G H A, which is the minor length and the minor axis.

Fig. 23. To draw the outline of mould, make 1 3 equal to E H, Fig. 21. With the compasses at 3, make the points 2 4 equal to E X. From 1 bisect at 2 4; connect these points as shown, forming the parallelogram 1 2 3 4. Connect 2 4, extended, which will be the minor axis. Draw 6 7 parallel to 1 3, touching at 4, which will be the major axis. Make 4 5 equal D O of ground plan, then 5 will be the centre of curve line and 1 2 and 2 3 the tangents.

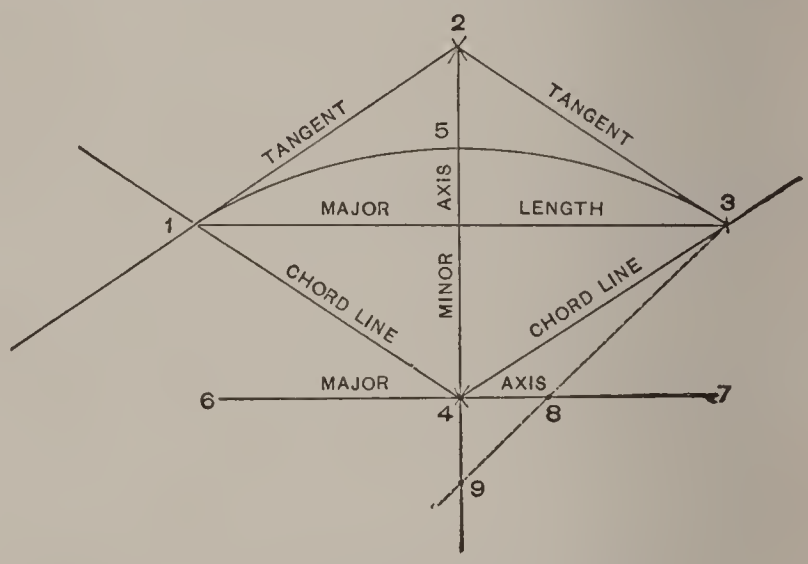


FIG. 23.—TO DRAW OUTLINE OF MOULD.

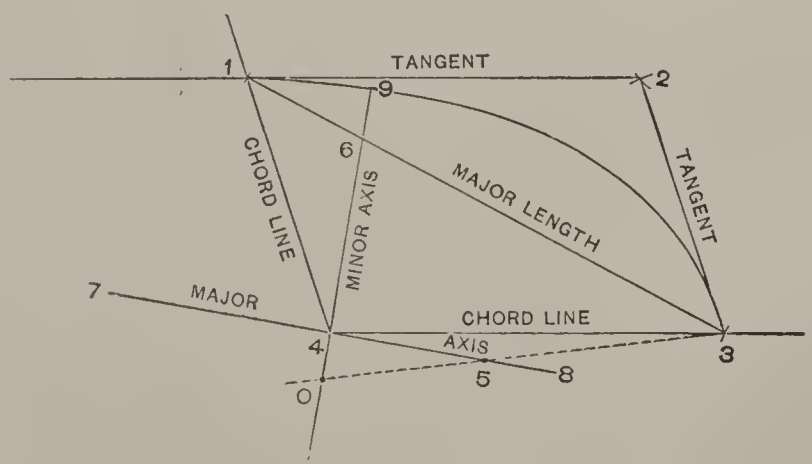


FIG. 24.—TO DRAW OUTLINE OF MOULD.

To find the length of trammel-rod, make 3 8 equal to 4 5. Extend this line to the minor axis, which will be the length of rod. 8 9 are the pins and 3 the pencil, which will describe the curve.

Fig. 22. Elevation for a mould having tangents of unequal pitches. Let A E be the hight, E X one pitch and X G the other. Connect E H for the major length. Draw the minor X O parallel to the base line A H G.

Fig. 24. To draw the outline of mould, make 1 3 equal to E H, Fig. 22, 1 4 and 2 3 equal E X, and 1 2 and 3 4 equal X G. Connect these points and form the parallelogram as shown at 1 2 3 4.

To find the position of the axis. Let 1 6 equal E O. Connect 6 4, which will be the minor axis. At right angles to 6 4 draw 7 8, touching at 4, which will be the major axis.

To find the centre of curve on the major axis. Let 4 9 equal D O of ground plan, then 9 will be the point required.

To find length of trammel-rod. Let 3 5 equal 4 9, crossing the major axis. Extend this line to the minor axis, then 3 5 O is the length required, O and 5 being the pins, and 3 the pencil, which will describe the curve.

ILLUSTRATIVE PROBLEMS.

The following eighteen problems embrace all the different forms of cylindrical hand-railing, drawn to a scale of ¾ inch to the foot, and having straight wood on both ends, which, in practice, is sometimes required. They are intended to fully illustrate the principles, and will be referred to, occasionally, in some of the other problems.

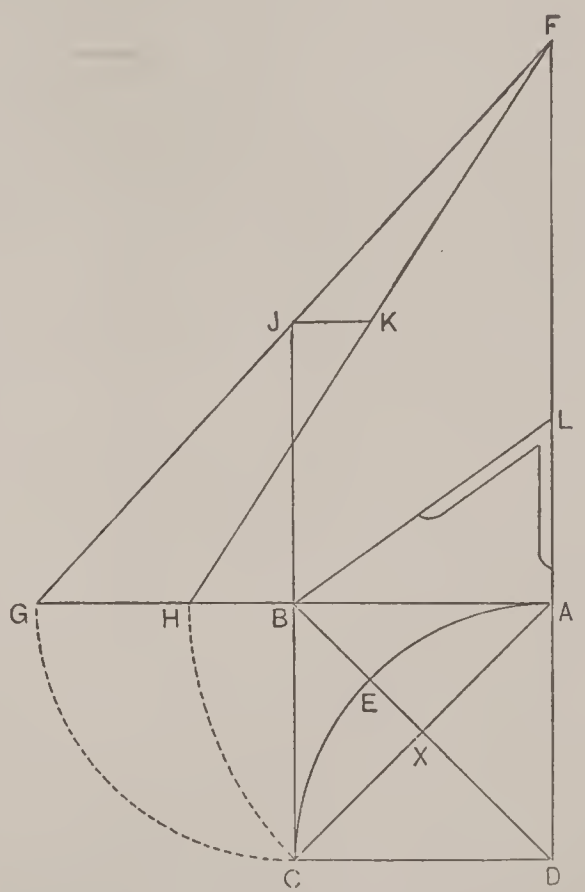


FIG. 25.—SHOWING QUARTER-CYLINDER, GROUND PLAN AND ELEVATION.

Fig. 25. To draw the stretch-out and pitch of tangents. Let A B C D be the ground plan, with A B C the tangents, E the centre of curve line, A to F the full hight. From B, as centre, describe the dotted line C G. Connect G F, which will be the tangents.

To find the major length. With A as centre, describe the dotted line C H and connect H F, which will be the length required. Extend C B, touching the tangents at J. Draw J K parallel to base line, as the minor length, and it will stand plumb over the base, B X D.

Fig. 26. To draw outlines. Let 1 3 equal F H. From points 1 3 draw tangents equal to F J and J. G. Connect 2 4 extended, which

is the minor axis. At right angles from 2 4 draw the major axis. For the centre of mould let 4 5 equal D E. From 5, lay off half the width of rail on each side as 6 7. Draw the dotted line 5 1 and parallel to it draw 6 0 and 5 0 touching the cord line at 00. The outer dotted lines are the width of rail. Draw the straight wood parallel to the tangent 1 2 and the other end of mould will be the same width.

To find the bevel to square up the rail. Draw the dotted line at right angles from 2 3, touching at 4. Take this length and place it from B to L, when the angle at L will be the bevel for both ends.

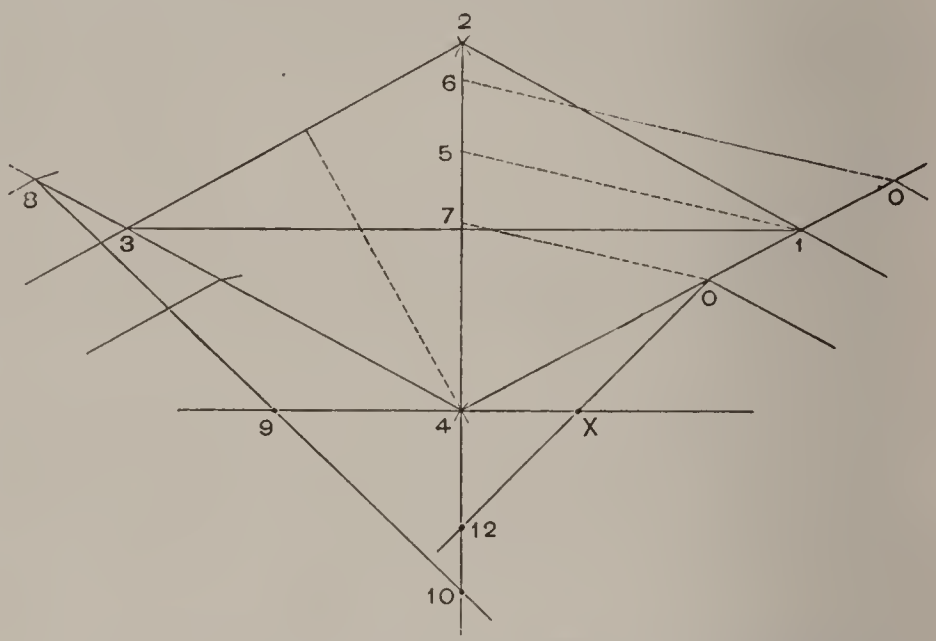


FIG. 26.—SHOWING OUTLINE OF MOULD, MODE OF FINDING BEVEL AND TRAMMEL ROD FOR CURVES; ALSO, WIDTH OF MOULD AT ENDS.

To find the length of trammel-rod for outside curve. Let 8 9 equal 6 4 and extend to 10. For inside, let 0 x equal 7 4 and extend to 12, which will be the lengths required.

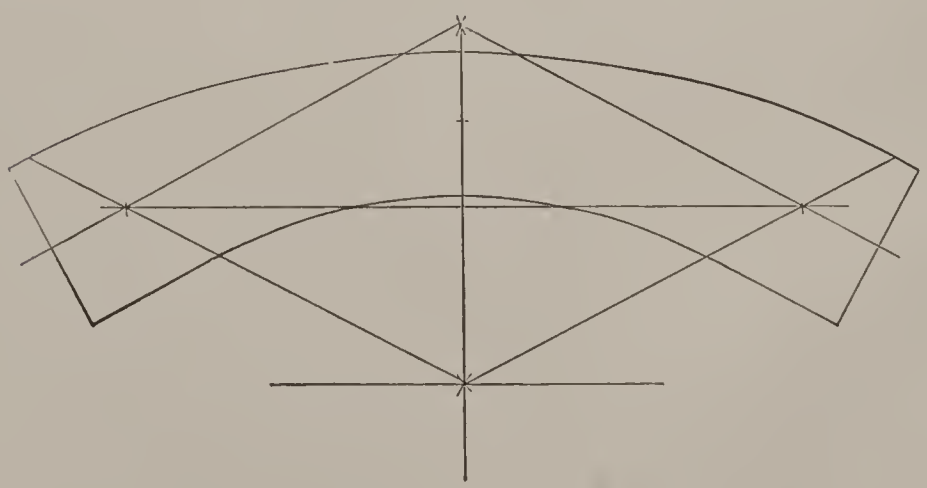


FIG. 27.—SHOWING MOULD COMPLETED.

A very easy way to make the curve is to take a small rod and mark the point upon the edge to correspond to those already described. Operation: Let 9 10 be placed at different points along the axis, and at the end of rod at 8. Make a mark, using as many points as desirable, and then trace the curve through the points thus formed, or use a flexible strip holding it in such a manner as to touch all the points, and mark the curve along its face, completing the mould.

Fig. 27 is the mould completed and will not need explanation.

Fig. 28 shows a quarter cylinder, ground plan and elevation, with tangents of unequal pitch, requiring two bevels for squaring up the rail. The position of trammel is also changed, as will be seen at Fig. 29.

To find the major length, tangents and bevels. Proceed as per directions, Fig 26.

Fig. 30 shows the mould complete, also points from which to get the bevels. Let A B C D, Fig. 28, be the ground plan, with E as the centre of curve. From A to F set up the hight. From F to J draw pitch, and from J to G will be the other pitch. From F to H will be the major length. Draw J K parallel to base line, A B G.

Fig. 29. To draw out-lines, let 1 3 equal F H. With the compasses take the length of tangent F J, and place one foot in 1. Describe the arc at 2, then with one foot in 3 describe 4. Next take length J G, and from 1 describe the arc bisecting at 4. Then from 3, bisecting at 2, connect 1 2 and 2 3 for the tangents. Connect 1 4 and 3 4, which will be the chord line, 4 being the point or centre of axis. To find position of axis let 3 5 equal F K, and draw the minor axis through 4 and 5. Draw major axis at a right angle to 4 5; touching at 4.

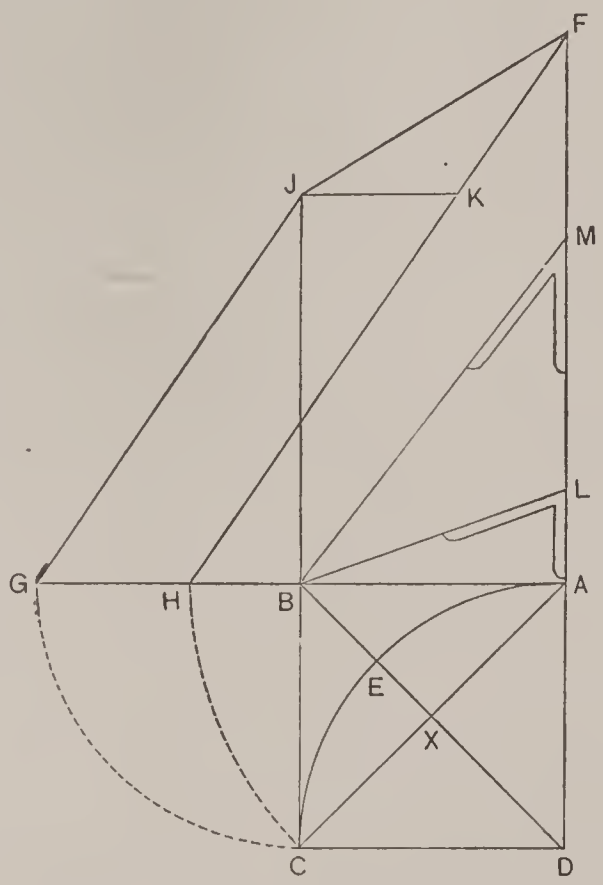


FIG. 28.—QUARTER CYLINDER, GROUND PLAN AND ELEVATION, AND TANGENTS OF UNEQUAL PITCH.

To find centre of mould on minor axis, let 4 7 equal D E. Find width of rail from 7 as the centre to 6 8. To find the width of mould at the ends, draw the parallel dotted lines 6 7 8, touching the chord line 1 4. Draw the straight wood parallel to tangents from the points 0 0, and repeat the operation at 3.

To find length of trammel rod for outside curve, let 9 12 equal 4 6; extend touching at 13, which will be the length required.

For inside let 0 14 equal 4 8; extend touching at 15, which will be the length required.

To find bevels. At right angles to 1 2, Fig. 30, from 5 draw the dotted line touching 4. From 2 3 at 6 in the same manner draw 6 4. Upon the elevation let B M equal 4 5; then the angle M will be the bevel

for the wide end of mould. For the other end, let B L equal 4 6, then the angle at L will be the bevel required for the other end.

Ground plan and elevation of a quarter cylinder, having a single pitch line, the other being a level line. Fig. 32 is a mould such as is used in starting or in landing, as in connection with winders. Fig. 33 is a mould similar to Fig. 32, except that the straight wood is on the opposite end. This is used in starting and landing for a straight flight of stairs.

Fig. 31. Let A B C D be the ground plan of a quarter-cylinder, E centre of curve as described from D. From A set up the hight required to F. Connect F D, which will be the pitch, and also the length of tangent to draw the mould. The angle at F gives the bevel to be applied at the wide end of mould. No bevel is required for the opposite end, as the rail is there taken square through the centre.

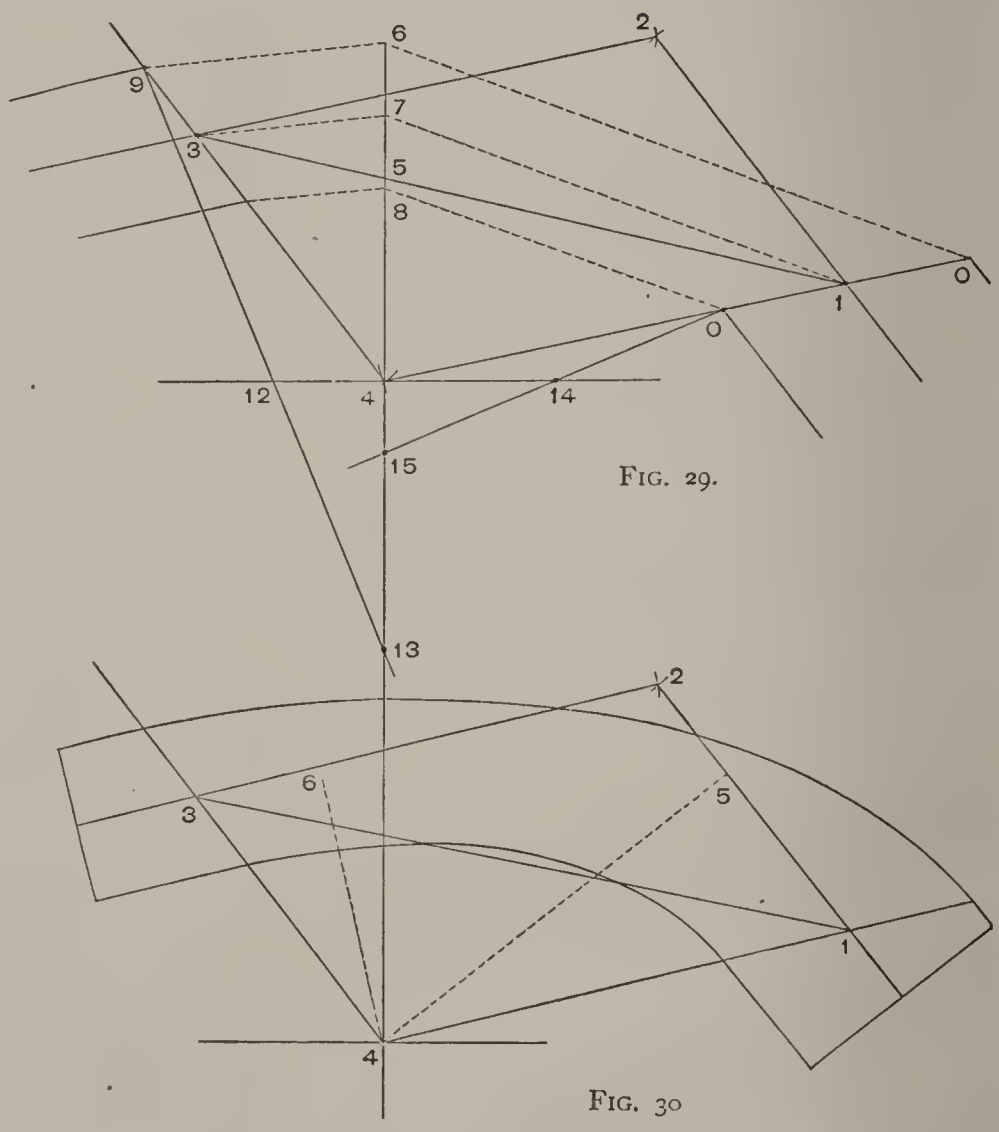


Fig. 29.

Fig. 30

Figs. 29 and 30.—Showing outline and mould complete.

Fig. 32. Let 1 2 equal F D, and 2 3 equal B C. Square from or at right angles to 1 2 and complete parallelogram at 4. Let 5 6 be the width of rail. Draw dotted lines, as indicated, parallel to 1 3, giving width of mould as required.

To find length of trammel rod to describe the curve. This being a quarter ellipse, 1 4 is the minor and 3 4 the major axis. For outside length let 9 0 equal 4 8, and 0 12 equal 6 4; then 9 12 are the pins and 0 the pencil to describe the curve.

Find the inside in the same manner. Let 13 14 equal 4 7, and 14 15 equal 4 5. This applies to Fig. 33 as well. All numbers in Fig. 33 correspond with those of Fig. 32.

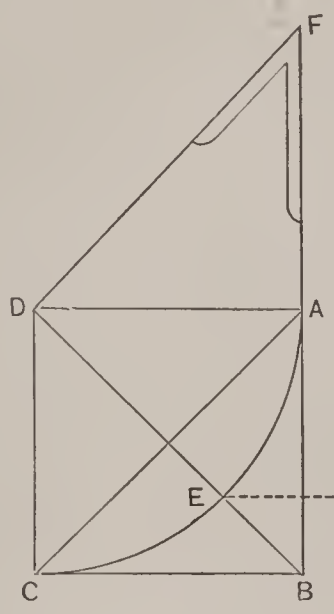


FIG. 31.—GROUND PLAN OF QUARTER-CYLINDER, SINGLE PITCH LINE.

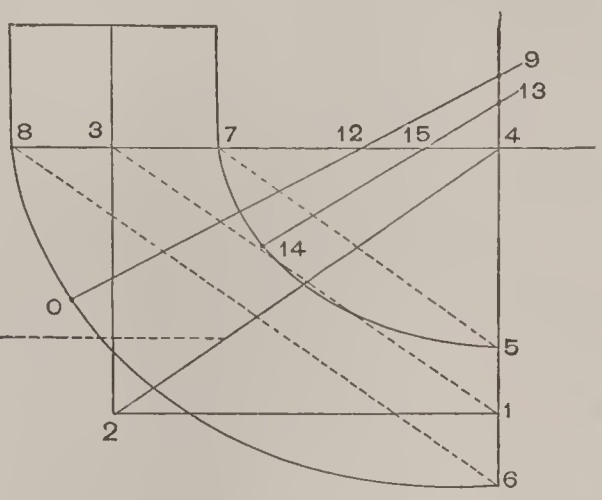


FIG 32.—MOULD STARTING AND LANDING, IN CONNECTION WITH WINDERS.

Fig. 34. An obtuse base, or less than a quarter, having tangents of one pitch. Let A B C E be the ground plan, with D forming parallelogram, and E the centre from which the curve is described. Find the stretch-out of tangents. From B as a centre, and C as a radius, describe the curve C G. From A to F set up full hight, and connect F G, giving the length of tangents required. At right angles from A B draw B J, bisecting the tangents at J. From A as a centre, and C A as the radius, draw the curve C H, and connect F H, for the major length of mould. Draw J K parallel to B A, giving the normal point and minor axis, as will be seen at Fig. 35.

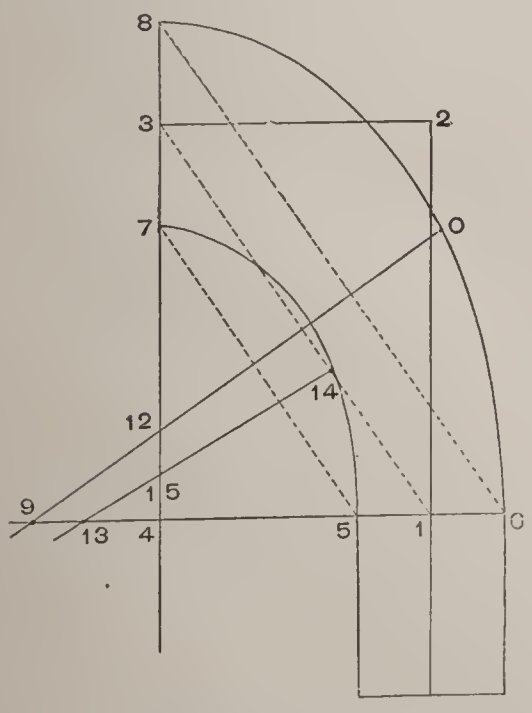


FIG. 33.—MOULD USED IN STARTING AND LANDING STRAIGHT.

Fig. 35. To draw the mould. Let 1 3 equal F H, 1 2 and 1 4 equal F J, and 3 2 and 3 4 equal J G. Let 2 5 equal B E, then 5 will be the centre of the axis. Connect 5 1 and 5 3 for the chord lines. For the centre of rail upon the normal and minor axis, let 5 6 equal E L, and 7 8 the width of rail. Draw the parallel dotted lines to find the width of mould at the ends, as described at Fig. 29. Make the straight wood parallel to the tangents. Find the length of trammel rod for outside, and let 9 12 equal 8 5. Extend to minor axis at 13, giving length required.

For inside, let 0 14 equal 5 7, extend to minor axis at 15, giving length required, and this setting will describe the curves. For bevel take length of dotted line 4 x, and make D M on ground plan equal; then the angle at M will be the bevel required for both ends.

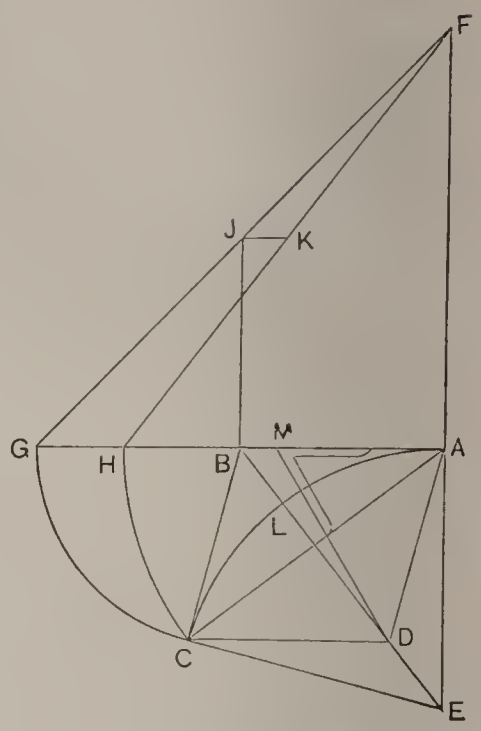


FIG. 34.—OBTUSE BASE WITH TANGENTS OF ONE PITCH.

Fig. 36. An obtuse base or ground plan having tangents of unequal pitch, requiring two bevels. Let A B C D be the base, with E as the centre, from which the curve is described. To find the stretch-out of tangents from B as centre, describe the curve C G. To find pitch and length of tangents: From A to F set up the full hight required. From F apply the pitch, touching the vertical line at K, then from K to F will be the long tangent. Connect K G, giving the short tangent.

To find the major length of mould with A as centre: Describe the curve C H, and connect H F, giving length required. From K draw K J parallel to A B as the point for the sub-normal. The normal proper is on the minor axis, as will be explained further on.

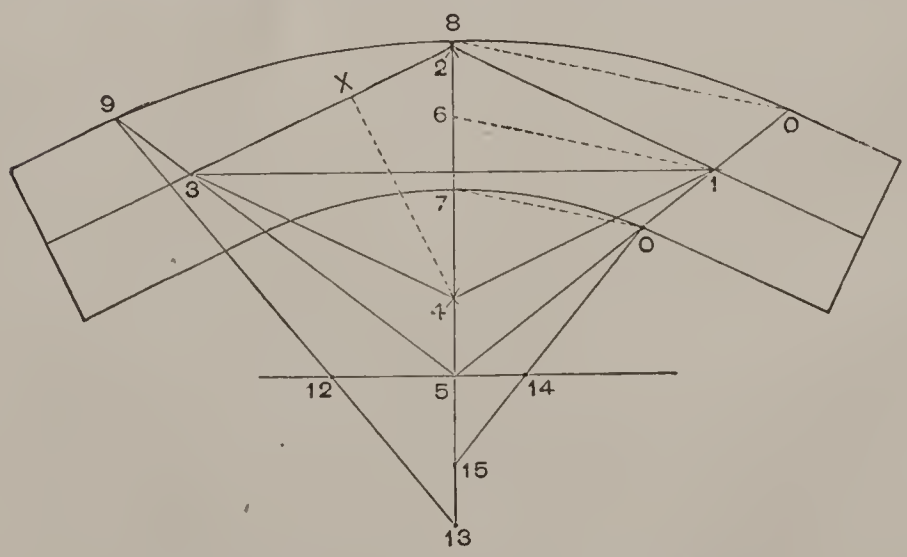


FIG. 35.—SHOWING MANNER OF DRAWING MOULD.

To find the minor length of mould: Extend the tangent G K to to M, as indicated by the dotted line; then from M to F is what is called the difference in hight. For example: we will suppose the hight of the long tangent to be 12 inches, and that of the short tangent 8 inches; then the difference between the two is 4 inches, which is found in this problem at M F. On the minor base line E B, erect perpendiculars from the points E and D, make D N equal to M F, and connect B N, extended to 0; then from B to 0 is the minor length. For the width of mould on

this line, lay down width of rail from L as the centre to P B. Erect the perpendiculars touching at S R.

Fig. 37. To draw the mould. Let 1 3 equal F H; let 1 2 and 3 4 equal F K, and 1 4 and 3 2 equal G K, completing the parallelogram. Connect 2 4 extended, making 4 5 equal to N O; then 2 5 is the minor length, 5 being the corresponding point over E of the ground plan. For the chord line, connect 5 1 and 5 3.

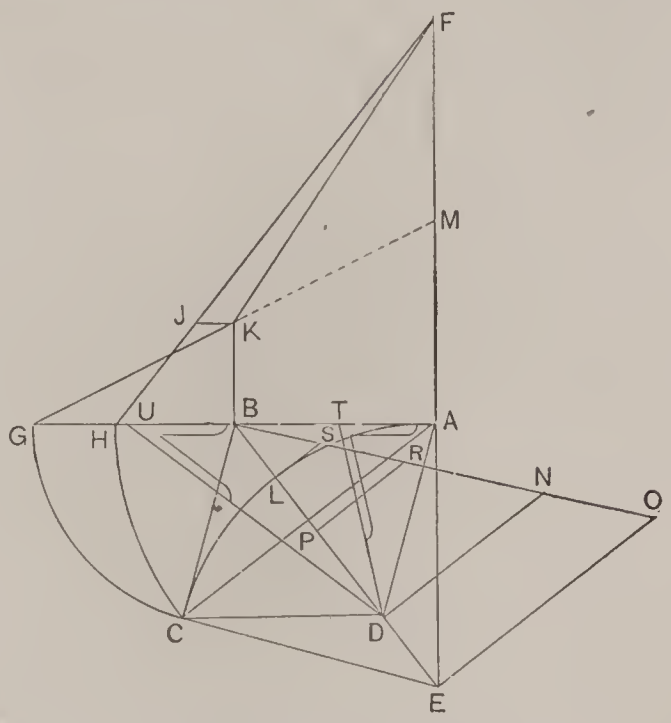


FIG. 36.—OBTUSE BASE WITH UNEQUAL PITCH TANGENTS.

To find the position of the axis. Make 1 6 equal J H, and connect 6 4, giving the sub-normal line. Draw 5 7 parallel to 4 6, then 5 7 is the minor axis and the normal proper. Draw the major axis at right angles to 7 5.

For width of mould on minor length. Let 2 8 9 equal B S R. Draw parallel dotted lines to give the width at the ends described in the previous problems.

For the **bevels,** square from the tangents as indicated by the dotted lines, touching at 4 10 and 4 12. Let D U on the ground plan equal 4 12, then the angle at U is the bevel for the wide end of mould. Let D T equal 4 10, then the angle at T is the bevel for the narrow end.

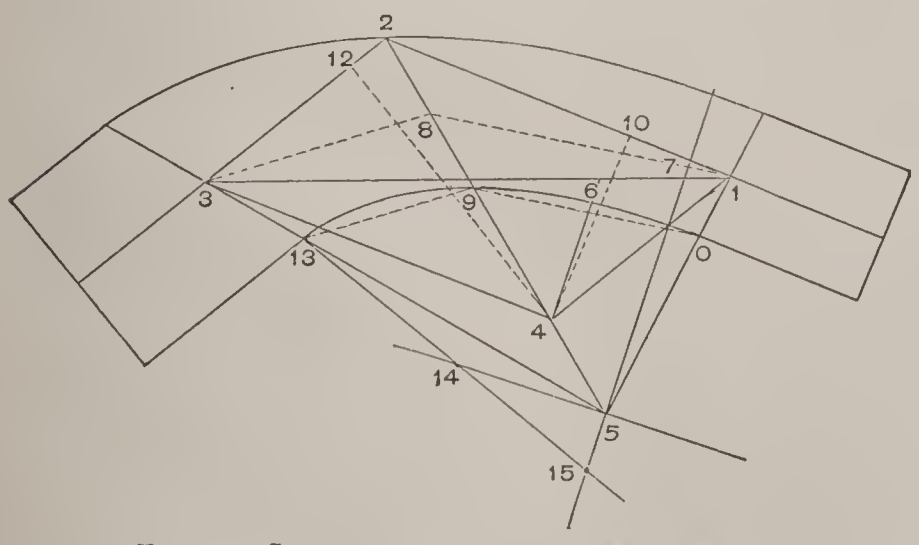


FIG. 37.—SHOWING MANNER OF DRAWING MOULD.

To find the length of trammel rod for inside curve. Let 13 14 equal 5 0, and extend to minor axis at 15, giving length required. The outside will be found in the same manner as already described in the previous problems.

Fig, 38. An obtuse base or ground plan having one pitch and one level tangent, requiring two bevels. The normal line of

this kind of mould will be outside of the parallelogram; consequently the bevels will both be applied from one side.

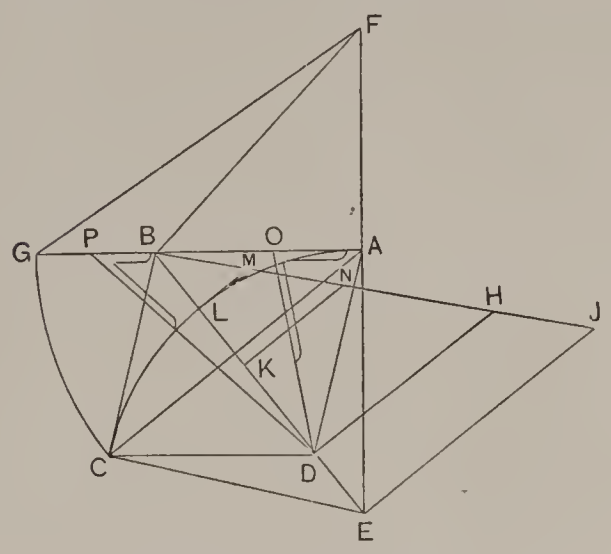


FIG. 38.—OBTUSE BASE WITH ONE PITCH AND ONE LEVEL TANGENT.

Fig. 38. Let A B C D be the base or ground plan, with E as the centre from which the curve is described. A to F will be the hight, F B the length and pitch of tangent. Find major length of mould, with A as centre; describe the curve C G, and connect G F, which gives the length required. Let L K be half the width of rail, and raise the perpendiculars to the points M N. Let D H equal A F. Connect B H extended to J, which will be the minor length, J being the centre of the axis.

Fig. 39. Let 1 3 equal F G, 1 2 equal F B, and 3 2 equal B C. Find the point 4 in the same manner as at 2, finishing the parallelogram. Connect 2 4 extended to 5. Then the points on this line from 2 5 will correspond with those from B J. Connect 3 5 extended, giving the major axis. From 5 at right angles to 3 5 draw the minor axis.

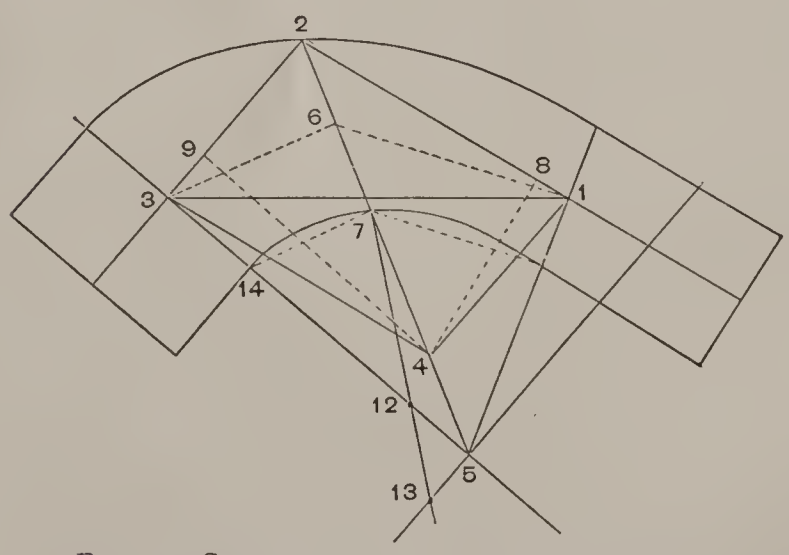


FIG. 39.—SHOWING MANNER OF DRAWING MOULD.

To find the **bevels,** draw the dotted lines at right angles to the tangents 1 2 2 3, terminating at 4, as indicated at 8 and 9. Let O D on ground plan equal 4 8, when the angle at O will be the bevel for the narrow end of mould. Let P D equal 4 9, then the angle at P will be the bevel for the wide end of mould. For the width of mould on minor length, let 2 6 equal M N, and 6 7 equal M B. Draw dotted lines, terminating at the chord lines 1 5 and 3 5, giving width of mould at the chord line.

For length of trammel-rod. Let 7 12 equal E K, and extend to minor axis at 13, which will be the length required, 7 13 being one-half of the major axis 5 14, and will describe the inside curve of mould. Find outside length in the same manner.

Fig. 40. An acute base, or more than a quarter, having tangents of equal length, requiring one bevel to be used on both ends. Let A B C D be the base of tangents, and E centre from which the curve is described. Let A F be the hight. From B as centre, and B C as the radius, describe the curve, touching base line at G. Connect F G, giving length and pitch of tangents. From B draw the perpendicular, touching pitch at J.

For major length of mould, with A as centre, and A C as radius, describe the curve, touching base line at H. Connect F H, giving length required.

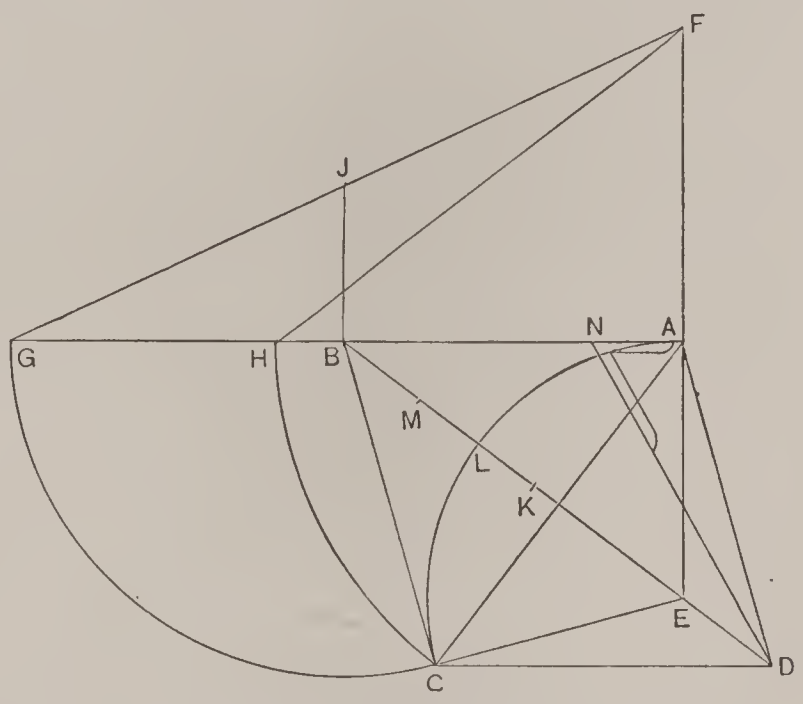


FIG. 40.—ACUTE BASE, TANGENTS OF EQUAL LENGTH.

Fig. 41. Let 1 3 equal F H, 1 2 and 1 4 equal F J, and 3 2 and 3 4 equal J G. Let 2 5 equal B E, giving centre of axis. From 5 draw the chord lines through 1 and 3. Let 5 6 7 8 equal E K L M; then 6 7 8 is the width of rail on the minor axis. Draw through 5 the major axis at right angles to the minor axis. For the bevel, let N D equal 4 3, as indicated by the dotted line, then the angle at N will be the bevel.

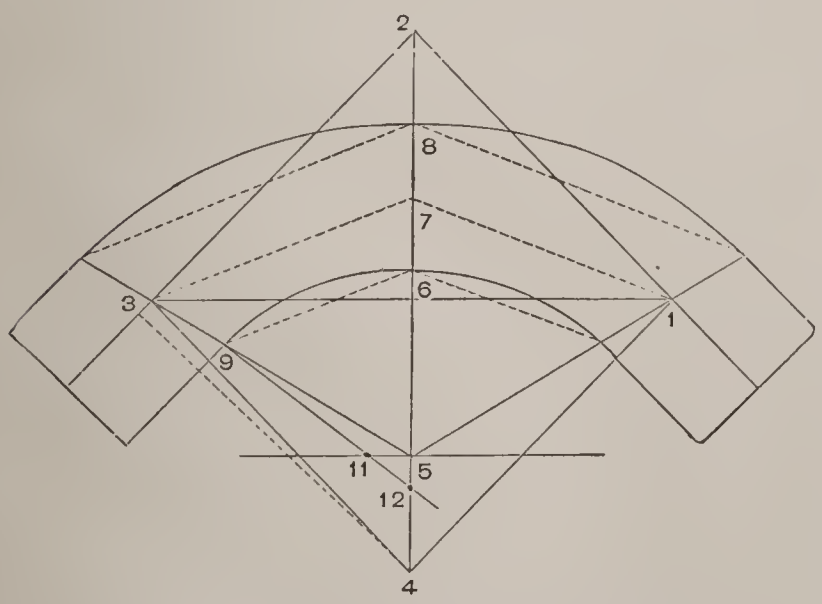


FIG. 41.—SHOWING MANNER OF DRAWING MOULD.

Find the width of mould at the ends by parallel lines already described, for trammel-rod. Let 9 11 equal 6 5, extend to minor axis at 12, giving length required, which will describe the inside curves. Find the outside length in the same manner.

Fig. 42. An acute base having unequal pitches, requiring two bevels. Let A B C D be the base or ground plan, and E

centre from which the curve line is described. From A to F set up the full hight. From B erect the perpendicular indefinitely. From F apply the pitch, cutting the perpendicular at J. From B as centre and B C as the radius, describe the curve C G. Connect G J, giving the length of short tangent. For major length, take A for a centre and A C as the radius, describe the curve C H, and connect H F, giving length required.

To find the point for sub-normal, from J draw the line J K parallel to A B, cutting the major length at K.

For minor length of mould, extend the tangent G J, as indicated by the dotted line, cutting the perpendicular at Y. Then erect the perpendiculars from D E O P R. Let D M equal F Y, and connect M B,

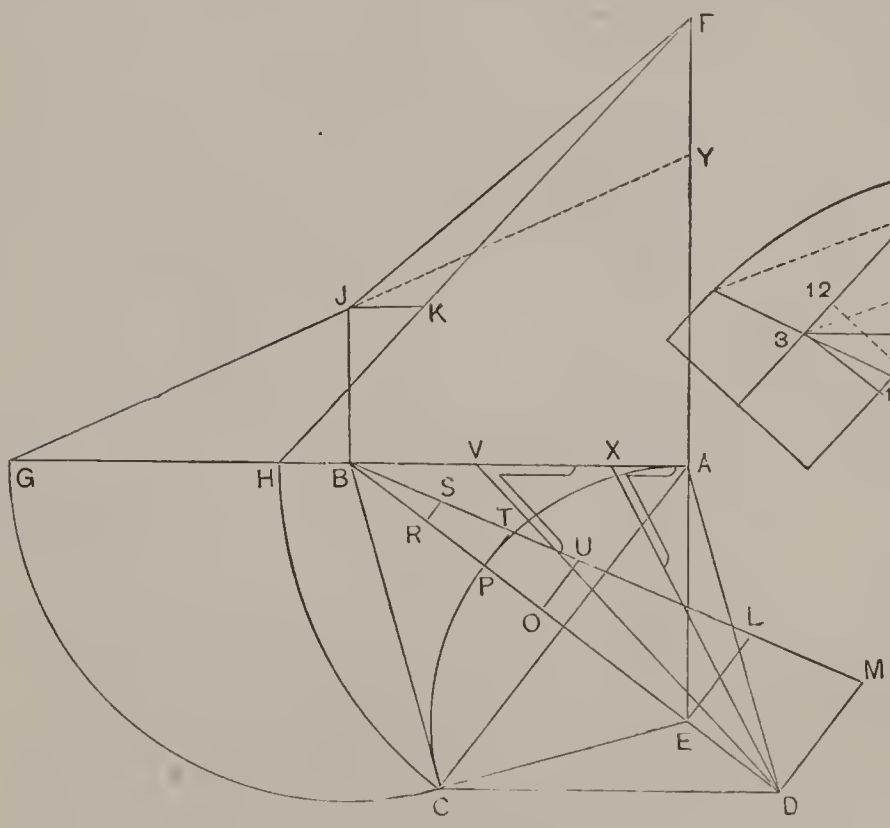


FIG. 42.—ACUTE BASE WITH UNEQUAL PITCHES.

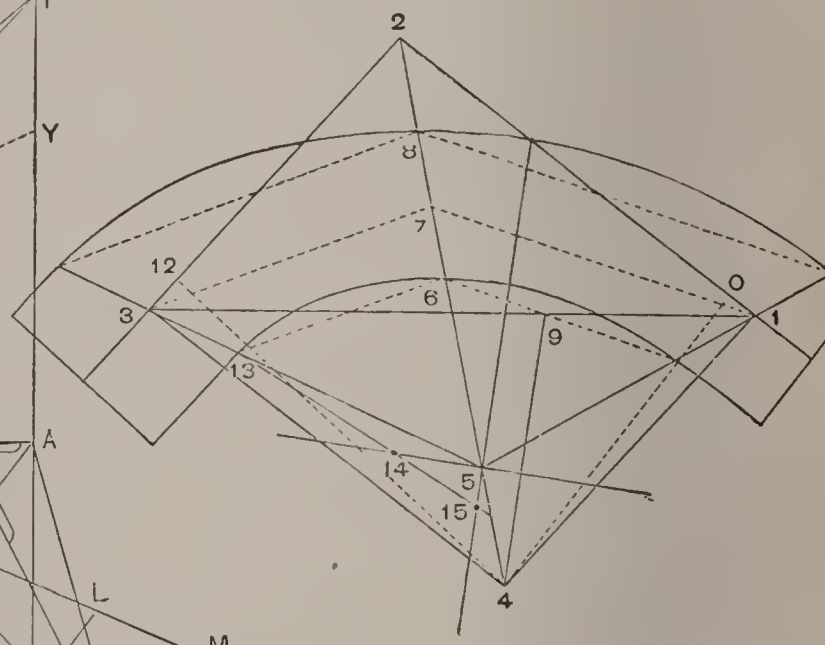


FIG. 43.—MANNER OF DRAWING MOULD.

which gives the minor length of mould as required. Then S T U will be the width of mould as applied at Fig. 43.

Fig. 43. Let 1 3 equal F H, 1 2 and 3 4 equal F J, and 3 2 and 1 4 equal J G, completing the parallelogram. Make all points on the minor length from 2 4, equal all points from B M. To find the sub-normal, let 1 9 equal H K, and connect 9 4, giving sub-normal. From 5 draw the minor axis parallel to 4 9, and at right angles draw the major axis. The minor axis is the normal point of mould as explained in Figs. 37-39. Again the points 4 and 5 are reversed from those in Figs. 37-39, etc. 4 in each case forms the parallelogram, and 5 corresponds to the

ground plan at E, and from which the curves are described. Then 5 will be plumb over the point E, when in position, and must be the centre of axis. The chord lines are drawn from 5 to 1 and 5 to 3. For the width of mould at ends, proceed in the manner already described, no further explanation being required.

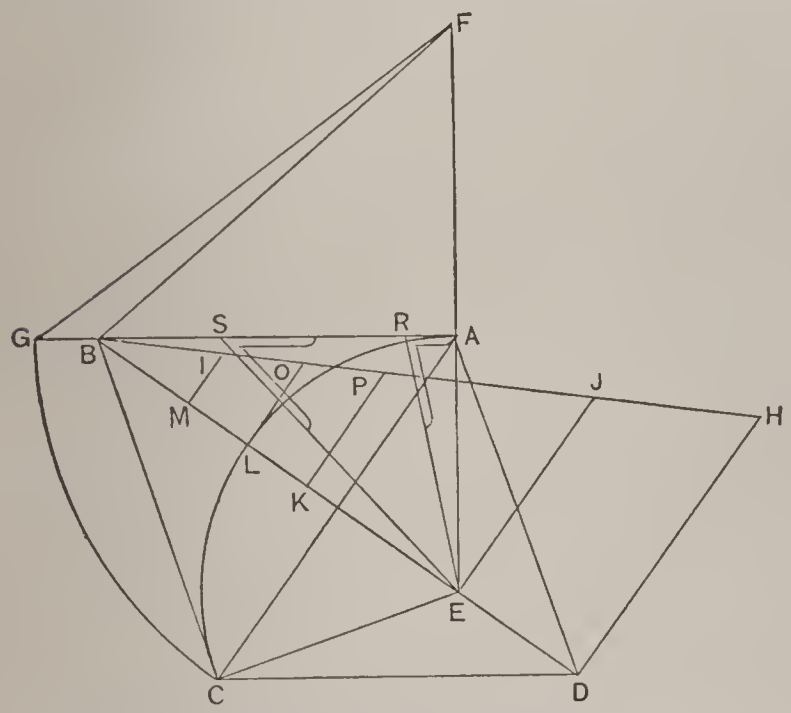


FIG. 44.—ACUTE BASE WITH ONE PITCH AND ONE LEVEL TANGENT.

For **bevels** in like manner as described. D X equals 4 0; then the angle at X is the bevel for the long tangent. Let V D equal 4 12; then the angle at V is the bevel for the short tangent.

For length of trammel-rod. Let 13 14 equal E 0, extend to minor axis at 15, giving length required. Find outside length in the same manner.

Fig. 44. An acute base or ground plan having one pitch and one level tangent, requiring two bevels. Let A B C D be the ground plan of tangents, with E as the centre from which the curve is described. From A to F, set up the hight, connect F B, giving pitch and length of tangent. For major length, with A as centre and A C as radius, describe the curve C G and connect F G, giving the length required to draw the mould. From D E K L M erect perpendiculars. Let D H equal A F, connect H B. H B will be the minor length and N O F the width of mould required.

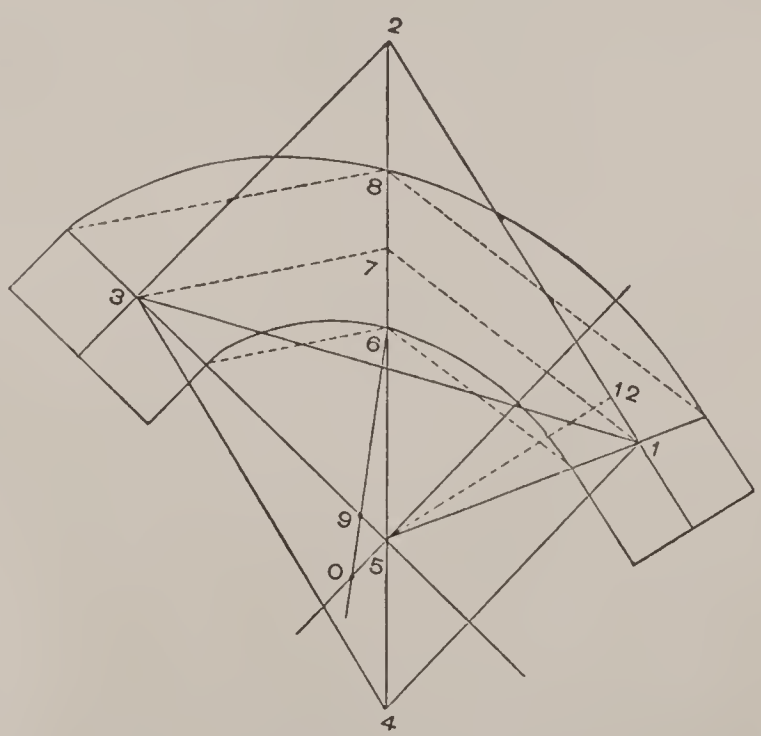


FIG. 45.—MANNER OF DRAWING MOULD.

Fig. 45. Let 1 3 equal F G; 1 2 and 3 4 equal F B; 3 2 and 1 4 equal B C, completing the parallelogram. Connect 2 4, and make 4 5 equal H J. 5 is the centre of axis, and the lines 5 1 and 5 3 will be the chord lines. 5 3 is also the major axis. Draw minor axis at right angles. For width of mould, let 6 7 8 equal P O N. For the width at the ends, find in the usual way by parallel lines. For trammel-rod, let 6 9 equal E K, extend to minor axis at 0, giving length required.

For **bevels**, let E R equal 5 12; the angle at R will then be the bevel for the long tangent. Let E S equal 3 5, when the angle at S will be the bevel for the short tangent.

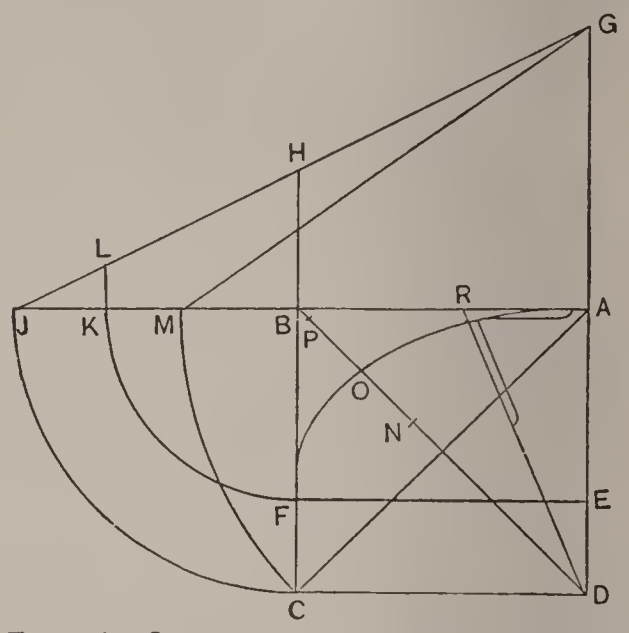


FIG. 46.—QUARTER ELLIPSE WITH TANGENTS OF EQUAL PITCH.

Having completed the nine problems as including all those of a true circle, we will now take those employing the Elliptical form, following in the same order and treating them in the same manner, viz: That the base or ground plan must have the short sides or tangents made equal to the long sides, because in hand-railing it is necessary to cross the curve as nearly square as possible. By connecting B D, Fig. 46, we cross the curve line at 0.

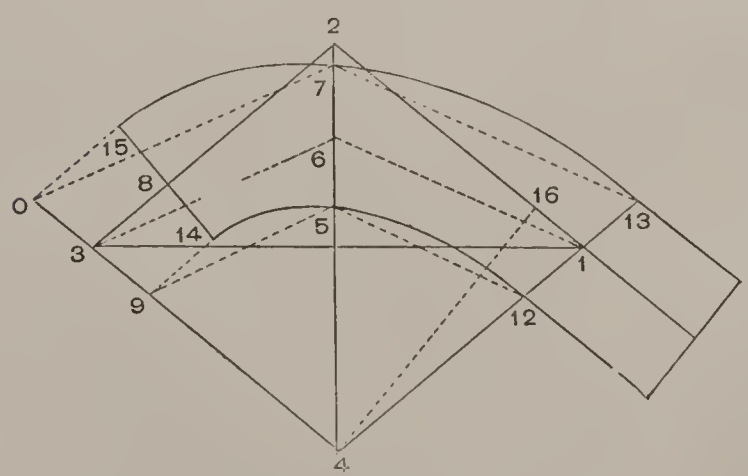


FIG. 47.—MANNER OF DRAWING THE MOULD.

Fig. 46 shows a quarter Ellipse with tangents of equal pitch. Let A B F E be the portion to draw the mould, C D being added. From A to G set up the hight. From B as centre and B C as radius, describe the curve, touching at J. Connect G J, giving the pitch and length of tangent. Extend C F B, cutting the tangent elevation at H. From B describe the curve F K, erect a perpendicular from K, cutting the tangent elevation at L. For major length of mould, with A as centre, and A C as radius, describe the curve C M. Connect G M, giving length required. It will require

additional hight in proportion as the short tangent has been lengthened ; this will be found at K L as the hight added. For the width of mould from O as the centre make N P equal to the width required.

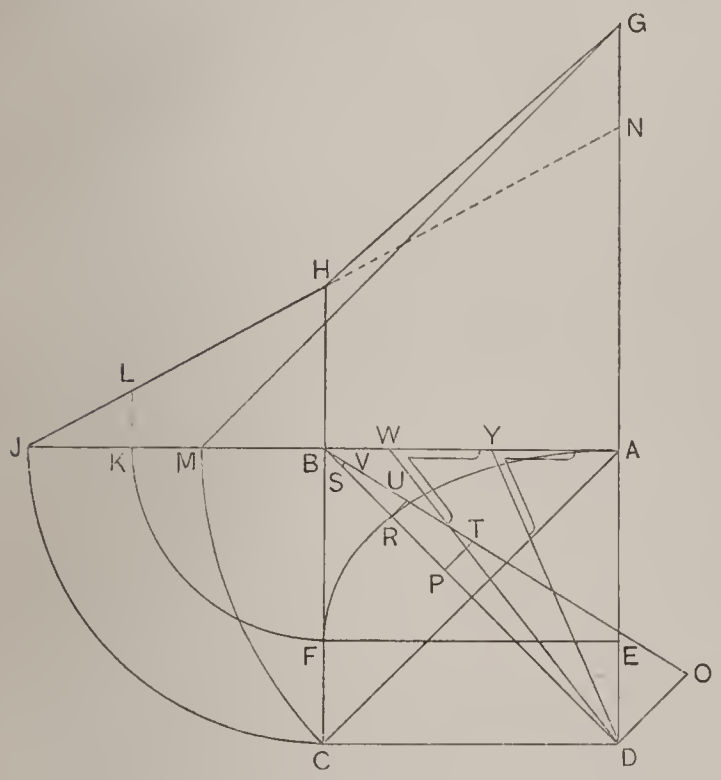


FIG. 48.—QUARTER ELLIPSE, TANGENTS OF UNEQUAL PITCH.

Fig. 47. mould. To draw the Let 1 3 equal G M, 1 2 and 1 4 equal G H, 3 2 and 3 4 equal H J; then complete the parallelogram. To make the joint on short tangent, let 2 8 equal H L and make the joint square from tangent 2 3. For the width of mould in centre, let 4 5 6 7 equal D N O P. From 5 6 7 draw the dotted parallel lines in the usual manner. From 9 O draw back parallel to the tangent, cutting the joint at 14 15. For outside curve use the flexible strip, letting it touch the points 15 7 13. The inside curve is found in the same manner from 14 5 12, completing the mould.

For **bevel,** let D R equal 4 16, the angle at R being the bevel for both ends.

Fig. 48. A quarter ellipse with tangents of unequal pitch, requiring two bevels. Let A B F E be the position to draw the mould, with C D added. A to G is the hight. From G apply the pitch for the long tangent, cutting the perpendicular B H at H. With B as a centre, describe the curves F K and C J. Connect J H, giving length and pitch of short tangent. With A as a centre describe the curve C M, and connect G M, giving the major length of mould. From K draw the perpendicular K L, cutting tangent line at L. Extend J H to N, as indicated by the dotted

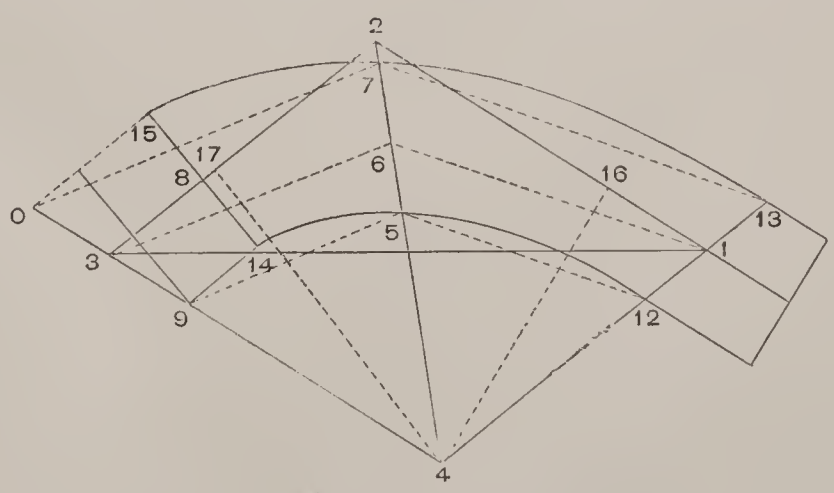


FIG. 49 —MANNER OF DRAWING MOULD.

line. For minor length, from D erect the perpendicular D O equal to N G; connect O B, giving length required. Let P S be the width of the rail.

Fig. 49. Let 1 3 equal G M; 1 2 and 3 4 equal G H; 3 2 and 1 4 equal J H, and 2 8 equal H L. At 8 make the joint square from the tangent 2 3. Let 4 5 6 7 equal O T U V. From 5 6 7 draw the parallel lines for width of mould at the ends, as explained in Fig. 45. Draw curves in like manner through 13 7 15, also through 14 5 12. Find the bevels in manner explained in all previous problems.

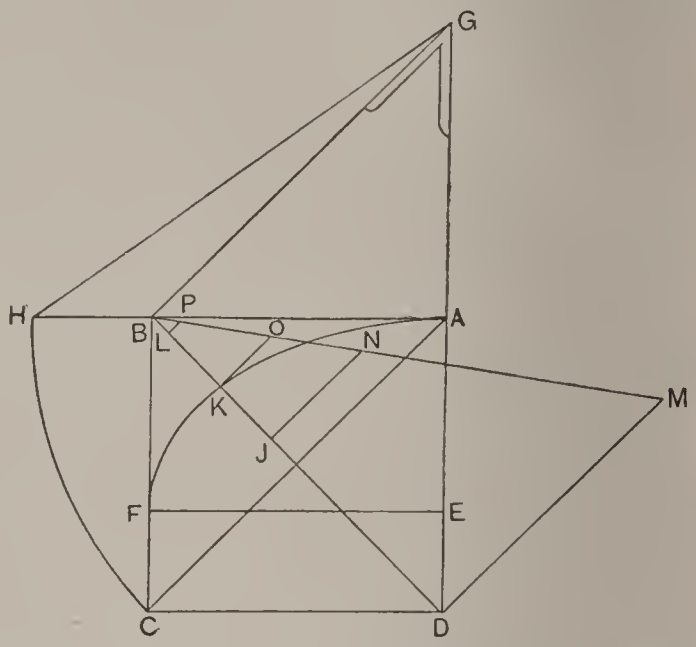


FIG. 50.—QUARTER ELLIPSE, SINGLE PITCH, LEVEL TANGENT, ONE BEVEL.

Fig. 50. A quarter ellipse having a single pitch with a level tangent requiring one bevel. Let A B F E be the portion to draw the mould, with C D added. From A to G set up the hight. In this figure there is no extra hight required, as it takes in the long tangent only. Connect G B, giving pitch and length of tangent required. For major length, with A as centre and A C as radius, describe the curve C H. Connect G H, giving length required. For minor length, let D M equal A G, as required.

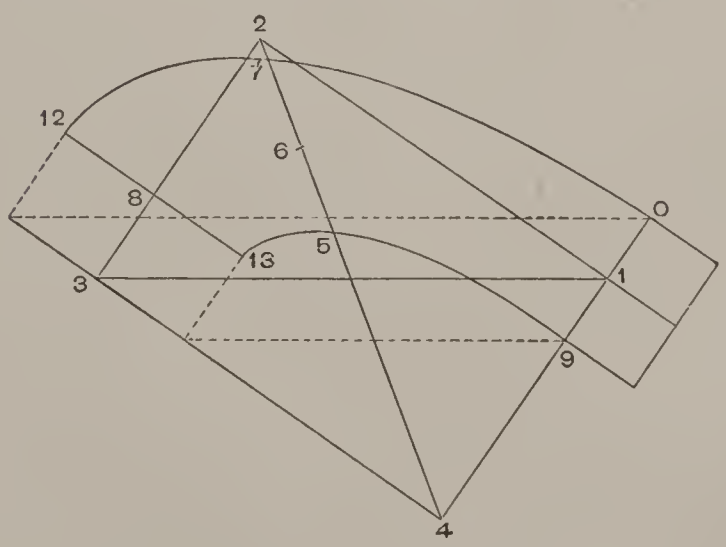


FIG. 51.—MANNER OF DRAWING MOULD.

Fig. 51. Let 1 3 equal G H; 1 2 and 3 4 equal G B, and complete the parallelogram. Connect 2 4 as the minor length. Let 4 5 6 7 equal M N O P, and make 9 1 0 equal to J K L. For the width on the wide end at 3, draw the parallel lines in the usual manner. For length of short tangent let 2 8 equal B F; draw curved lines through the points indicated 12 7 0 and 13 5 9. The angle formed at G is the bevel to be applied at the wide or level end, as at 3.

Fig. 52. An obtuse base with Elliptical curve, having tangents of equal pitch, requiring one bevel. Let A B F E be the portion to draw the mould, with C D added. From A to G set up the full hight as required for extra length from F C, for length of tangents. With B as centre and B C as radius, describe the curves C M. Connect G M, giving length and pitch of tangents. With B as a centre describe F J, draw the perpendicular J L, cutting the tangent line at L. With A as a centre describe C K and connect G K, giving major length of mould. From B erect the perpendicular B N, cutting the tangent line at N.

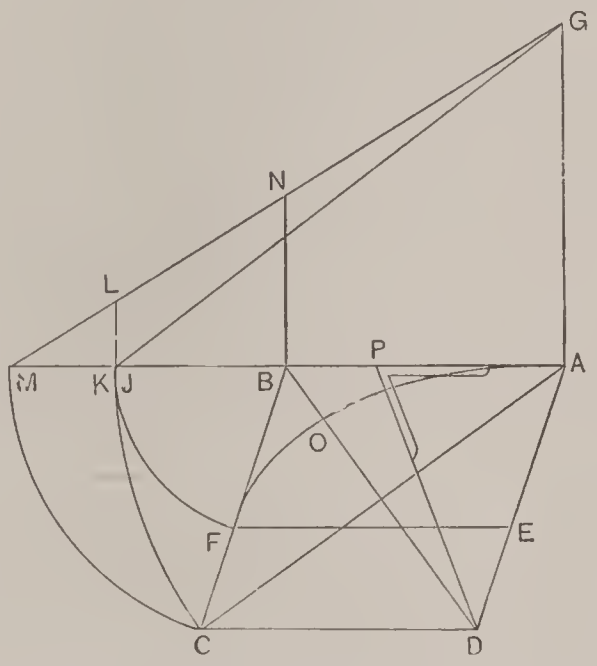


FIG 52.—OBTUSE BASE WITH ELLIPTICAL CURVE TANGENTS OF EQUAL PITCH, ONE BEVEL.

Fig. 53. Let 1 3 equal G K; 1 2 and 1 4 equal G N; 3 2 and 3 4 equal N M, and complete the parallelogram. For joint, let 2 7 equal N L, and make joint at 7 square from tangents. For width of mould on minor line, let 4 6 equal D O, and from 6 as the centre make 5 2 equal to the width required. For the width at end draw the parallel lines in the usual manner. For the bevel, let D P equal 4 8. The angle at P gives the bevel for both ends.

Fig. 54. Form of base similar to Fig. 52, but with tangents of two pitches, requiring two bevels. Let A B F E be the portion to draw the mould for with C D added. Find length and pitch of tangents. From A G as the hight, apply the pitch from G, cutting the perpendicular B H at H, and connect H J. Then G H is the long tangent and H J the short one. With A as centre and A C as a radius, find the point M; connect G M for major length. For the minor length, from D erect the perpendicular D O equal to N G, and connect O B, giving the length required. From P as the centre of mould and R as half the width, erect the

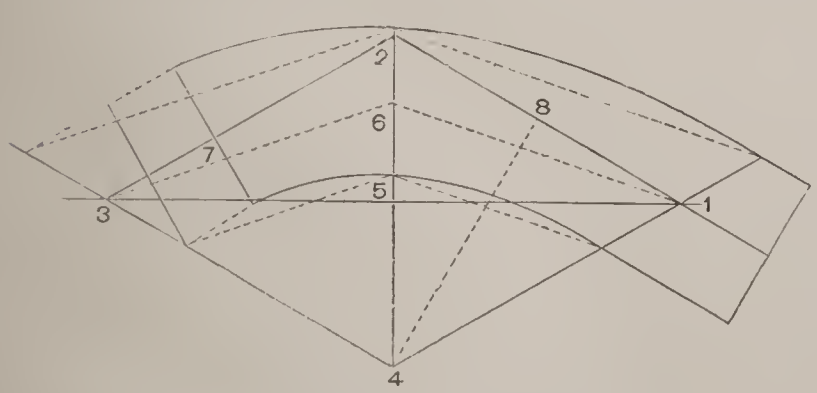


FIG. 53.—MANNER OF DRAWING MOULD.

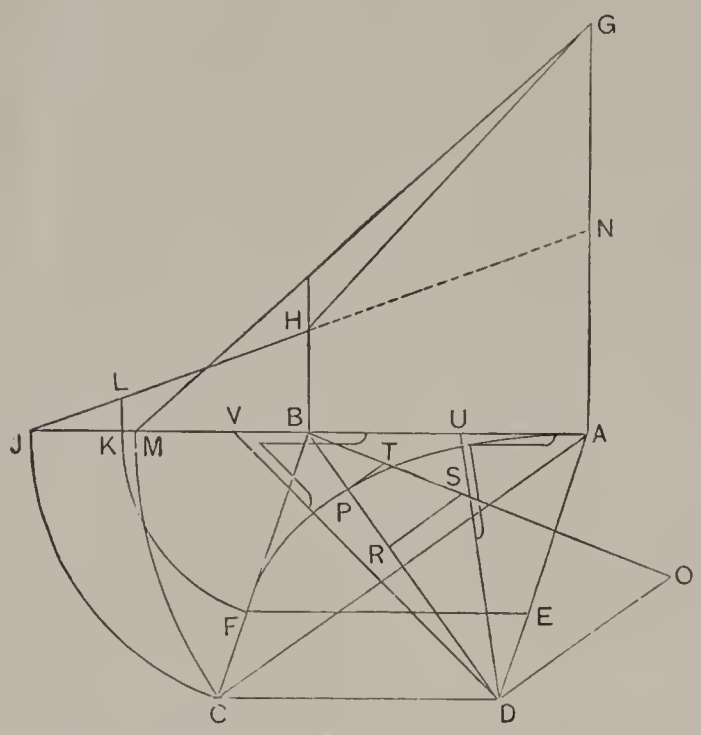


FIG. 54.—BASE SIMILAR TO 50, WITH TWO BEVELS.

perpendiculars, cutting the minor length O B at S and T.

Fig. 55. Let 1 3 equal G M; 1 2 and 3 4 equal G H; 1 4 and 3 2 equal J H, and complete the parallelogram. Let 2 7 equal H L, and at 7 make joint square from tangent. For centre and width of mould, let 4 5 6 2 equal O S T B. For the width at ends, draw the parallel lines as indicated and complete the mould by drawing the curves.

For the bevels, let D U equal 4 8, the angle at U being the bevel for long tangent. Let D V equal 4 9, when V gives the bevel for the short tangent.

Fig. 56 shows a base similar in form to Figs. 52 and 54, but with a simple pitch tangent, and a level tangent requiring two bevels, the same as for a turnout easement. Let A B F E, Fig. 56, be the portion to draw the mould, with C D added. From A to G set up the full hight and connect G B, giving the length and pitch of tangent. For major length, from A as centre and A C as radius, describe the curve C H, and connect G H, giving length required. For minor length, from D erect the perpendicular D L equal to A G, and connect L B, giving length required. For width of mould on minor length. From J as centre of mould, and J K as half the width, erect the perpendiculars, cutting the line B L at O and P.

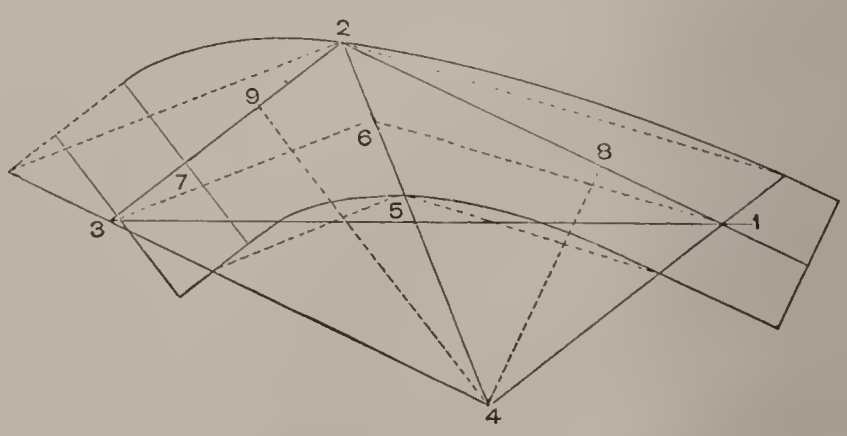


FIG. 55.—MANNER OF DRAWING MOULD.

Fig. 57. Let 1 3 equal G H; 1 2 and 3 4 equal G B; 1 4 and 3 2 equal B C, and complete the parallelogram. Connect 2 4 as the minor length. For width of mould, let 4 5 6 2 equal L P O B. For width at the ends, draw the parallel lines as

indicated. For joint on short tangents, let 2 7 equal B F, make joint square from tangent, and complete the mould by drawing the curved line in the usual manner. For the bevels, let 4 8 equal D R; the angle at R will then be the bevel for the long tangent. Let 4 7 equal D S; the angle at S will then be the bevel for short tangent.

An acute angle base with an elliptical curve, having tangents of equal pitch, and requiring one bevel to be applied at both ends.

Fig. 58. Let A B F E be the portion to draw the mould, with C D added. From A to G set up the full hight. With radius B C, describe C H, connect G H, giving length and pitch of tangents. With radius A C, describe C K, and connect G K, giving major length. From J B erect the perpendiculars, cutting the tangents at M and L. Draw S T parallel to A B, the distance between to be equal to the width of mould at its normal point, and where the bevel D P crosses this line will be the width of the mould at the ends P and V.

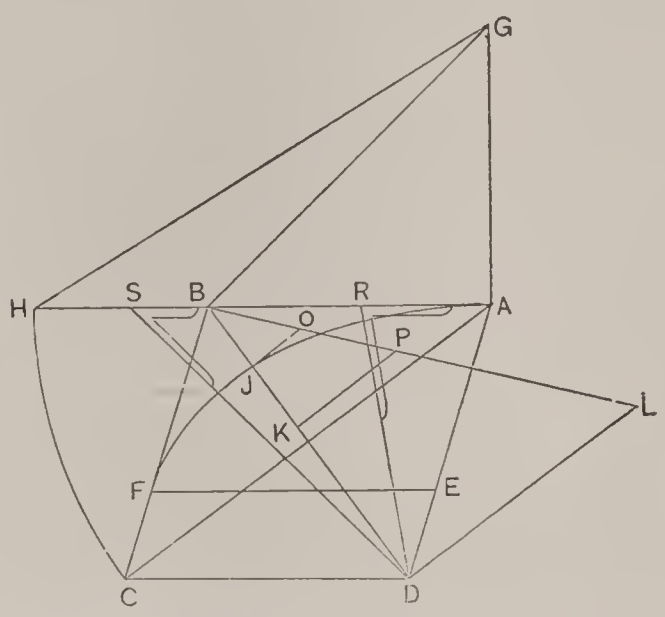


FIG. 56.—BASE SIMILAR TO FIGS. 52 AND 54, SINGLE PITCH AND LEVEL TANGENT, TWO BEVELS.

Fig. 59. Let 1 3 equal G K; 1 2 and 3 4 equal G L; 3 2 and 1 4 equal L H, and complete the parallelogram. Connect 2 4 as the minor length. Let 4 5 6 9 equal D U O R. Let 8 12 equal P V as the width at both ends. Complete the mould by drawing the curved line through the points indicated. For joints on short tangent, let 2 7 equal L M, and draw square from tangent, giving point required. For the bevel, let D P equal 4 O; the angle at P will then be the bevel required for both ends of the mould.

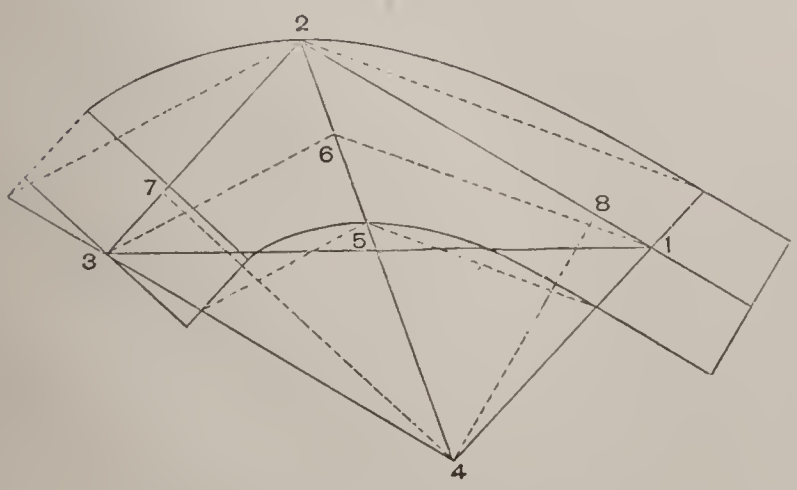


FIG. 57.—MANNER OF DRAWING MOULD.

An acute angle base with an elliptical curve, having tangents of unequal pitches, requiring two bevels.

Fig. 60. Let A B F E be the portion to draw the mould, with C D added. From A to G, set up the hight. From B erect the perpendicular B M, and at G apply the pitch, cutting the perpendicular at M for long tangent. From B as centre describe the curve F J. From J erect the perpendicular, cutting the tangent at L. For major length of mould, from A as centre, describe the curve C K, connect G K, giving length required. Extend H M to N, as indicated by the dotted line. For minor length, from D erect the perpendicular D O equal to N G; connect O B, giving length required. Let R P S be the width of rail, and erect perpendiculars, cutting the minor length at V U and T. Draw W X parallel to A B and equal to R S.

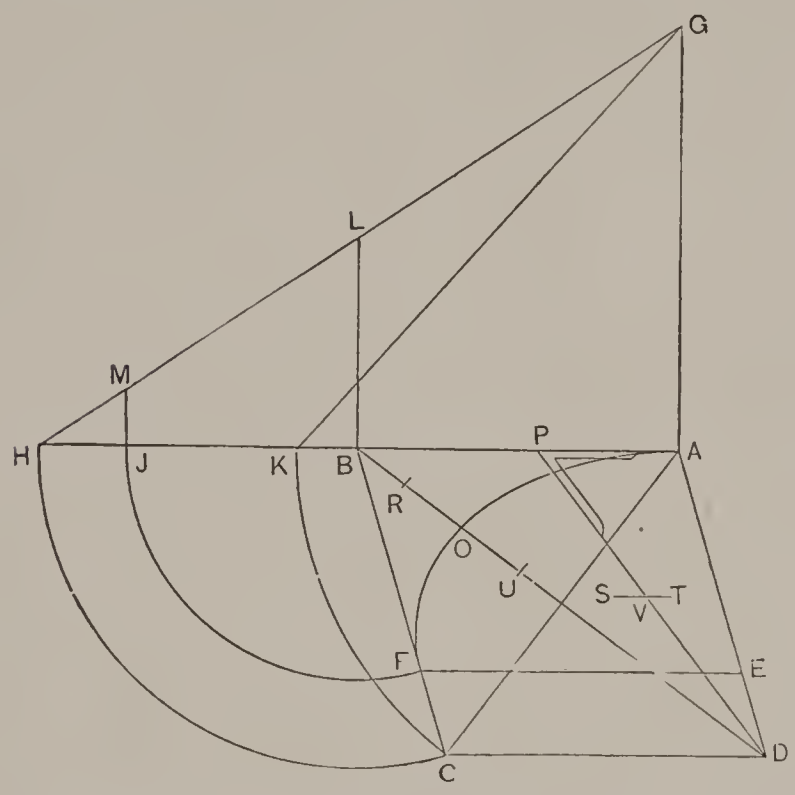


FIG. 58.—ACUTE ANGLE BASE, ELLIPTICAL CURVE, TANGENT OF EQUAL PITCH.

Fig. 61. Let 1 3 equal G K; 1 2 and 3 4 equal G M. Let 1 4 and 3 2 equal H M; complete the parallelogram and connect 2 4 as the minor length. For joint on short tangent, let 2 8 equal M L. For width on minor length, let 4 5 6 7 equal O V U T. For bevels, let D Z equal 4 14, then the angle at Z is the bevel for long tangent. Let D Y equal 4 15, then the angle at Y is the bevel for the short tangent. For width of mould at the ends, let O 9 equal Y W; 12 13 equal X Z, and complete the mould by drawing the curves through the points indicated.

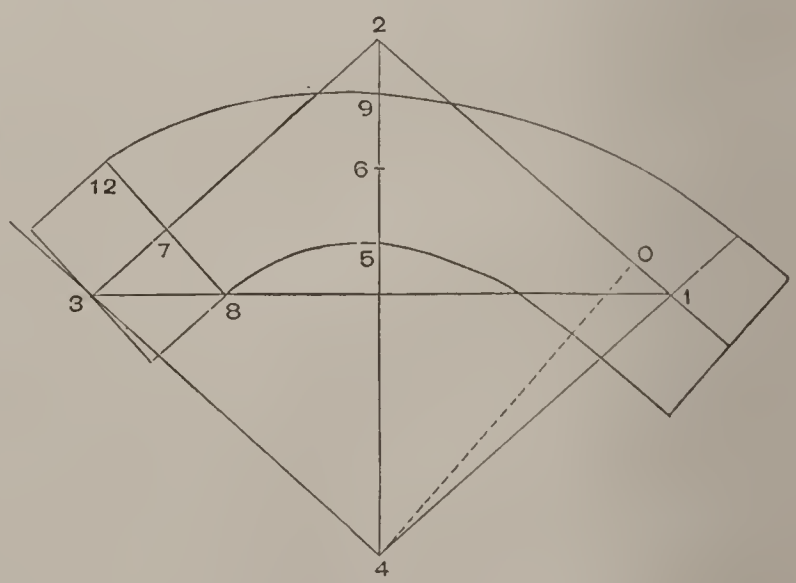


FIG. 59.—MANNER OF DRAWING MOULD.

An acute angle base with an elliptic curve, having one pitch and one level tangent, requiring two bevels.

Fig. 62. Let A B F E be the portion to cover with the mould, C D added. From A to G set up the hight; connect G B, giving length and pitch of tangent. From A as centre, describe the curve C H and connect G H, giving major length of mould. For minor length, from D erect the perpendicular D J equal to A G and connect J B, giving the length required. Let K L M equal the width of rail, erect the perpendiculars, cutting the minor length at N O and P. Draw T U parallel to A B and equal to K M.

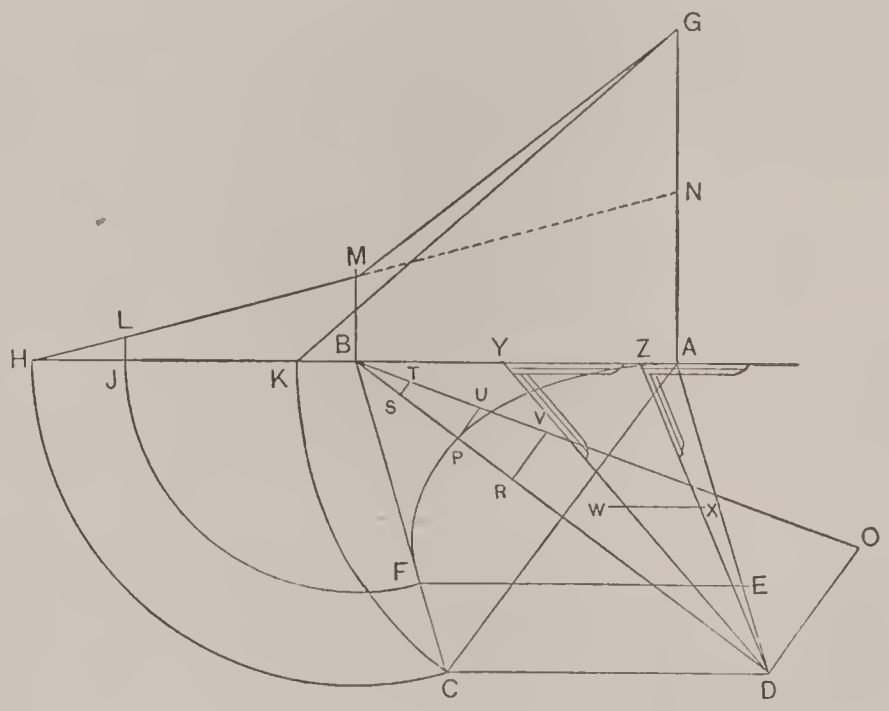


FIG. 60.—ACUTE ANGLE BASE, TANGENTS OF UNEQUAL PITCH.

Let 1 3 equal G H; 1 2 and 3 4 equal G B; 1 4 and 3 2 equal C B, and complete parallelogram. Connect 4 2 as the minor length. For the joint on short tangent, let 2 8 equal B F. For width on minor length, let 4 5 6 7 equal J N O P. For the bevels, let D S equal 4 14, then the angle at S is the bevel for long tangent. Let D R equal 4 15, then the angle at R is the bevel for short tangent. For width of mould at the ends, let 9 O equal T R, and 12 13 equal U S. Complete the mould by drawing the curves through the points indicated.

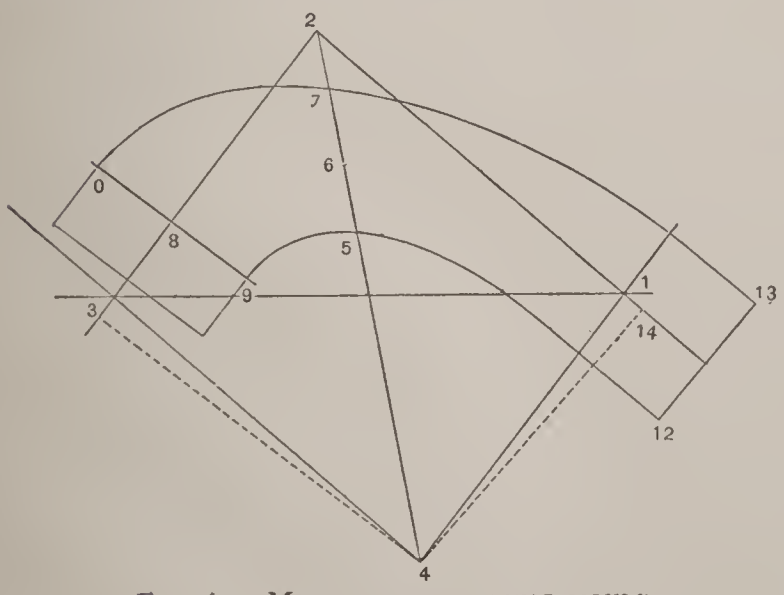


FIG. 61.—MANNER OF DRAWING MOULD.

The plan of a straight flight of stairs, drawn to a scale of ¾ inch to the foot. The landing-rise is placed at the chord line, the cylinder

being 8 inches in the clear. The centre of the rail is drawn ½ inch on, as indicated by the dotted line. The risers are 7½ inches and the treads 10 inches, which is the size of the pitchboard.

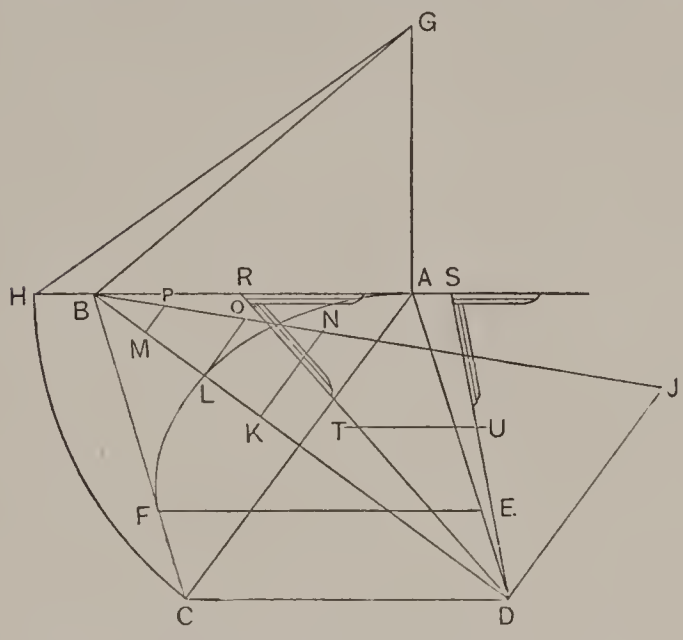


FIG. 62.—ACUTE ANGLE BASE TANGENTS, SINGLE PITCH AND LEVEL.

Fig. 64 is the **plan of stairs.** A, centre of cylinder; B B, centre of rail and tangent line; C, joint through centre of the cylinder. A1 and A2 are the risers; D, centre of the short baluster, at which point the bottom line of the rail must rest.

Fig. 65 shows the piece from which the rail is to be made placed in position, and with the bevel applied at E.

Fig. 66 shows the **level mould** drawn over the ground plan of cylinder from the centre at A. B X is the straight wood, which may be varied as to length, according to circumstances, and will be made from 3½ or 4 inch plank.

Fig. 67 is the piece as it will be when squared up. F G shows the centre line or tangent, from which the mould is to be drawn.

Draw the chord line B B, extended indefinitely. Draw from C as the centre of mould parallel to B B indefinitely. From the line F C apply the pitch at F, giving the inclination of tangent F G through centre of plank, which must be 3½ or 4 inches thick.

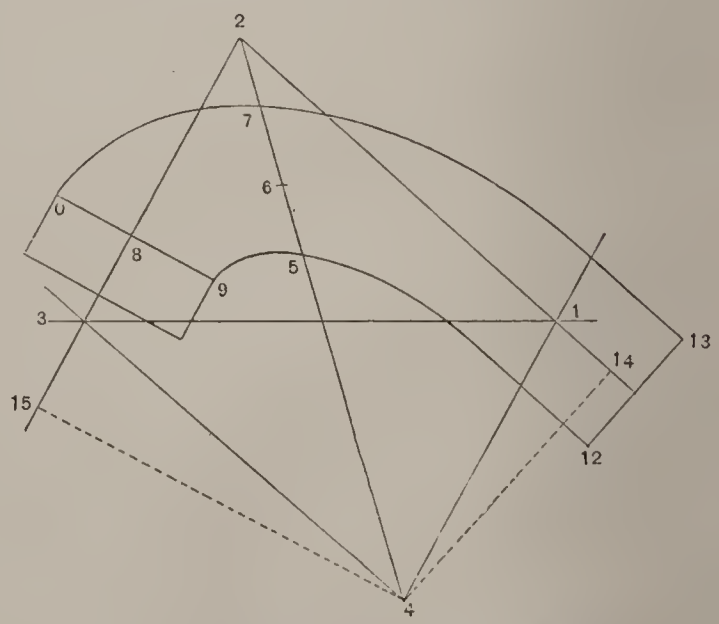


FIG. 63.—MANNER OF DRAWING MOULD.

Fig. 68. To draw the mould, let 1 2 equal F G, Fig. 67, and 2 3 equal A C, Fig. 64. From the parallelograms, with 4 as the centre of the axis, let 6 8 equal the width of rail, 3½ inches. Let 5 7 equal H J, Fig. 67.

Fig. 69. To find the length of rods to strike the ellipsis. For the outside curve, let 9 0 equal 4 8, Fig. 68; and let 9 12 equal

4 7, Fig. 68. For inside, let 13 14 equal 4 6, Fig. 68; and let 13 15 equal 4 5, Fig. 68. The rods as applied are shown at Fig. 68, and for fuller explanations refer to Figs. 31-33.

GENERAL PRACTICE.

Fig. 70 shows the **level piece of rail squared up,** having an easement. A B, thickness of plank; C D, thickness of rail; E, the floor line; C, the under side of rail, 4 inches from the floor, and at F, 3½ inches, giving an easement of ½ inch, completing the turn. A plan of stairs starting with a curve, commonly called a turn-out or offset, showing how to calculate the hight of the newel.

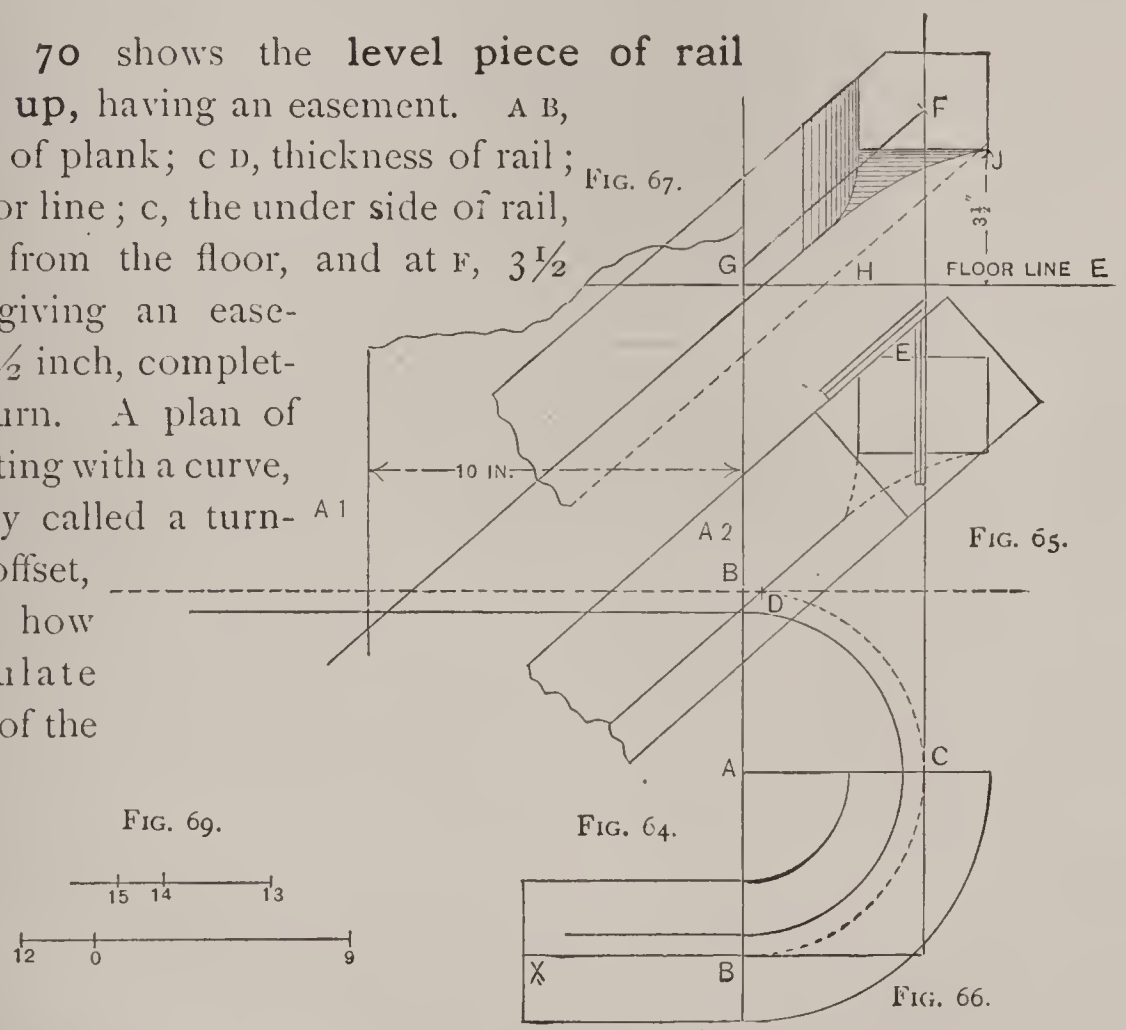


Fig. 67.

Fig. 65.

Fig. 64.

Fig. 66.

Fig. 69.

Fig. 64.—Plan of stairs.
Fig. 65.—Piece from which rail is made.
Fig. 66.—Level mould on ground plan.
Fig. 67.—Section of rail squared.
Fig. 69.—Scale.

In this case the hight is made to agree with the rail, and will give a full easement in the rail. Scale, ¾ inch to the foot.

Fig. 71. Let A B C D be the ground plan, with E as the point from which the curve is described; the lines 1 2 3 4 represent the rise lines, and the broken lines the ends of tread. The dotted lines are the centre of rail, and the points as described on this line are the centre of balusters. In locating the position of the rail, the short baluster is used as the point of contact for the bottom of the rail, oo being the width of rail.

The centre of the newel is located on the face of the first rise. The mitre is drawn first to determine the end of the rail or point of the mitre. The line H H, crossing at the intersection of the rail and cap, is called the cheek line, and is used to make the mitre in the cap as the guide to square into the centre.

For length and pitch of tangent. From the base line A B apply the pitch-board, and from the point touching at B extend the pitch, cutting the perpendicular line A F at F; then B F is the length of tangent and A F the hight. B C is the length of level tangent. For major length of mould, with A as centre, and A C as radius, draw C G, and connect F G, giving length required. For minor length, from D erect the perpendicular D J, equal to A F; connect B J, extended to K, cutting the perpendicular erected from E. From O O erect the perpendiculars, cutting the line B J K at L L. Having made all the lines from which to draw the mould, draw it on the board or paper, which is to be cut out for use, thereby saving time.

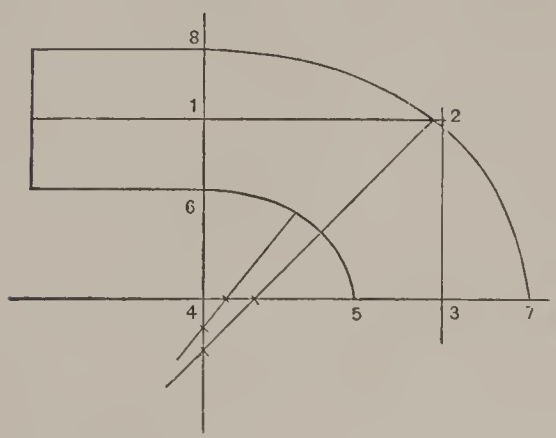


FIG. 68.—MANNER OF DRAWING MOULD.

Fig. 72. Let 1 3 equal F G; 1 2 and 3 4 equal F B; 1 4 and 3 2 equal B C. Connect these points, completing the parallelogram. Connect 2 4, extend to 5, equal to B K. From 5 as the centre, draw lines crossing at 1 and 3, which will be the chord line; 3 and 5 is also the major axis. Having fully explained the axis in the previous problems, hereafter we will give the points through which to draw the curves, using the flexible strip as the most convenient to accomplish the desired end.

For the bevels, set the compasses equal to D N, place one foot in 4, describe the segment 6, draw a line parallel to 1 3, touching the segment at 6. For the bevel at 1, set the compasses in 4, extend to the tangent line 1 2, as indicated by the dotted line; describe it until it touches the line at 7, draw back to 4, then the angle at 7 is the bevel. For the other end, extend the compasses to 8, as indicated by the dotted line, describe the curve, touching at 9, and draw back to 4; then the angle at 9 is the bevel for the end at 3. For the width of mould at the ends, let 6 O equal the width of the rail, draw the dotted line as indicated parallel to

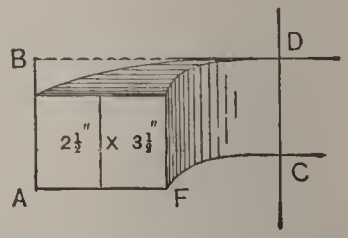


FIG. 70.—SHOWING LEVEL PIECE SQUARED.

7 9, cutting the bevel lines at 12 13. For the end at 1, make it equal to 7 13; and for 3, make it equal to 9 12. For centre, let 4 x x equal J L L. Then through the points thus made draw the curve, completing the mould.

Fig. 71. For the hight of Newel, let M be the under side of the rail, over the short baluster S, on the third step from M. Drop a perpendicular to the floor equal to three risers, as shown at P. Add 2 feet 2 inches as the hight of the rail over the short baluster to the hight P S, less half the thickness of the rail, which will be the hight of the newel from the floor to the underside of cap, making in this case 3 feet 6 inches.

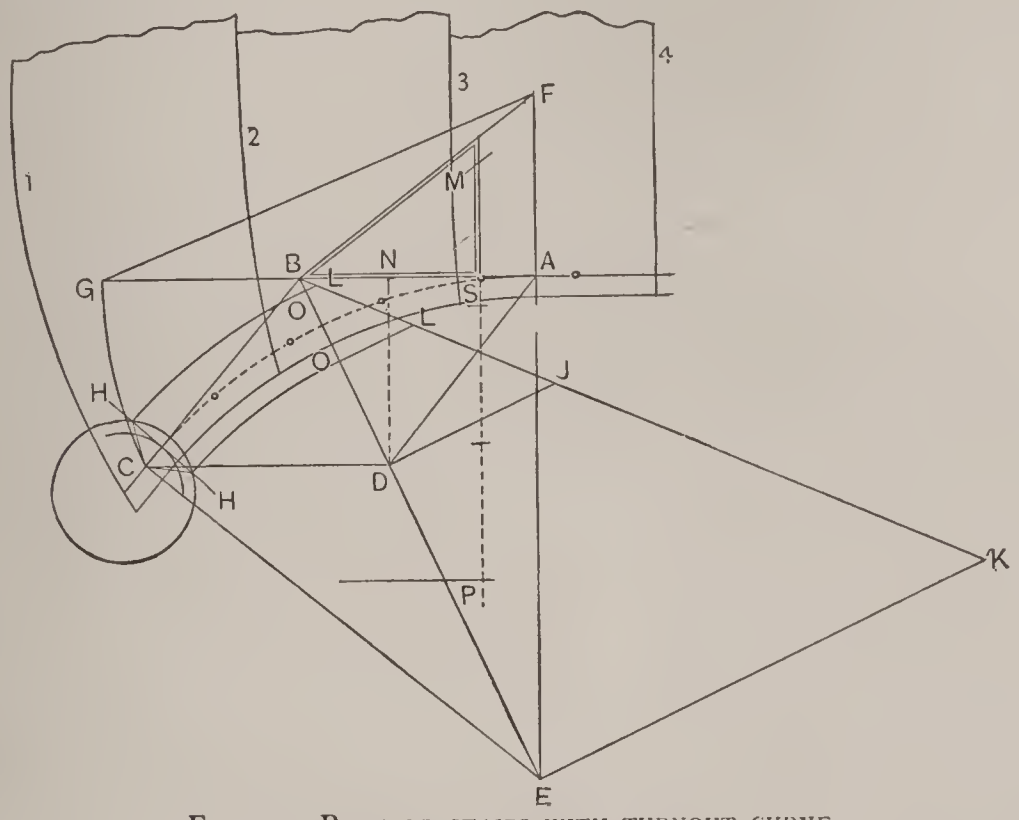


FIG. 71.—PLAN OF STAIRS WITH TURNOUT CURVE.

Fig. 72. For the mitre line or cheek, draw 14 14 parallel to the joint 3 5, and the same distance from 3 as it is on the ground plan from C. In squaring the rail, the mitre is left until ready to put on the cap, leaving the under side at the end flat and square from the joint, in order to set the cap on a line, after which the surplus wood can be removed, and the easement finished. The sections of rail 15 16 show the bevels as applied. The stock of the bevel is on the top or face side.

Fig. 73 shows the ground plan of stairs starting with winders, and having a newel located same as in Fig. 71. The pitch line is on the same inclination as the straight rail, no romp being required. The

plan of this is more than a quarter, and forms an acute angle on the line of tangents. Let A B C D be the ground plan of tangents, E the centre from which the curve is described. From B apply the pitch-board extending to the perpendicular at F. Find the major length in the same manner as described in other problems as at G F, and produce the minor length in the usual manner from the hight A F; apply at D J, B J being the minor length. For the hight of newel, set off half the thickness of rail from pitch line F B at M, over short baluster at S. From M drop the perpendicular through the centre of short baluster, equal to five risers, to the floor at P. Add 2 feet 2 inches to the hight P S, less half the thickness of rail, which will be the hight from floor to under side of the cap, which in this case will be 4 feet.

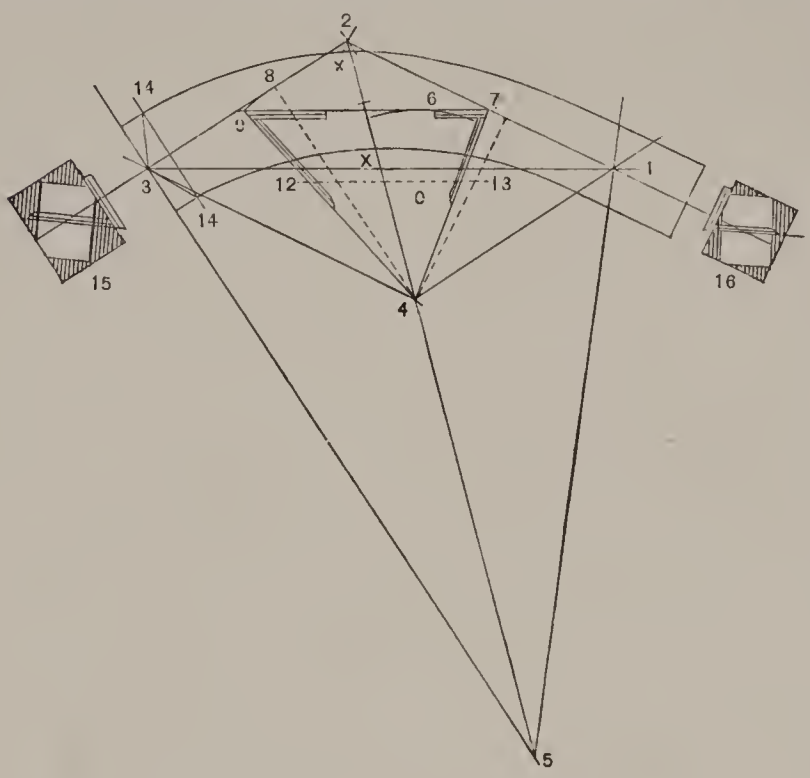


FIG. 72.—MANNER OF DRAWING MOULD.

Fig. 74. To draw the mould in the usual manner. Let 1 3 equal F G; 1 2 and 3 4 equal F B; 1 4 and 3 2 equal B C. Complete the parallelogram. Connect 2 4, and let 4 5 equal J K. From 5 find width of mould, also the bevels from the same point. Let 5 6 equal E A, and let 6 o equal the width of rail, the width at the ends being shown at 8 13 and 9 12. Sections 15 16 show the bevels as applied. It will be seen that they do not apply in the same manner as in Fig. 72, but cross each other, because the angle is acute.

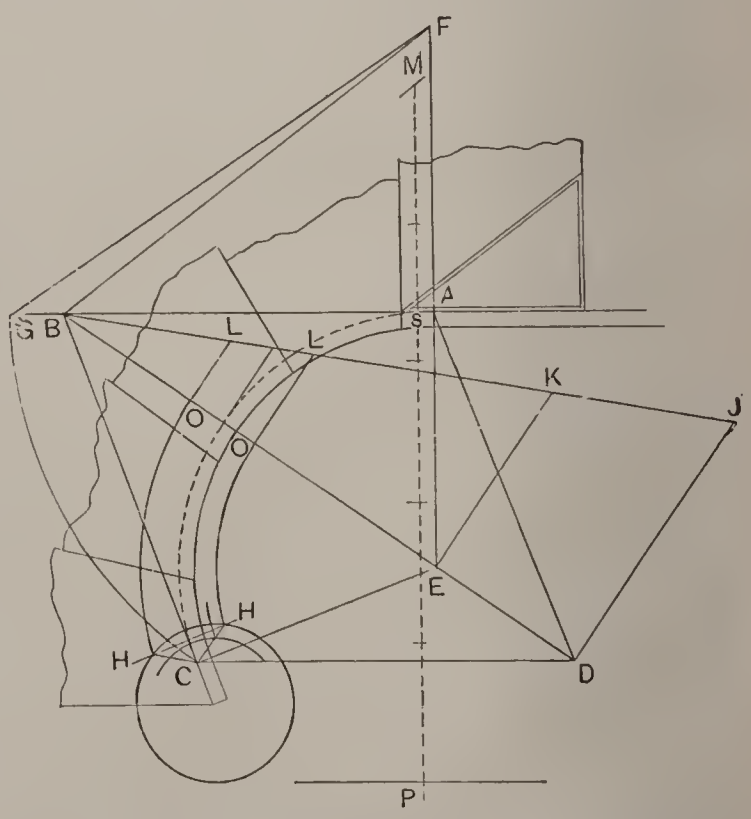


FIG. 73.—GROUND PLAN, STARTING WITH WINDERS.

Easements of this kind—that is, having one pitch and one bevel, have the bevels applied in the following manner: A right angle has one bevel applied on the level end, the opposite end being square. The obtuse base, as in Fig. 71, has the bevels applied from one side, as in Fig. 74. The bevels cross each other, because the minor axis is within the parallelogram, while the axis of the obtuse angle is outside. This will be so easily understood as to need no further explanation.

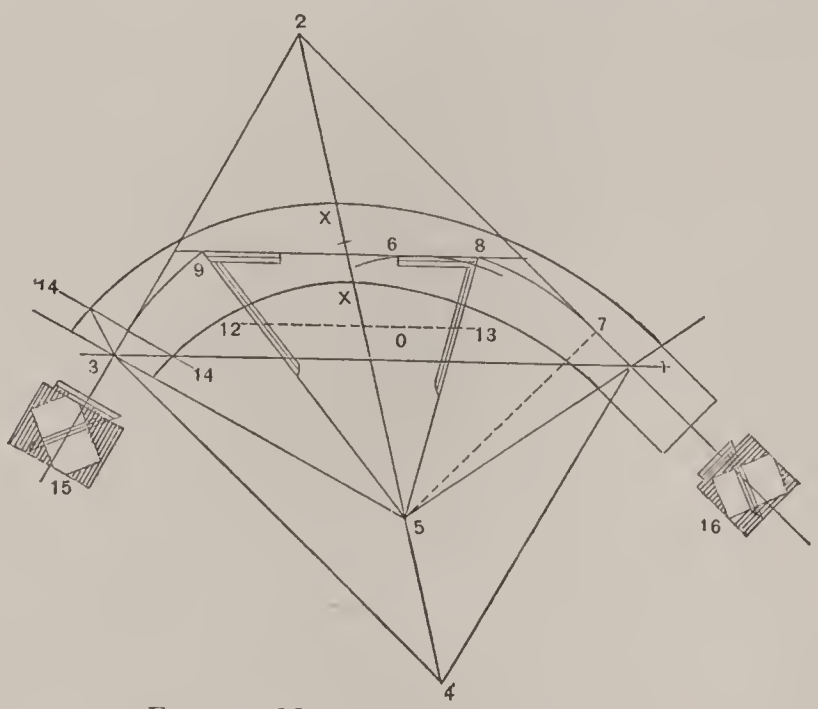


FIG. 74.—MANNER OF DRAWING MOULD.

The four following figures exhibit a plan of 8 inch cylinder stairs, with the landing rise 2¾ inches in the cylinder; rise 7½ inches, tread 9 inches. This will require two pitches in the lower piece, and is what is known as a half easement, while the top or landing piece is a full easement. Rail, 2⅜ inches thick, by 3½ wide. Scale 1½ inch to the foot.

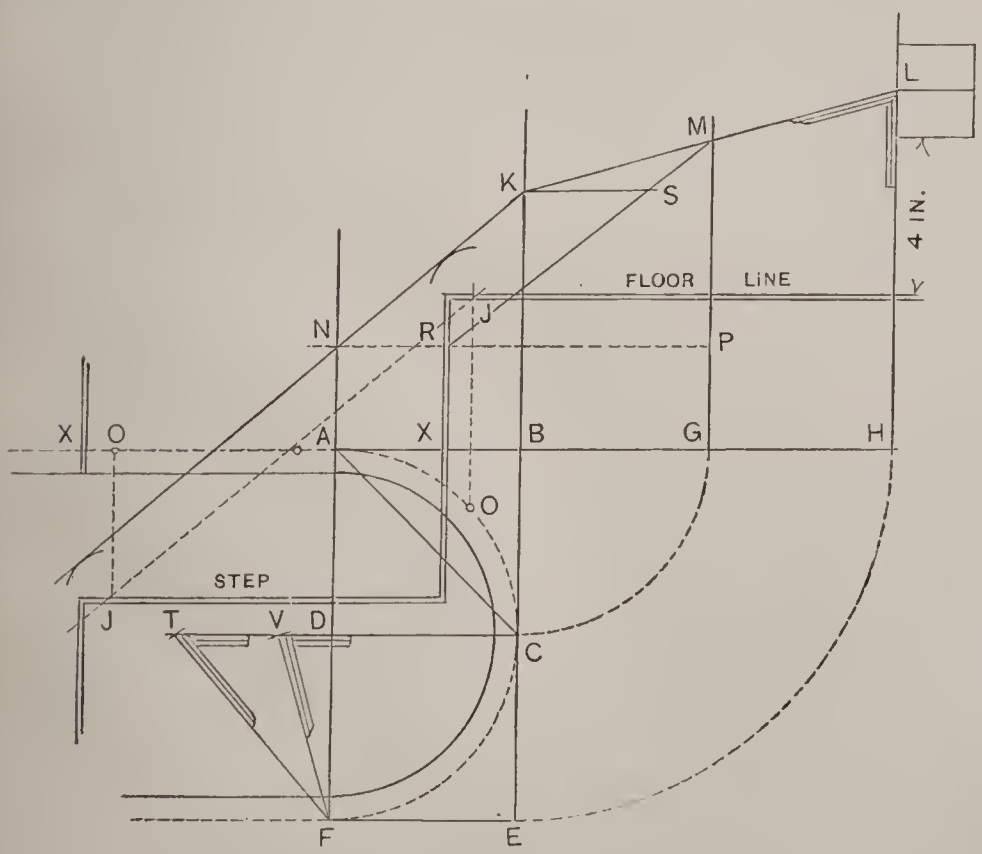


FIG. 75.—PLAN OF 8-INCH CYLINDER STAIRS.

Fig. 75. Proceed to find the length and pitch of tangents, and the major length of the mould. The dotted curve line is the centre of the rail, with the points showing the location of the balusters. Let A B C D be the quarter to draw the mould, with a half easement, and C E F D

the portion for a full easement. Let x x be the risers as drawn on the plan. Extend A B indefinitely for the base line. Extend the tangent lines on plan E C B indefinitely, also F D A. Stretch out the tangents by placing one foot of the compasses at B extended to C, and describe the curve C G, also E H, from the same point. Erect perpendiculars from G and H indefinitely. Draw the elevation as shown by the double lines at any convenient distance from the base line A B. From o o as the location of the short balusters on plan, let J J represent the same on elevation, and connect J J for the bottom line of the rail. From J J set off half the thickness of the rail; extend this line until it cuts the perpendicular E C B. On the perpendicular H, set up 4 inches to the under side of the rail; add half the thickness of the rail as at L; connect K L,

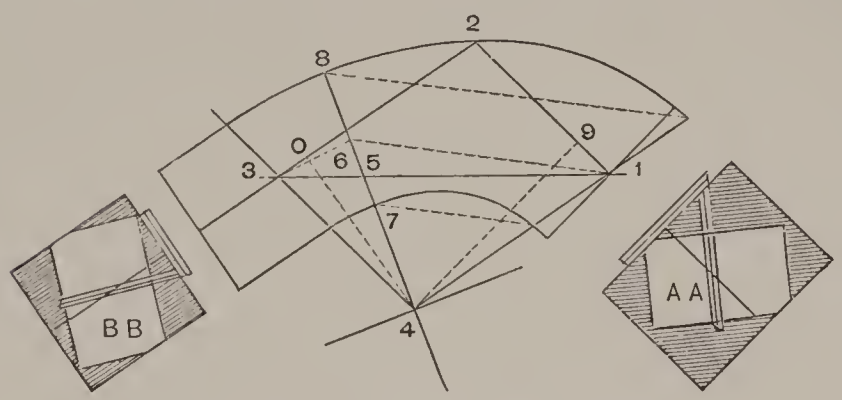


FIG. 76.—MANNER OF DRAWING MOULD.

FIG. 77.—SHOWING FLEXIBLE STRIP OF RATTAN.

giving the length and pitch of the short tangents, which will correspond to the plan B E. N K M will be the tangents for the mould at Fig. 76.

From N draw N P parallel to A G. The full hight contained in the mould will be found at P M. Let P R equal A C on the plan Fig. 75, and connect M R, which will be the major length of the mould, Fig. 76. From K draw K S parallel to B G, cutting the major length at S.

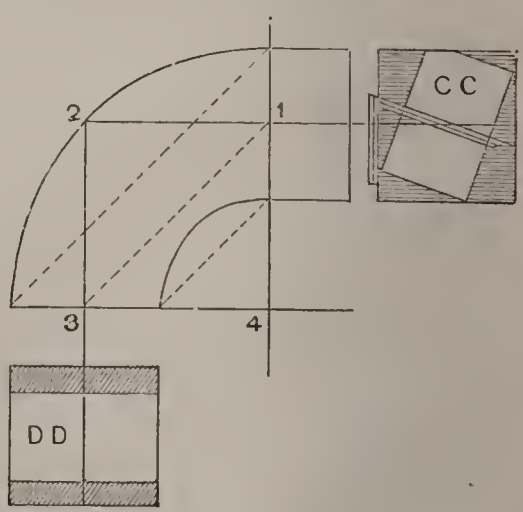


FIG. 78.—MANNER OF DRAWING MOULD.

To draw the mould, let 1 3, Fig. 76, equal R M, 1 2 and 3 4 equal K M, 2 3 and 1 4 equal N K, and complete the parallelogram. Let 1 5 equal R S and connect 4 5 extended indefinitely, which will be the minor axis and normal line. Draw the major axis at right angles to 4 5 through 4. For the centre of the rail let 4 6 equal D A. From 6 set off half the width of rail as 7 8. Find the width at the end by the parallel dotted lines. For the bevels,

with the compasses, take the length 4 9 and place it on the plan F T; the angle at T will then be the bevel for section A A as applied. Let F V equal 4 0; the angle at V will be the bevel at section B B as applied. Add whatever straight wood is required from 3 parallel to the tangent. Complete the mould by drawing the curve through the points as given

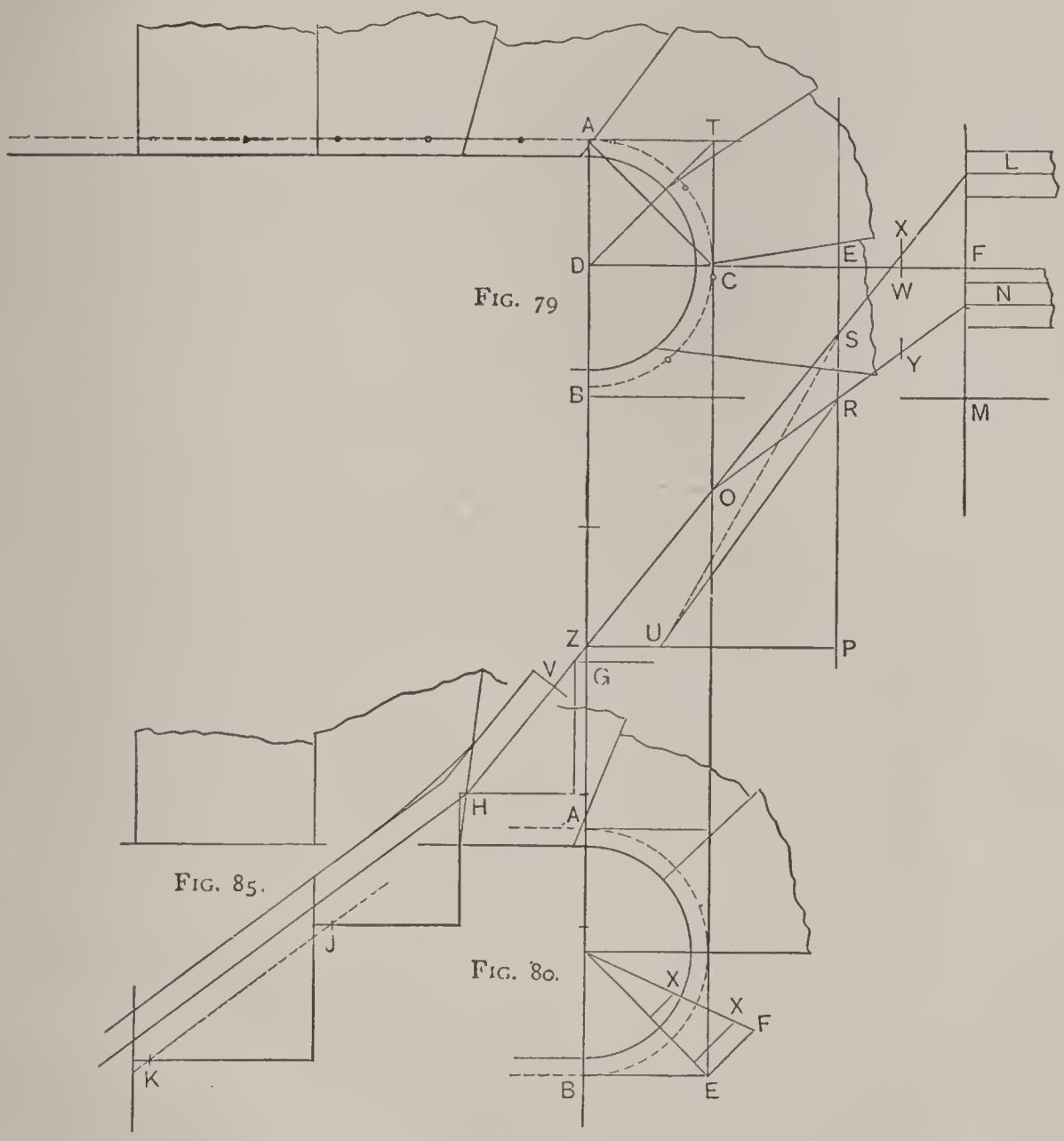


FIG. 79

FIG. 85.

FIG. 80.

FIGS. 79, 80 AND 85.—TWO TOP PORTIONS OF LANDING-ELEVATION.

by the dotted lines, using a flexible strip or the trammel rod, as may be most convenient.

The best flexible strip for all moulds is a piece of rattan planed down at one end to ⅛ of an inch and the edge squared, leaving the other end about ½ inch thick, as shown at Fig. 77. This will naturally form an elliptic curve as it is bent, using the thin end at the short tangent.

Fig. 78. Let 1 2 equal F E (Fig. 75) and 2 3 equal L M. At right angles to tangent from 1 and 3 draw the lines crossing at 4, giving the

axis, 3 4 being the minor axis and normal line, and 1 3 the major axis. At 3 lay off the width of rail, draw the parallel lines to find width on the opposite ends, add the straight wood and complete the mould by drawing the curve. The bevel is found at L, the pitch being the bevel and applied at section C C. At section D D the rail is taken square through the centre. The stock of the bevel is shown as applied from the top or face of the stuff in all cases.

A plan of two top portions of stair landing with four and five winders—Figs. 79 having five, and 80, four winders. The straight portion is the same for both, using the same ramp-scale, ¾ inch to the foot, 7½ inches rise, 10 inches tread, 12 inches cylinder. Rail 2½ x 3½ inches. The dotted line shows centre of rail on which the balusters are spaced off, as shown at Fig. 79, and represented by dots. The centre of rail will be regulated by the size of balusters; in this case the centre of rail is 1 inch on.

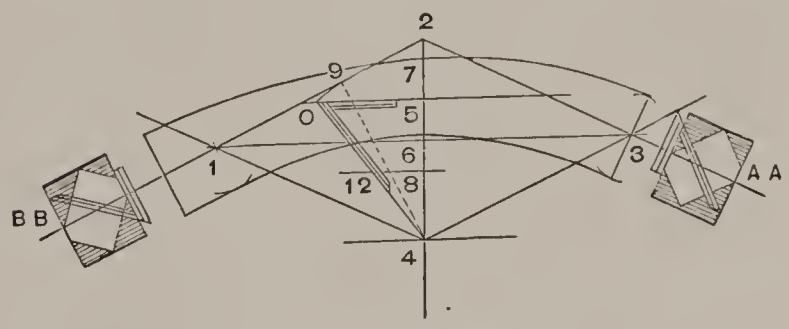


FIG. 81.—THE MOULD.

Draw the elevation by setting off from the chord line A B three spaces equal to C D as D C E F. This line will also be the floor line, from which drop down three risers to the point G; then draw the elevation of the steps outside of the cylinder, as H J K. At J K will be the bottom of the rail, as it cuts the treads at the centre of the short balusters. From F set up 5½ inches to the centre of the rail on the landing, as at L, and connect L H, giving the length of the tangents for Figs. 81 and 82. From F drop down one rise to M, which will be the floor line for plan, Fig. 80. From M set up 5½ inches to the centre of the rail at N, connect N O for the tangents of Figs. 83 and 84. At the intersection of the tangents with the chord at Z, square off, touching the perpendicular at P. From P to S is the hight contained in

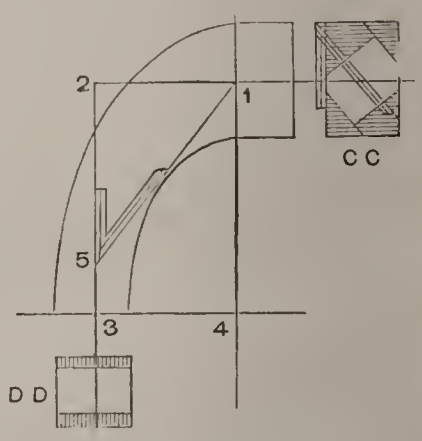


FIG. 82.—THE MOULD.

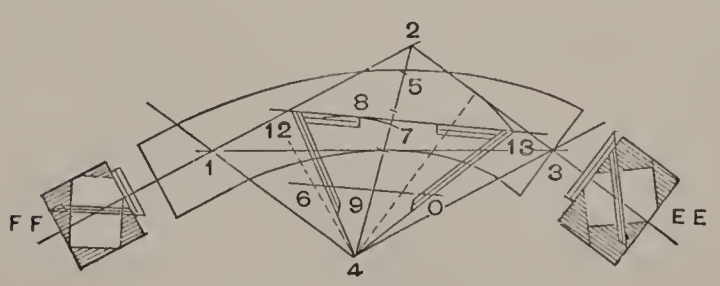


FIG. 83.—THE MOULD.

Fig. 81, and will cover the plan, Fig. 79. A T C and P R will also cover the same portion at Fig. 80. From P, Fig. 79, set off to U, equal to A C. Connect U R, giving the major length to draw Fig. 83, and S U the major length for Fig. 81.

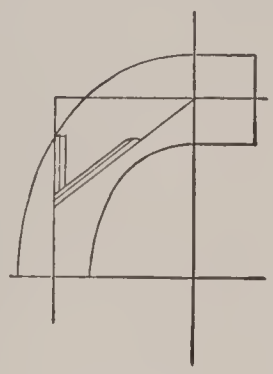


Fig. 84.
The mould.

Fig. 81. Let 1 3 equal S U, and form the parallelogram from the tangent S O, all sides being equal. Connect 2 4, giving the normal line and minor axis. Let 4 5 equal D C as the centre of the mould. Mark the width of rail 6 7; through 5 draw a line parallel to 1 3, and let 5 8 equal the width of the rail; draw parallel to 1 3, cutting the bevel lines for the width of the mould at the ends. Find the bevel 4 9 to O, when O 12 will be the width for the ends. Complete the mould by drawing the curve, sections A A and B B showing the bevel applied.

Fig. 82. To draw the parallelogram. Let 1 2 and 3 4 equal

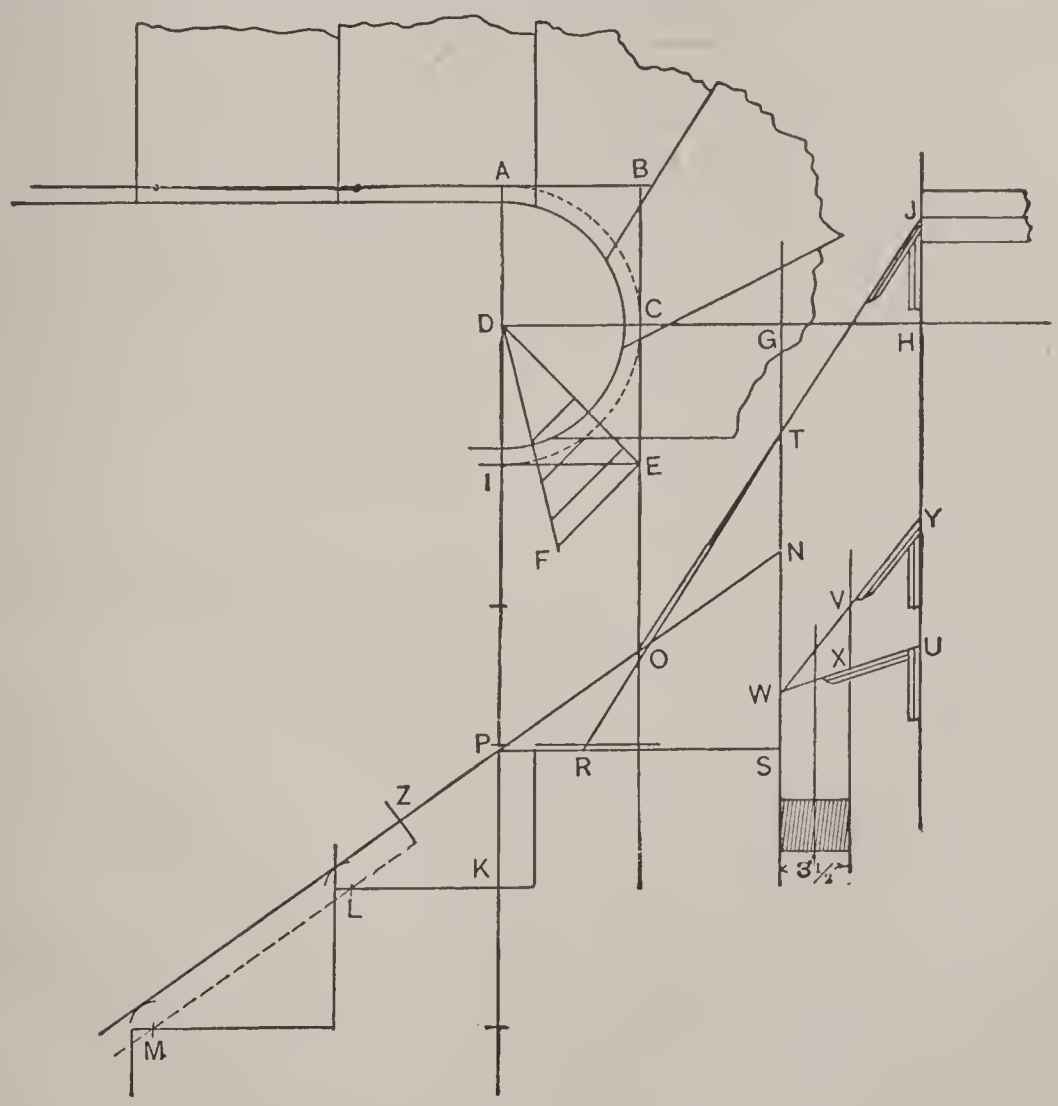


Fig. 86.—Plan with four risers in cylinder.

A T, Fig. 79, and 1 4 and 2 3 equal L S. Let F W equal the width of the rail, cutting the tangent at X. Then X L will be the width of the

mould at 1; at 3 make it the width of the rail, and complete the mould by drawing the curve. For the bevel, take the length of tangent 2 3, placing it from 1 to 5; then the angle at 5 will be the bevel for the end at 1. The angle at L of the elevation is also the bevel; section C C as the bevel is applied, section D D as the rail is taken square through centre of the staff.

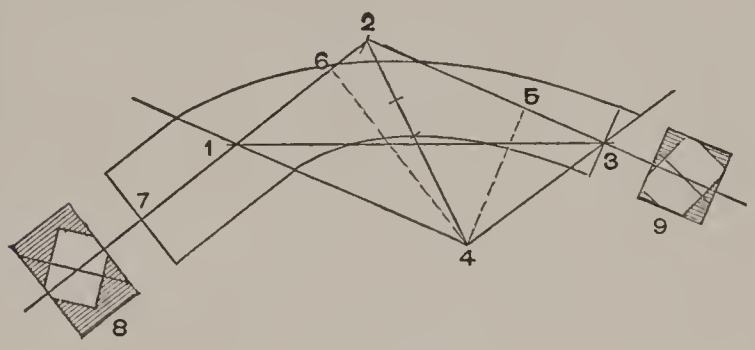


FIG. 87.—THE MOULD.

Fig. 83. Let 1 3 equal U R, Fig. 79, 1 2 and 3 4 equal O Z, and complete the parallelogram. The normal line is not given on the mould, but will find the width required on minor length. At Fig. 80, let E F equal R S, and connect F with the centre; this line will then equal 2 4. On this line mark off the points 2 5 7, as they are shown at F X X, Fig. 80. For the bevels, from 4 describe the arc 8, equal to D C. Draw a line touching at 8, and let 8 9 equal the width of the rail, drawing it parallel to 8, crossing the bevels at 6 O. Find the bevels as indicated from the dotted line 4 to 12 13. The width of the mould at 3 will be equal to O 13, and at 1 equal to 6 12. Complete the mould by drawing the curve. Sections E E and F F show the bevels as applied.

Fig. 84. From the tangents E B, Fig. 80, and N R of the elevation, draw the mould as before described, finding the bevel in like manner.

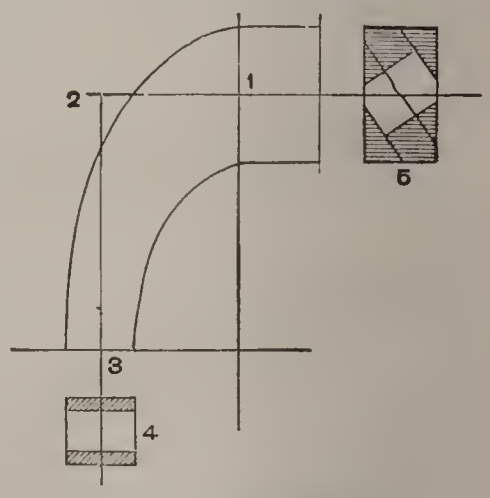


FIG. 88.—THE MOULD.

Fig. 85. The ramp is drawn as shown by transferring the tangent lines with a bevel to the board, to be used for the pattern. Let V be the end and joint at which the mould, Figs. 81 and 83, will join, as the straight wood equals V Z. Always working on the centre line as the tangent, draw the rise line J across the face of the pattern as taking in all the winders. The length of straight rail may be measured off with the pitchboard.

A plan of stairs with winders at the landing, having four risers in the cylinders, to which straight treads run. In this case there will be no ramp, but the mould will have two pitches forming a half easement. Scale, ¾ inch to the foot.

Fig. 86. Let A B C E I be the line of tangents. From D stretch out the tangents as shown, making three spaces equal to D C, D H being the floor line. From D drop 4 risers contained in the cylinder at K. From K draw the elevation of steps and risers outside the cylinder. Locate the short balusters as shown at L M by the dotted line. From this line set off half the thickness of the rail, and draw the tangent from these points extending to N. From the floor line at H, set up 5¼ inches to the centre of the rail on the landing at J, and connect O J, giving the length of tangents. For major length of mould, let S R equal E D and connect R T, giving length required. For the minor length, proceed in the usual way as shown at D E F; this needs no further explanation.

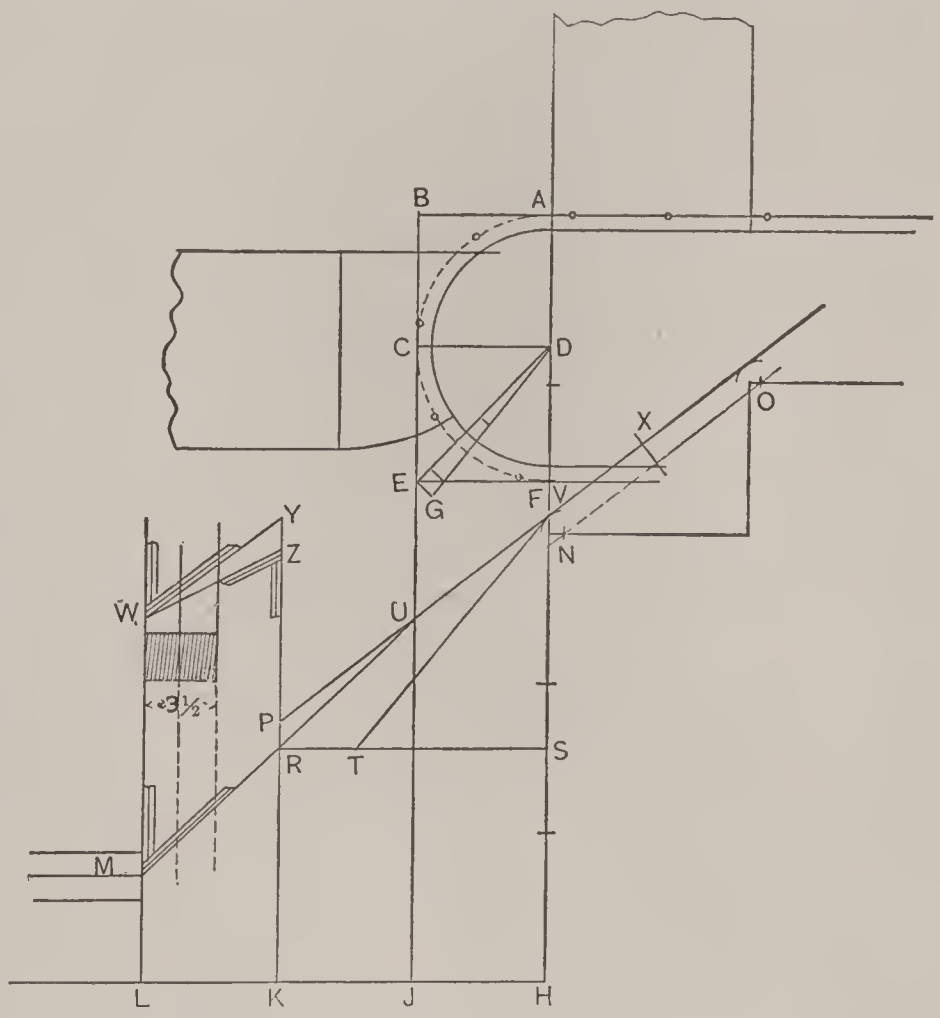


Fig. 89.—Starting with one step to a quarter platform.

Fig. 87. Let 1 3 equal T R; 1 2 and 3 4 equal P O; 1 4 and 3 2 equal O T, and complete the parallelogram. For the bevels take the length 4 5 and 4 6, and place them on the elevation from W to U Y. Lay off the width of the rail as shown below the bevels, and extend the line at the side, cutting the bevels at X V. For the width of the mould at the ends, X W for the long tangents at 3, and W V for the short tangent at 1; make the points on minor length 2 4, the same as from D to F. Draw the curve and complete the mould. Let the straight

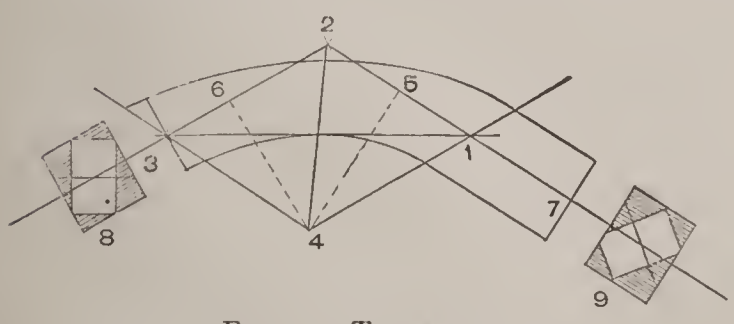


Fig. 90.—The mould.

wood 1 7 equal P Z. Sections at 8 and 9 showing the end of the twist as squared from the plank.

Fig. 88. Draw this mould the same as described at Fig. 82. Let 1 2 equal A B, and 2 3 equal J T. Find the width for the end from the bevel at J, and complete the mould by drawing the curve. Section showing the end of the twist as taken from the plank at 4 and 5.

A plan of stairs starting with one step to a quarter platform in the cylinder: no ramp needed for this, as the rail will have two pitches, forming a half easement. Scale ¾ inch to the foot, 7½ inch rise, 10 inch tread, 12 inch cylinder, 2¼x3½ inch rail.

Fig. 89. From the tangent A B, drop the perpendiculars to H J, which will be the floor line. Stretch out the tangents equal to A B C E, and at L set up 5¼ inches to the centre of the rail at M. From H to N set up the three risers contained in the cylinder. At N draw elevation of one step, and locate the short balusters N O. Draw the dotted line for bottom of rail; set off half the thickness of rail, draw the tangent extending to P, and connect M U. From R draw R S parallel to K H, let S T equal D E, and connect V T, giving major length of mould. For minor length, let E G equal R P, and connect G D, giving length required. Mark the width required for the rail on this line in the usual way.

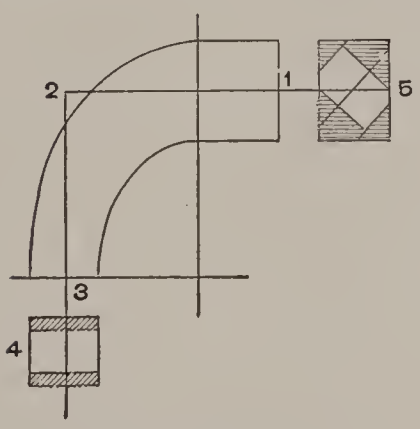


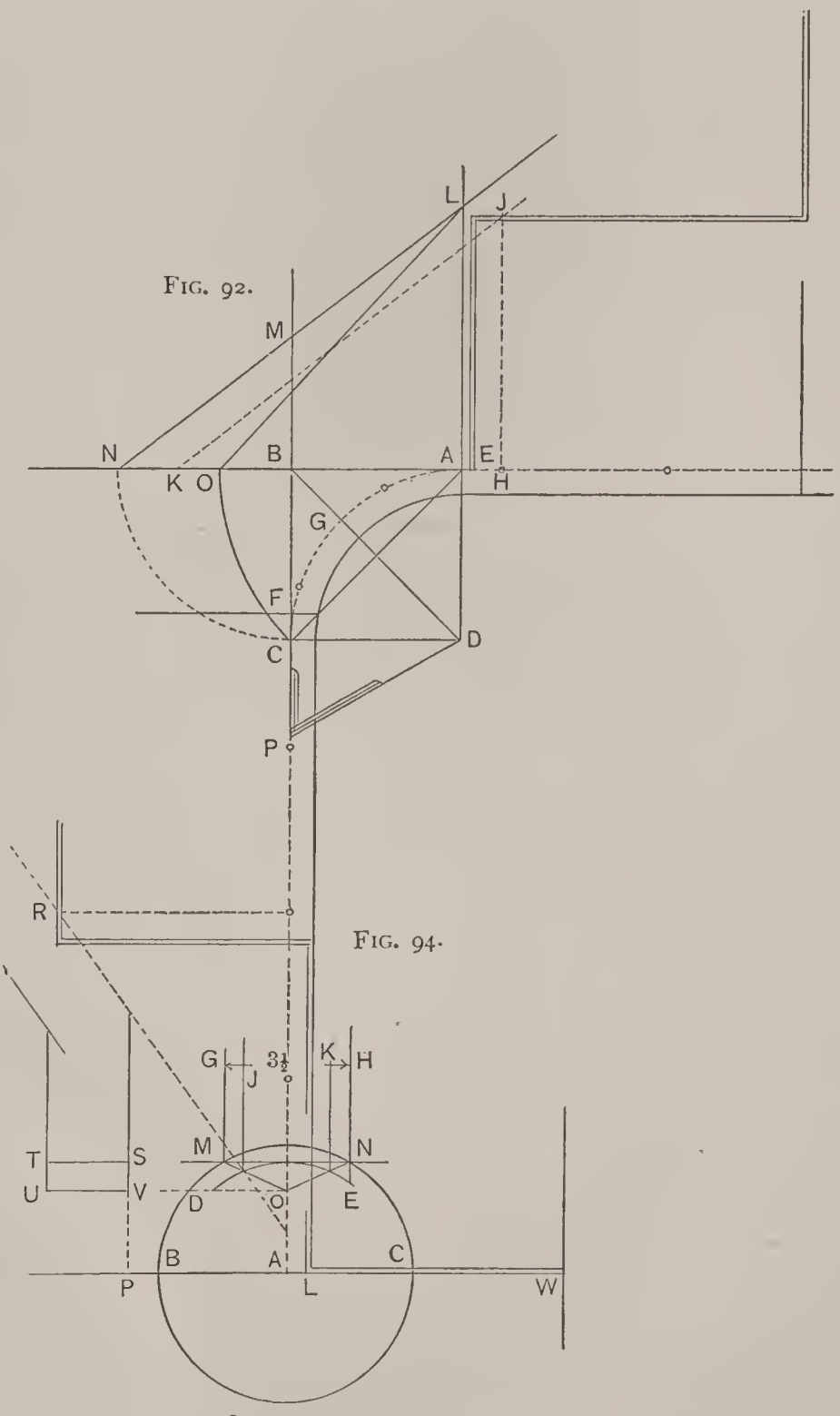
FIG. 91.—THE MOULD.

Fig. 90. Let 1 3 equal T V, Fig. 89; let 1 2 and 3 4 equal U V, 1 4 and 3 2 equal U R, and complete the parallelogram. On the minor length from 2 4 mark the points equal to those on G D. For the bevels, take 4 5 and 4 6, and place them from W, as indicated at Z Y. Mark the width of the rail, letting the side cut the bevels on the line W Y. This gives the width for the end of mould at 7, Fig. 90, and on W Z is found the width for 3. For the straight wood, from 1, make 1 7 equal V X, and complete the mould by drawing the curve. Sections 8 and 9 show the end at joint as squared from the plank.

Fig. 91. Draw same as Figs. 82 and 88. Let 1 2 equal M R, and 2 3 equal E F. The bevel and width of mould is found at M. Apply in the usual way, draw curve and complete the mould. Sections 4 and 5 show the end of the twist as squared from the plank.

A plan of quarter platform stairs having the risers at the cylinder placed in such a manner that the rail will run on a continuous pitch, requiring no easing. Scale, 1½ inches to the foot.

Figs. 92 and 94. Plan and elevation. Let A B C be the line of tangents, with D as centre and E and F the risers. It will be seen that E is outside of the cylinder, while F is inside. The location of E must govern the location of F. Let E be located anywhere on the tangent line; then to find where F will come, take the distance E B, as here shown to be 5 inches; then the distance from B to F will be 4 inches, making the length of one tread from E to F. Extend A D and B C indefinitely, and draw the elevation of one rise and tread, letting A B be the base line. From the location of the short baluster H on plan, produce it on the elevation at J. From J apply the pitch board, as shown by the dotted line J K, as the bottom line of the rail. Set off half the thickness of the rail and draw the tangent line L M N. For the major length of the mould, from A as centre, describe the curve C O, and connect L O, giving length required.



FIGS. 92 AND 94.—QUARTER PLATFORM, RISERS SO PLACED AS TO GIVE RAIL ONE PITCH. CENTRE OF RAIL SHOWN BY DOTTED LINE.

Fig. 93. Let 1 3 equal L O, and 1 2 and 3 4 equal L M. Produce 4 in like manner, as all the lines in the parallelogram are one length.

For the centre of the curve, let 4 5 equal D G. Find the width of the mould at the ends by the parallel lines, as shown, the width at 2 7 being 3½ inches. For the bevel, let D P equal 4 6 ; then the angle at P is the bevel for both ends. From 1 and 3 add whatever straight wood is

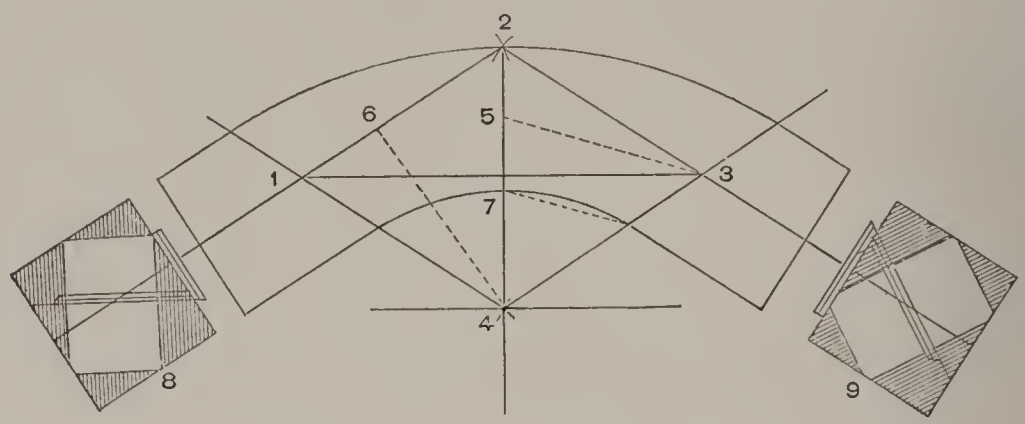


FIG. 93.—THE MOULD.

required—usually 3 to 4 inches is sufficient. Complete the mould by drawing the curve in the usual manner. Sections 8 and 9 show the bevel applied.

Fig. 94. To draw the mitre on the rail to intersect a turned cap. Let A be the centre of the cap at the intersection of the rise and centre line of the rail. Describe the outside circle B C as the size of the cap. Draw the arc D E equal to the depth of the turning. Let G H be the width of the rail, 3½ inches ; draw the depth of the mould on the rail, as shown at J K, and extend these lines, intersecting the line of the cap ; then through the intersection draw the line of the mitre as M N O, and through M N draw the cheek line. Draw the elevation of two risers, and from the top of the first step set up 5 inches as the hight ; the cap will rise as from L P. Through the point of short baluster R apply the pitch board for the bottom line of the rail, produce the mitre lines on the pattern, T S as the cheek and J V as the point of the mitre. For the hight of the newel, add 2 feet 2 inches to P W, giving the hight from the floor to the under side of the cap.

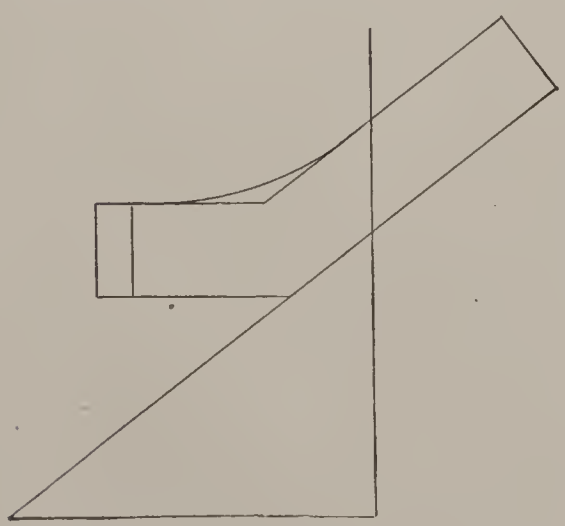


FIG. 95.—CAP EASEMENT WITH MITRE.

Fig. 95. Shows an **elevation of the pitchboard** with the easement, having the top curve drawn, also the second rise line extended across the pattern, to be used in measuring the length of straight rail.

A plan of stairs commonly called a full turn of winders, having three pieces in the rail to complete the cylinder. Scale, ¾ inch to the foot.

Fig. 96. Plan. Let A B C D E F G be the tangents, and H the centre from which the curve is described. To locate the joints C E, set the compasses in A, extend to H and make the point C. Then in G make the point E, connect C and E to H; at right angles to C H draw the tangent B C D; then at E, in the same manner, draw the tangent D E F. Extend the centre line of rail, completing the tangent A B and G F. Extend G F indefinitely, and stretch out the tangents from G to H on the line thus made. From F as a centre describe E I and D J.

Fig. 97. Elevation. Drop perpendiculars from G F I J indefinitely. From any convenient point outside of the plan, make the hight of the risers on the perpendicular G, the six risers which is in the cylinder as at K L. Then at K L draw the elevations

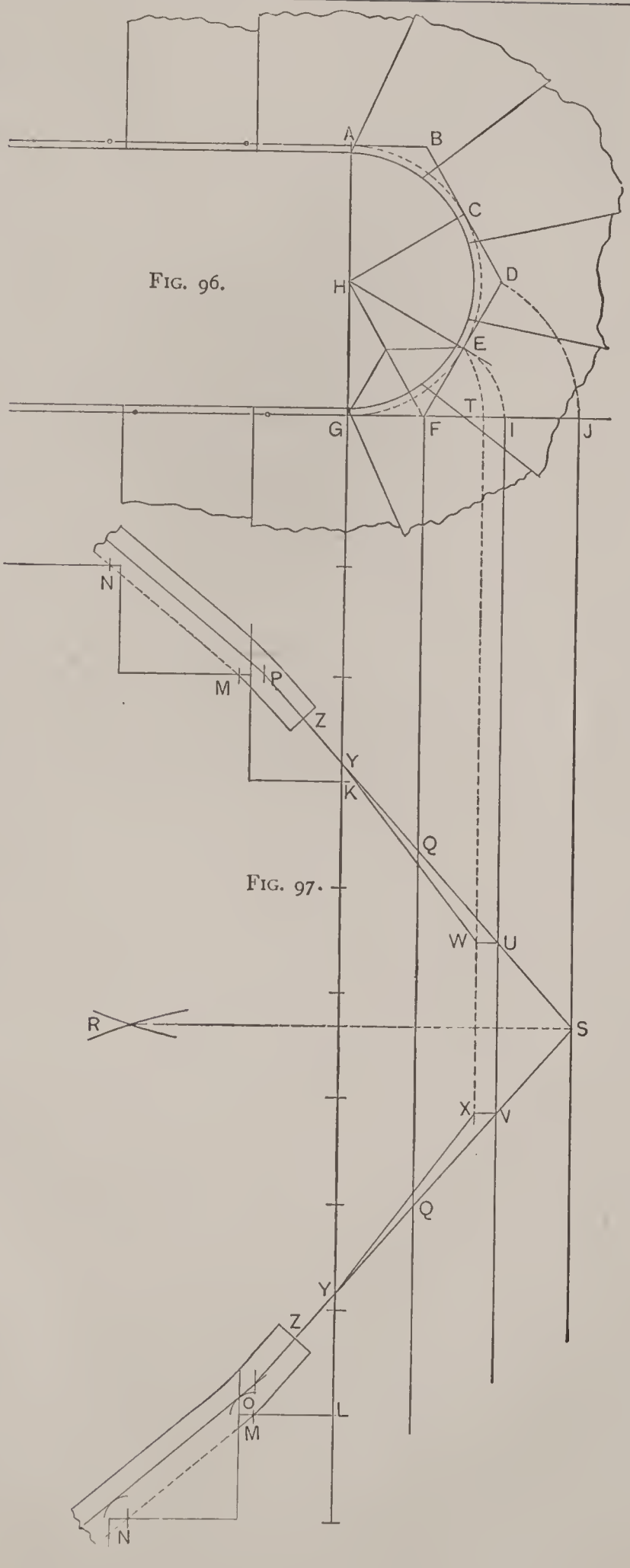


FIG. 96.

FIG. 97.

FIGS. 96 AND 97.—FULL TURN OF WINDERS THREE PIECES IN CYLINDERS.

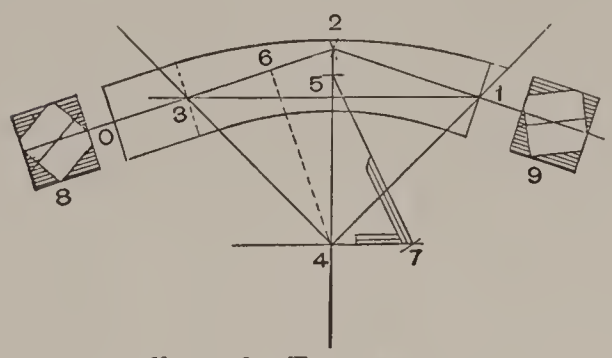


FIG. 98.—THE MOULD.

of the steps and risers outside of the cylinder over which the ramp is drawn. Let M N of the elevation be the centre of the short balusters, also the bottom line of the rail, and draw the centre line for the ramp. From M in the lower elevation, draw a line cutting the centre line of the rail at O ; locate a point at P which will be plumb over O, but not the short baluster in this case. This is done for the purpose of making both ramps the same, requiring only one ramp pattern, and one mould for the cylinder, to be used for the three twists, thereby saving time in drawing. From O and P as centres, bisect the hight at R ; from R draw R S at right angles to K L, and connect S P and S O, giving the lengths of tangents required. To find the major length of the mould. From G as centre, draw E T, and drop the dotted line indefinitely. From U V draw parallels to R S, cutting the dotted line from T at W and X. Connect W Y and X Y, giving the major lengths. Draw the ramp pattern as shown, making the joint at Z, allowing 3½ inches from Y to be added on the mould, Fig. 98.

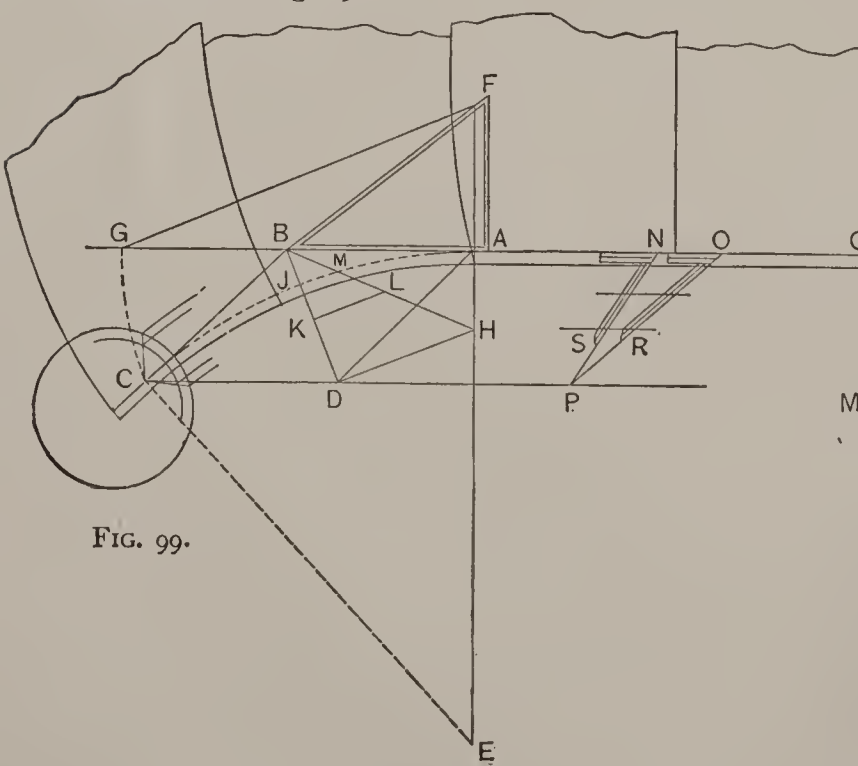


FIG. 99.

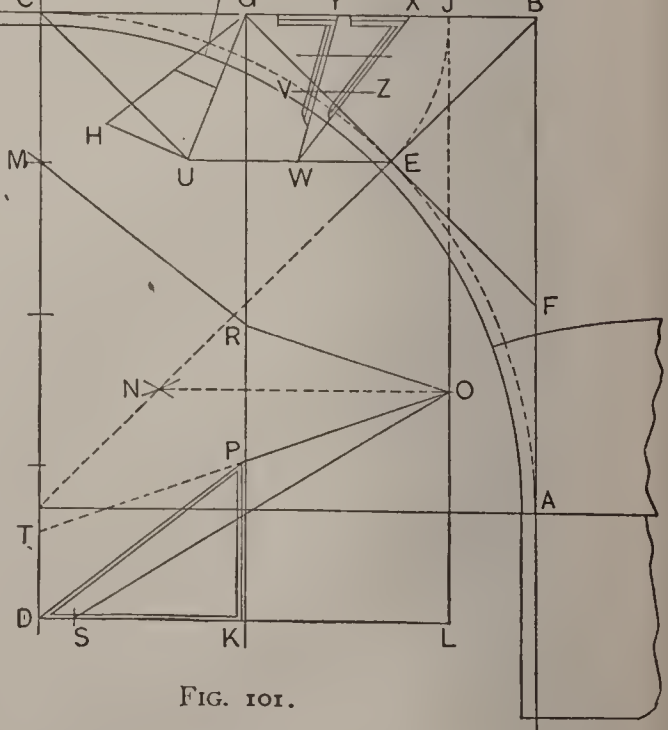


FIG. 101.

FIGS 99 AND 101.—TURNOUT AND QUARTER PLATFORM.

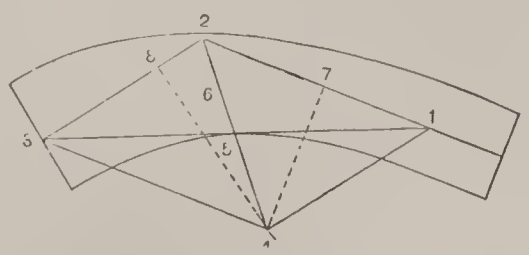


FIG 100.—THE MOULD.

Fig. 98. Let 1 3 equal W K, 1 2 and 3 2 equal U Q, and connect 1 2 and 3 indefinitely, as the tangents. Let 2 4 equal H F, and connect 4 1 and 4 3, giving the chord line. For the centre of the mould on the normal, let 4 5 equal H E, and mark the width of the rail on this line, from the centre at 5. Find the width at the ends, in the usual way, and draw the straight wood 3 0 equal to Y Z. The point 4 is the centre of the axis. Draw the major axis at right angles to 2 4. For the bevel, let 5 7 equal 6 4; the angle at 7 is the bevel for all the pieces as applied at the sections 8 and 9. Complete the mould by drawing the curve with a flexible strip or the trammel as may be desired. Fig. 98, as it is drawn, will be the two pieces to join the ramps for the centre piece on the plan, Fig. 96. C D E will be found at the elevation, Fig. 97, as U S V for the tangents. Make the joint at 3, cutting off the straight wood, which gives the required mould to complete the cylinder.

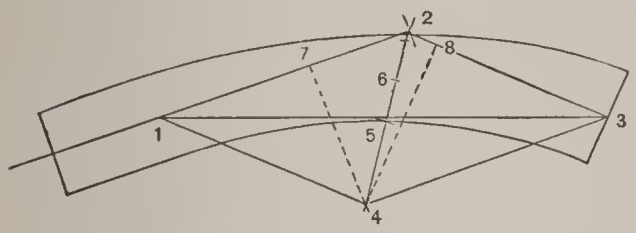


FIG. 102.—THE MOULD.

A plan of stairs starting with a turnout and having a quarter platform. The rail to be in two pieces for the quarter, forming half easements, requiring but one mould which will reverse, as the hight will be 11½ risers in each piece. Scale, ¾ inch to the foot.

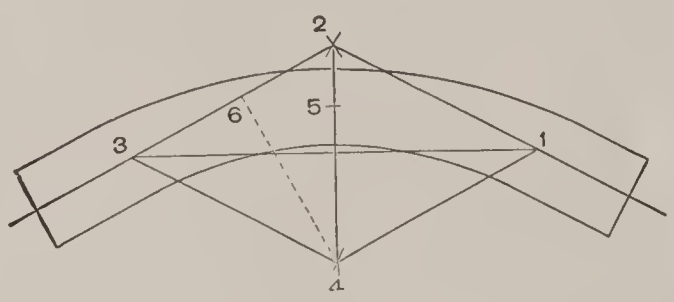


FIG. 104.—THE MOULD.

Fig. 99. Turnout. Let the face of the first rise be the centre of the newel. To find the end of the mould, draw the cap with the mitre in the usual way, as the lines indicate at C. From C as the end of the mould, draw the dotted line to E, at right angles to E C. Draw C B, cutting the base line as the centre of the rail from A. Then A B C will be the tangents of equal length. Produce D in the parallelogram as indicated. Place the point of the pitch-

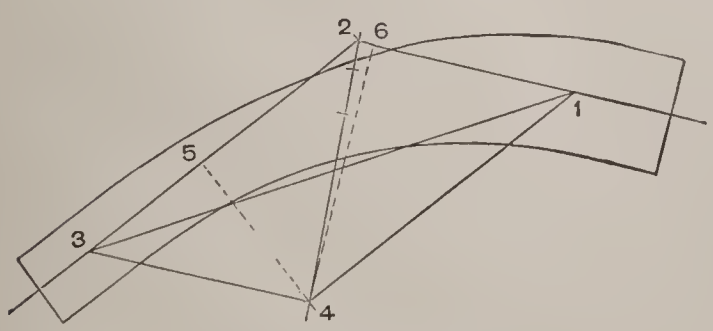


FIG. 106.—THE MOULD

board at B and draw the pitch, cutting the perpendicular E A at F. For the major length of the mould, from A as centre, describe C G, and connect G F, giving the length required. For the minor length, at right angles from B D, set the hight D H equal to A F, and connect H B, giving length required. Let J be the centre line of the rail, K one-half the width, and erect the perpendiculars, cutting the minor length at L M.

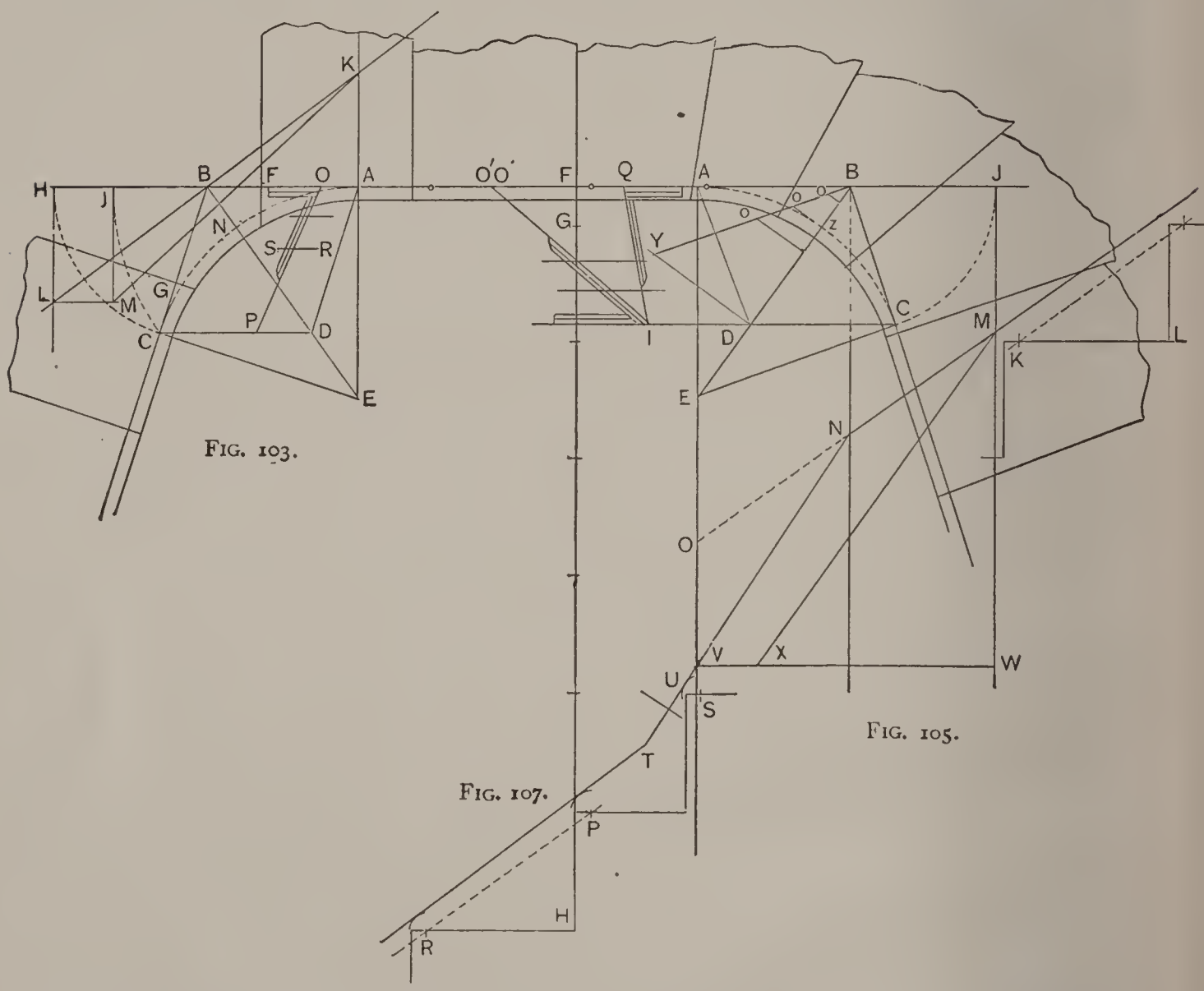


Fig. 103.

Fig. 105.

Fig. 107.

Fig. 103.—Obtuse angles, tangents of one pitch.

Figs. 105, 107.—Ramp, and two pitches to cylinder.

Fig. 100. Let 1 3 equal G F; 1 2 and 3 4 equal F B; and 1 4 and 3 2 equal C B. Complete the parallelogram, and connect 2 4. Let 4 5 6 2 equal H L M B, then 5 2 will be the width of the mould. Find the width at the ends from the bevels, and extend C D indefinitely. Let P N equal 4 7, and P O equal 4 8. Draw S R parallel to N O equal to the width of the rail. Then O R will be the width of the mould at 3, and N S will be the width for end at 1. Add the straight wood from 1,

mark the joints at the ends square from the tangents, and complete the mould by drawing the curve in the usual manner.

Fig. 101. From T, the point from which the curve is described, draw the square T A B C, and connect T B, cutting the curve at E. At right angles to E B, draw the tangent lines F G, thus making all the tangents of one length. Form the parallelogram at U; from G as centre, describe E J, and drop the perpendiculars G K and J L. From D set up

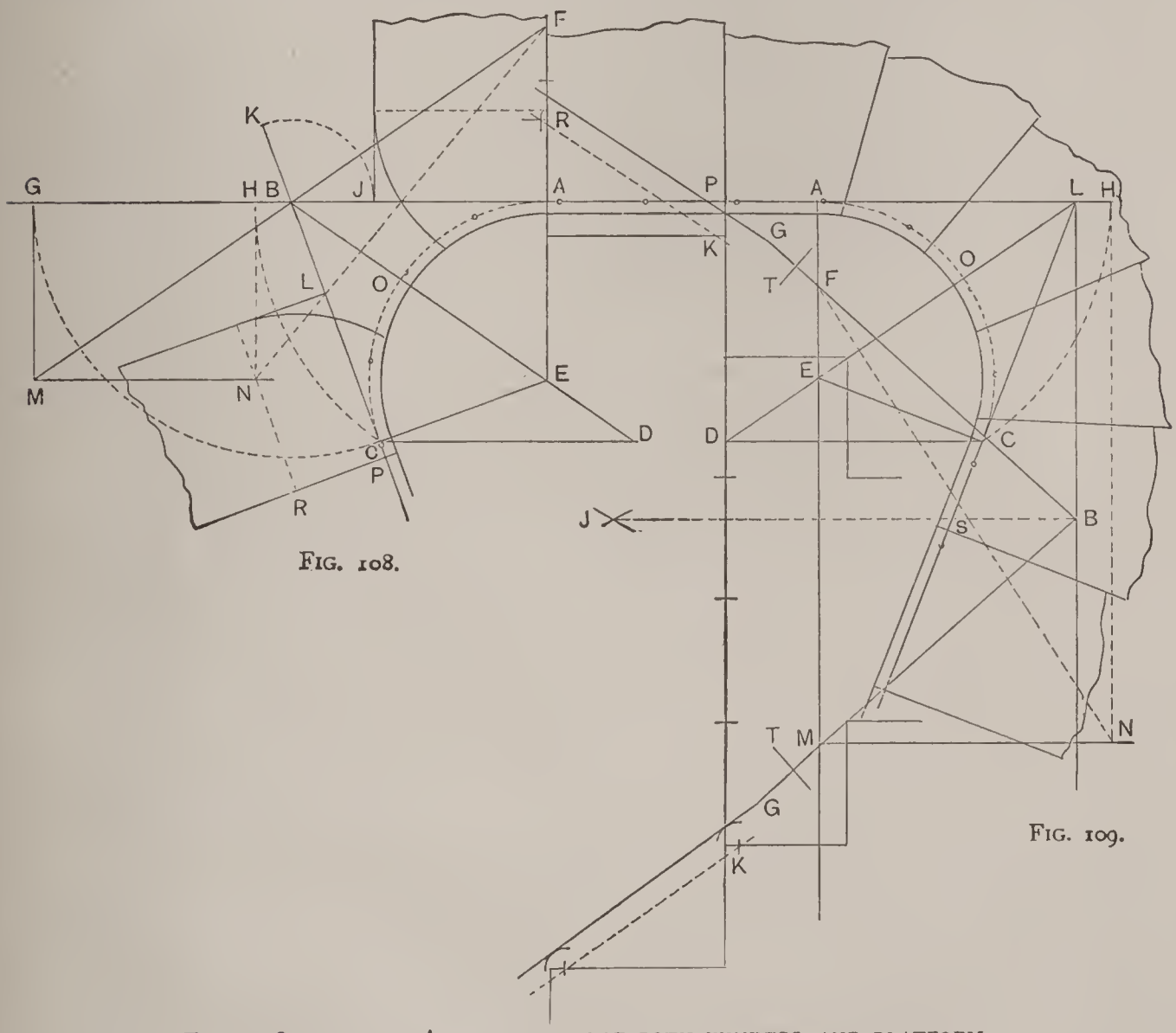


FIG. 108.

FIG. 109.

FIGS. 108 AND 109.—ACUTE ANGLE FOR BOTH WINDERS AND PLATFORM.

three risers to M. From M and D bisect the hight at N, and from N draw parallel to T A, cutting the perpendicular J L at O. Place the point of the pitchboard at D, draw the pitch to P, and connect P O, giving the tangents for the mould. From M draw M R O in the same manner. For major length, let S L equal C E, and connect S O, giving length required. For minor length, extend O P to T; let H U equal D T, and connect H G, giving the length required. Find the width of the mould in the same manner as described in Fig. 99, viz : from bevels.

Fig. 102. Let 1 3 equal S O ; 1 2 and 3 4 equal D P ; 1 4 and 3 2 equal P O, and connect 2 4. Find the width of the mould 5 2 in the same manner as explained in Figs. 99 and 101. To find the bevels, let X W equal 4 8 and Y W equal 4 7. Parallel to Y X, and the width of the rail, draw V Z, cutting the bevels ; then X Z will be the width of the mould at 3, and V Y for the end at 1. Add the straight wood and complete the mould by drawing curve. This mould reverses and completes the quarter, 3 being the centre joint over E.

The amount of the straight may be left on the moulds, so as to join them together, or there may be a straight piece put between them. This is left to the judgment of the workman.

A plan of stairs having two obtuse angles, or less than a quarter cylinder. Fig. 103 is a platform with risers so placed as to have the pitch of the tangents on the same inclination as the straight rail. Fig. 105 has winders at the lower portion, with one outside of the cylinder and requiring a ramp; the upper portion has the straight treads running to the chord line. Scale, ¾ inch to the foot.

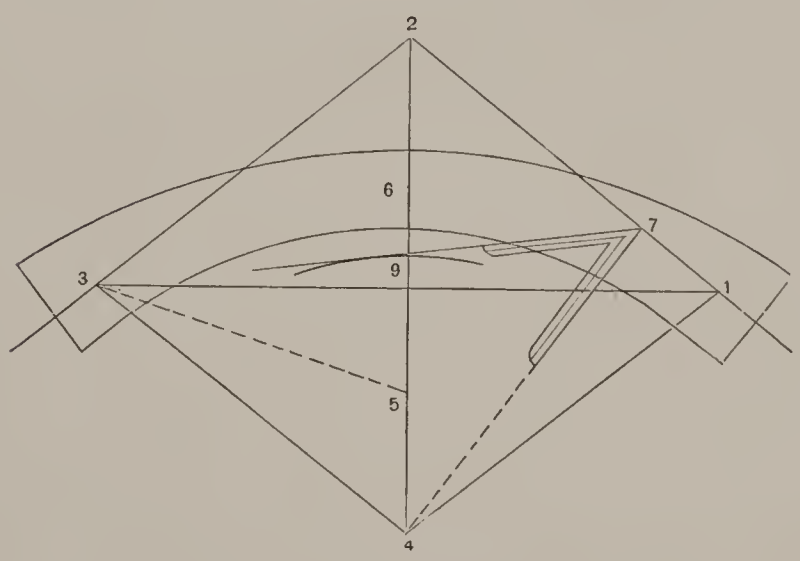


FIG. 110.—THE MOULD

Fig. 103. A B C D is the portion to draw the mould D, the corresponding point to B, forming the parallelogram, and E the centre from which the curve is described ; set F B G on the line of the tangents, which equals one straight tread. From B as centre, describe C H, giving the stretchout of the tangents. From A as centre, describe C J to get the major length. At H J drop perpendiculars indefinitely. For the length of tangents, place the point of the pitchboard at B, draw to K and extend to L ; then K B L is the length. From L draw parallel to H J, cutting the perpendicular from J at M ; connect K M, giving the major length.

Fig. 104. Let 1 3 equal K M ; 1 2 and 3 4 equal K B, and 1 4 and 2 3 equal B L. For the width of the mould in the centre, let 4 5 equal D N. From 5 as the centre of the mould, mark the width equal to the rail, 3½ inches. For the bevel, let P O equal 4 6, and parallel to O F draw S R equal to the width of the rail, cutting the bevel and giving

the width for the mould at the ends. Add whatever straight wood is required, and complete the mould by drawing the curve.

Fig. 105. From the rise at F drop a perpendicular indefinitely, and from any convenient point set the hight required as from G H, six risers. Draw the elevation of the two treads outside of the cylinder, over which the ramp is to be drawn. From B as centre, describe C J. From A B J drop perpendiculars indefinitely. At the hight of five risers

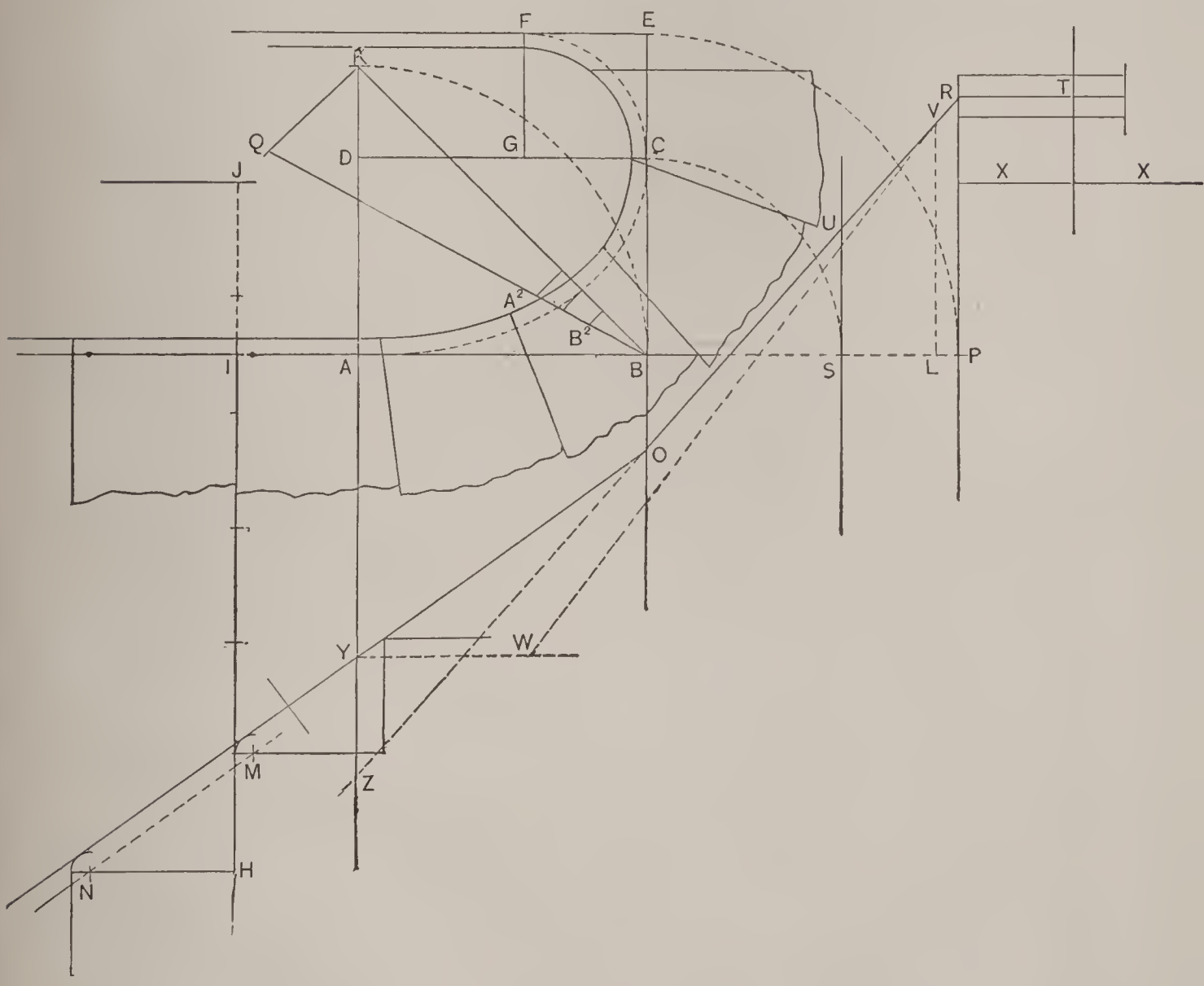


FIG. 111.—TWO QUARTER CYLINDERS, ONE CIRCULAR, ONE ELLIPTICAL, WITH ELEVATION.

draw one straight tread as K L, place the pitchboard with the point at the centre of the short baluster as at K. Draw the dotted line for the bottom of the rail, set off half the thickness of the rail from K, and draw the centre line for the tangent M N, extended to O. From P R as the centre of the short balusters, draw the dotted line for the bottom line of the rail, set off half the thickness of the rail, and draw the centre line of the ramp. From the short baluster at S, set off half the thickness of the rail, as

shown at U, and draw N V T, touching at U. Then M N V are the tangents for the mould. For major length of the mould, let W X equal A C, and connect M X, giving the length required. For the minor length, let D Y

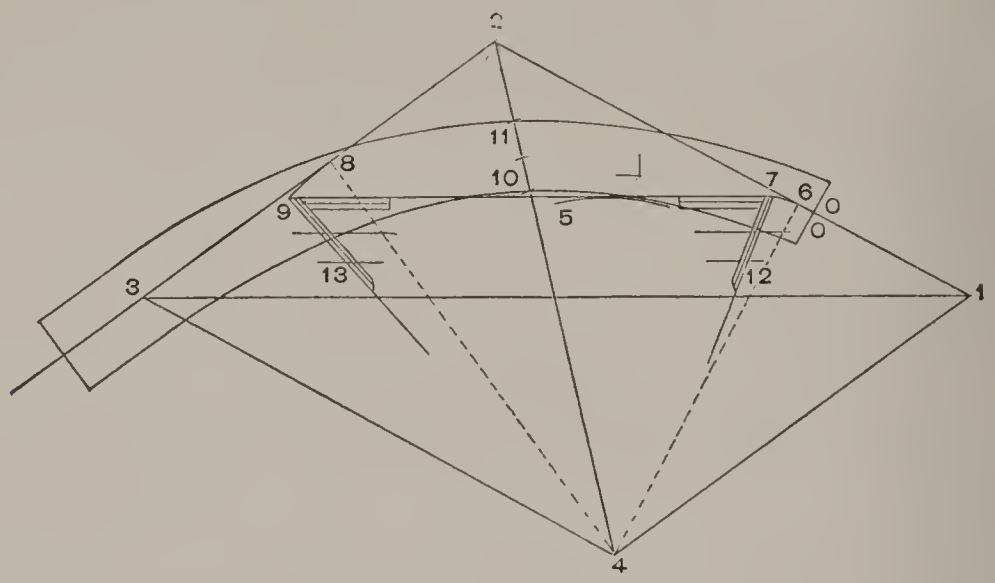


FIG. 112.—THE MOULD.

equal O V, and connect Y B, giving the length required. From Z as the centre of the rail, draw the perpendiculars equal to the width of the rail, touching the minor length B Y, as shown at O O O.

Fig. 106. Let 1 3 equal M X; 1 2 and 3 4 equal M N, and 1 4 and 3 2 equal N V. Connect 2 4 and make the points for the width of the mould same as from B Y. For the bevels, let 1 Q equal 4 5, and let 1 O O equal 4 6. Then the angle at Q is the bevel for the end at 3, and the angle at 1 is the bevel for the end at 1. Find the width at the ends in the same manner as already described from bevels. Add the straight wood required, and complete the mould by drawing the curve.

Fig. 107. Draw the ramp from the centre line, as shown; make the length T U so as to join to Fig. 104.

A plan of stairs having acute angles, or more than a quarter cylinder. Fig. 108 is a platform with the risers so placed as to have the inclination of the tangents on the same pitch as the straight rail. Fig. 109 is the same angle as Fig. 108, but having winders with a portion of a tread outside of the cylinder, requiring ramps. The mould for the cylinder has tangents of equal length, and will be drawn the same as for Fig. 108. Scale, ¾ inch to the foot.

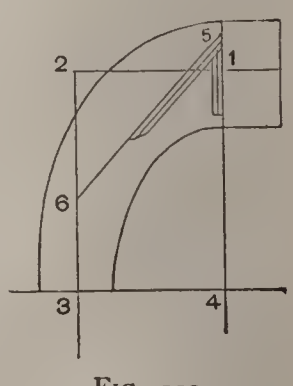


FIG. 113.
LANDING MOULD.

Fig. 108. Let A B C be the portion to draw the mould, with D as the corresponding point to B, forming the parallelogram with E as the centre, from which the curve is described. Let A J equal one tread, cutting

the plan on the tangent line. Extend C B indefinitely. From B as centre, describe J K; make K L equal to one tread. The risers J K will have to be bent so as to finish on the string nicely. In this case the treads and platform are the same width from A to P. The centres to draw the curve of the risers are at R R. For length of the tangents, with B as centre, describe C G. From G drop a perpendicular indefinitely.

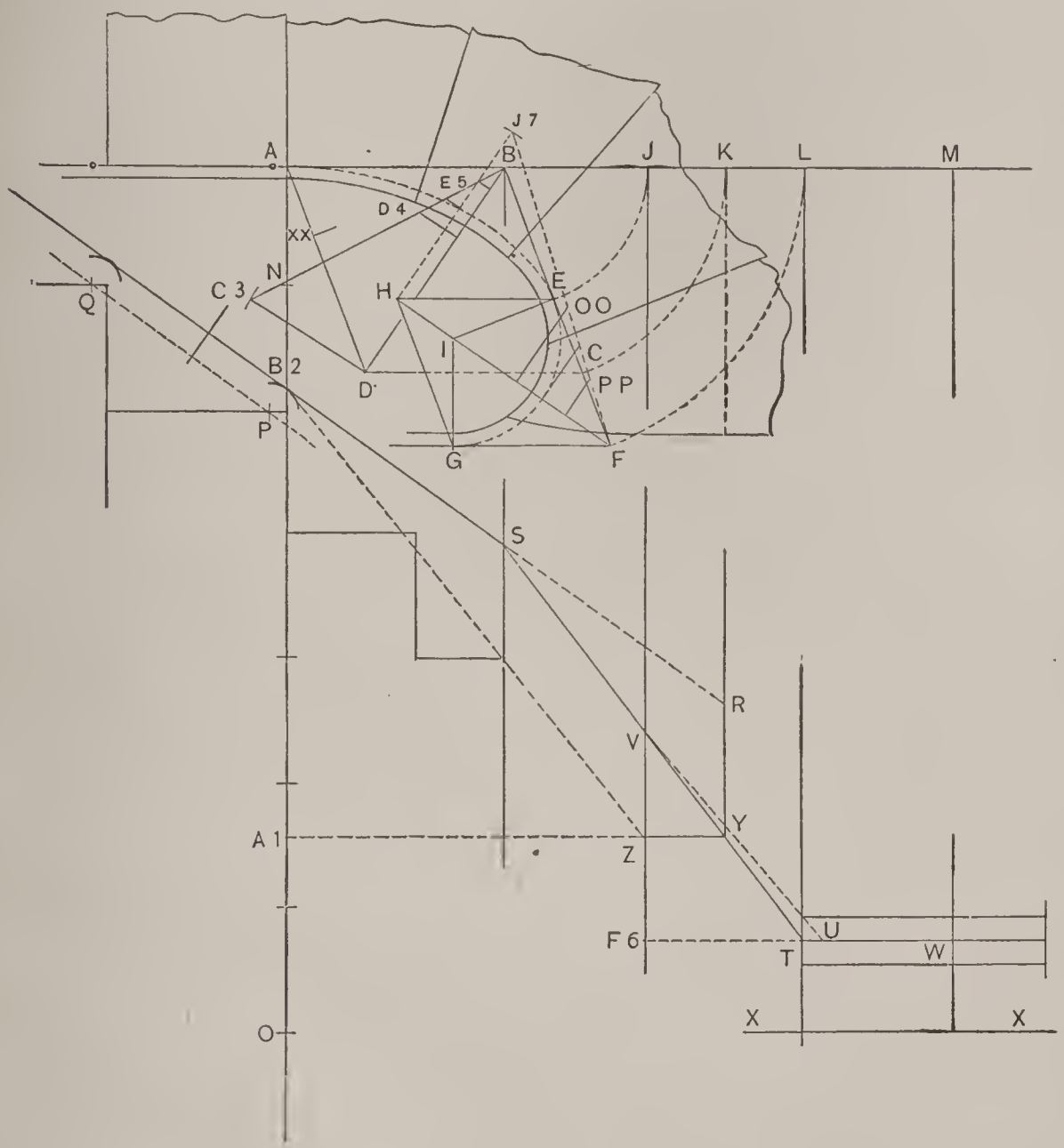


FIG. 114.—THUMB ELLIPSE, ACUTE AND OBTUSE ANGLES.

From B apply the pitchboard, extending the line to F and M, giving the length of the tangents. For the major length of the mould, with A as centre, describe C H, and from H drop a perpendicular indefinitely. From M draw M N parallel to H G, and connect N F, giving the required length. Draw the mould as shown, Fig. 110, using F N for major length and F B M for the tangents. This figure will require no further explanation.

Fig. 109. Let A L C be the portion to draw the mould, D as the corresponding point to L, forming the parallelogram, with E as the centre from which the curve is described. From P A L drop perpendiculars indefinitely. From any convenient point below P, let K K equal five risers as contained in the winders from P S. From K K draw the elevation of the treads outside of the cylinder. Locate the centre line of the rail from K K as the centre of the short balusters. At any convenient point on the pitch, as at G G, bisect the hight at J. Draw J B parallel to A L, cutting the perpendicular from L. At B connect B G; then B G, B M and B F are the tangents for the mould. For the major length of mould, from A as centre, describe C H. From H drop a perpendicular indefinitely. Draw M N parallel to A H, and connect N F, giving the required length.

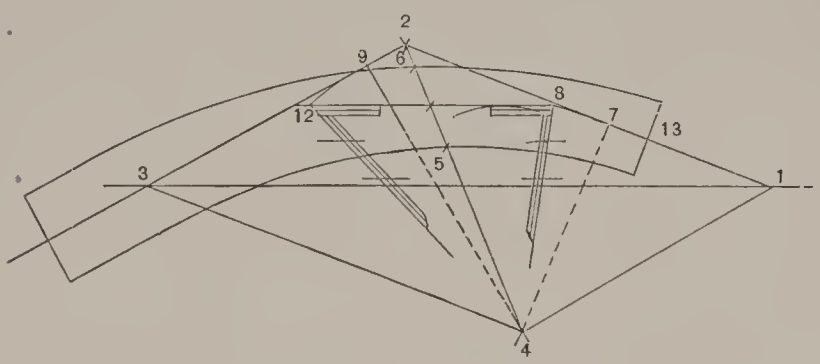


FIG. 115.—THE MOULD.

Fig. 110. Let 1 3 equal F N of Fig. 109. Let 1 2 and 3 2 equal M B and M F; produce 4 in the same manner, to complete the parallelogram, as all sides are equal. Let 2 6 5 equal L O E, 5 being the point from which to draw the chord line through 1 3. Let 4 9 equal D P, draw parallel to 1 3, and make 4 8 equal 4 7. The angle at 8 will then be the bevel. Find the width of the mould at the ends on the bevel in the usual manner.

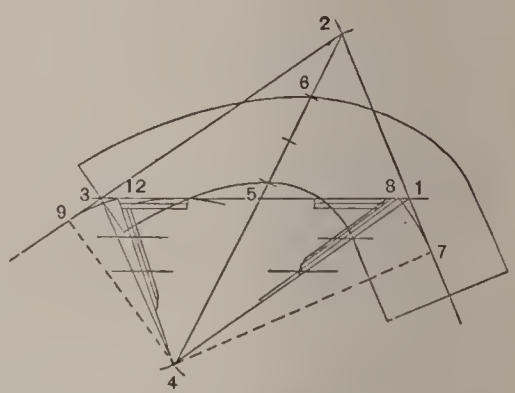


FIG. 116.—THE MOULD.

Draw the ramps from the angles at G, as indicated, T T being the joints.

Draw the mould for Fig. 108 from the major length N F, as shown.

A plan of stairs having a cylinder constructed of two quarters, the landing portion being that of a circle, the lower or flight being an ellipse. This is called a "Thumb Ellipse," and is preferable to a true cylinder. It has five winders, but requiring no ramp in the rail, as the lower piece will be a half easement, forming a graceful, easy turn. Scale ¾ inch to the foot.

Fig. 111. Plan. Let A B C E F be the plan of the tangents, with G and D as the centres. At the rise I extend a perpendicular indefinitely. Let H J equal the hight of six risers as contained in the winders. Draw the elevation of straight step and winder outside of the cylinder. Let M N be the short baluster, also the bottom line of the rail. Set off half the thickness of the rail, and draw the pitch line cutting the perpendicular line C B at O. Let B L on the base line equal B A, and erect a perpendicular at L, as indicated by the dotted line, indefinitely. From B as centre describe the dotted line, C S, also E P. At S P erect perpendiculars indefinitely. Locate the floor line X X from the hight at J on the left. From X X set up four inches to the bottom of the rail, with half the thickness of the rail, as at R. Draw level tangent R T equal to E F, and connect R O, giving tangents required. For the major length of mould, from Y, draw parallel to step line indefinitely. From the perpendicular L V set off W equal to B K, and connect V W for the length required. Extend the tangent line R O to Z. For minor length at right angles from B K set up K Q equal to Y Z, and connect Q B for length required. Find the width of mould on minor length in the usual way, as at A^2 B^2

Fig. 112. Let 1 3 equal W V, and 1 2 and 3 4 equal O V; 1 4 and 3 2 equal O Y; and connect 2 4. For the bevels let 4 5 equal A B, and draw parallel to 1 3, touching the tangents. From 4 describe 6 7, also 8 9. Then 7 and 9 are the bevels. Let 4 10 11 equal Q A2 B2 for the width on minor length. Find the width for the ends by the bevels—at 7 12 for the end at 00 and at 9 13 for the end at 3. Let 2 00 equal O U for the joint, add the required straightwood from 3, and complete the mould by drawing the curve.

Fig. 113. Let 1 2 and 3 4 equal R T; and 1 4 and 2 3 equal R U. For the bevel let 5 6 equal 2 3, the angle at 5 being the bevel. Let the end at 3 equal the width of the rail. Find the width of the other end by the bevel in the usual way; add the straight wood and complete the mould by drawing the curve.

A plan of stairs starting with four winders, the cylinder being a Thumb Ellipse. The flight piece of rail will be an obtuse base. The starting or easement will be acute. The straight treads start from the chord line—no ramp required. Scale ¾ inch to the foot.

Fig. 114. Let A B E be the portion for the flight or upper piece. Draw the parallelogram, all sides equal, to A B. Then A B C D is the parallelogram. The starting will be E F G H, with I as the centre from

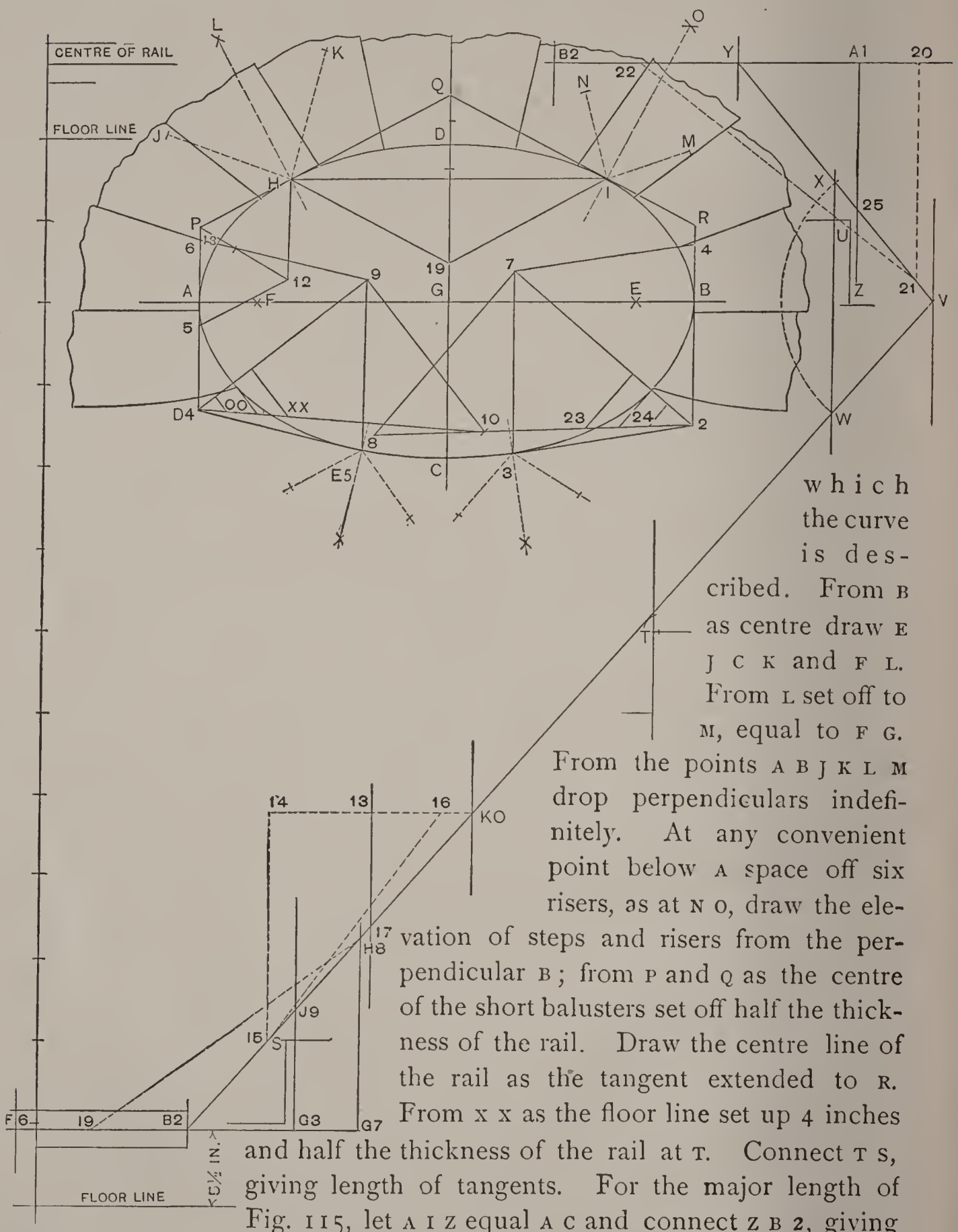


FIG. 117.—PLAN AND ELEVATION. ALL OBTUSE ANGLES.

which the curve is described. From B as centre draw E J C K and F L. From L set off to M, equal to F G. From the points A B J K L M drop perpendiculars indefinitely. At any convenient point below A space off six risers, as at N O, draw the elevation of steps and risers from the perpendicular B; from P and Q as the centre of the short balusters set off half the thickness of the rail. Draw the centre line of the rail as the tangent extended to R. From X X as the floor line set up 4 inches and half the thickness of the rail at T. Connect T S, giving length of tangents. For the major length of Fig. 115, let A I Z equal A C and connect Z B 2, giving length required. For the minor length let D C 3 equal Y R and connect C 3 B, giving the length required. Find the width of the mould on the minor length in the usual way, as indicated at D 4 and E 5. For the major length of Fig. 116 see Fig. 114

preceding. Let U F 6 equal E G, and connect U V, giving length required. For the minor length from H, set up J 7 equal to F 6 V; connect J 7 F for the length required. Find the width of the mould on minor length in the usual way as at O O and P P.

Fig. 115. Let 1 3 equal Z B 2, 1 2 and 3 4 equal S Y, 1 4 and 2 3 equal S B 2, and connect 2 4. Let 4 5 6 equal C 3, D 4 and E 5. For the bevels draw a line parrallel to 1 3, the distance from 4 to be the same as from B to the nearest point X X on the line A D. Let 4 8 equal 4 7, touching the parallel line. The angle at 8 will be the bevel for the end at 13. Let 4 12 equal 4 9, touching the parrallel line. The angle at 12 will be the bevel for the end at 3. For the joint at 13 let 1 13 equal V Y as the borrowed length; mark the joint at right angles to the tangent; add the straight wood required. Find the width of the mould for the ends by the bevels in the usual way, and complete the mould by drawing the curve.

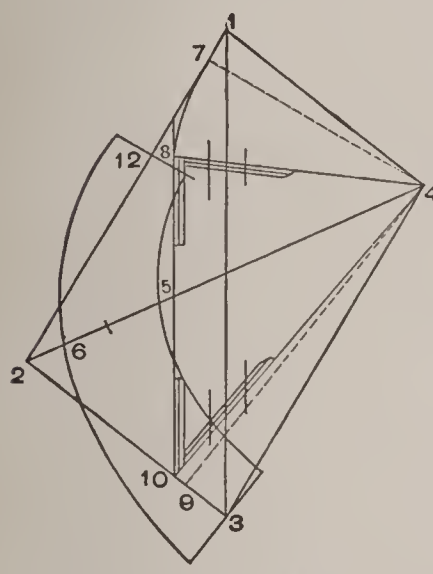


FIG. 118.—THE MOULD.

Fig. 116. Let 1 3, equal U V, 1 2 and 3 4 equal T W, 1 4 and 3 2 equal T V, and connect 2 4. Let 4 5 6 equal J 7, O O, P P. From 4 draw the parallel line equal to the distance from G to the tangent E F; in this instance it is over the line 1 3; or in other words, the line 1 3 is the required line. Let 4 8 equal 4 7, then the angle at 8 will be the bevel for the level end. Let 4 12 equal 4 9, then the angle at 12 will be the bevel for the end at 3. Add the required straight wood from 1, find the width of the mould for the ends by the bevel in the usual way, and complete the mould by drawing the curve.

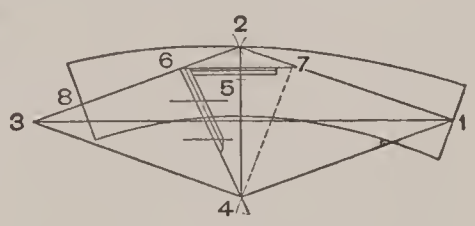


FIG. 119.—THE MOULD

A plan of Elliptical stairs showing the mode of producing the tangents on the ground plan from the foci. The starting and landing is made the same, having two risers past the major axis, but requiring different moulds for the rail, as will be seen by the following explanations. Scale ¾ inch to the foot. The centre line of rail only is drawn in this figure.

Fig. 117. Plan. Let A B be the major and C D the minor axis. The points E F upon the major axis are the foci, and are found thus: Take half of the major length, making D E and D F equal to G B.

Locate the joints in the rail at whatever point is desired (in this instance A H I B) leaving the other two joints on the level to be determined hereafter from the elevation. At A, as the point of the first joint occurs on the major axis, draw the tangents at right angles to the same indefinitely, and at B in like manner. Draw lines from each focus through H indefinitely, and with the compasses take any distance on the extended lines, as J and K; place one foot of the compasses in each of these points and describe the arcs bisecting at L; connect L H, which is the joint required. Draw the tangents at right angles to the joint; through I draw lines from each focus in the same manner. With the compasses set off M N, and from these points describe the arcs bisecting at O, and connect O I, giving the joint required. Draw the tangent at right angles to the joint. Draw the elevation with the spaces corresponding to A P H Q I R B. At any convenient point locate the second rise, as at S on the bottom to the left for a starting point, also locate the seventh and twelfth risers as indicated at T U. From the centre of the short balusters at S T describe the arcs, through which draw the tangents indefinitely. At the point of intersection V, which is the corresponding point to R of the ground plan, Fig. 117, place one foot of the compasses in V, extending to W; describe the dotted line W X, connect V X, extending until it touches the centre line of the rail on the landing, as at Y. From the perpendicular, V, set off Z equal to R B of the ground plan, Fig. 117. Erect a perpendicular extending to the level tangent line, as at A 1. Let B 2 on the ground plan equal Y A 1 of the elevation. From 2 draw the tangent touching the curve at 3, giving the point at which to make a joint on the level. Proceed in the same manner as described for H I. For the bottom easement extend the tangent downward until it touches the centre line of the rail 5½ inches above the floor, as at B 2, from which erect a perpendicular. Let A D 4 of the ground plan equal B 2 C 3 of the elevation. From D 4

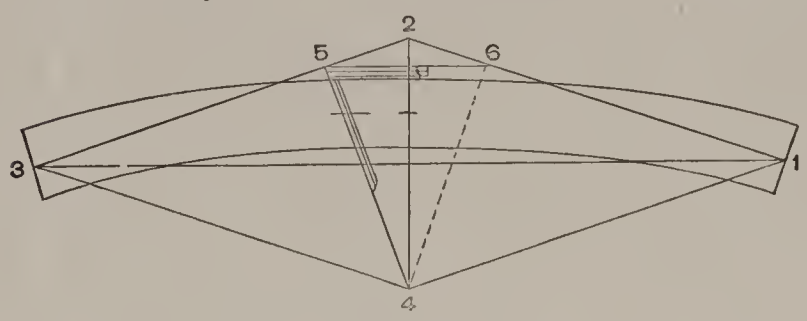


FIG. 120.—THE MOULD.

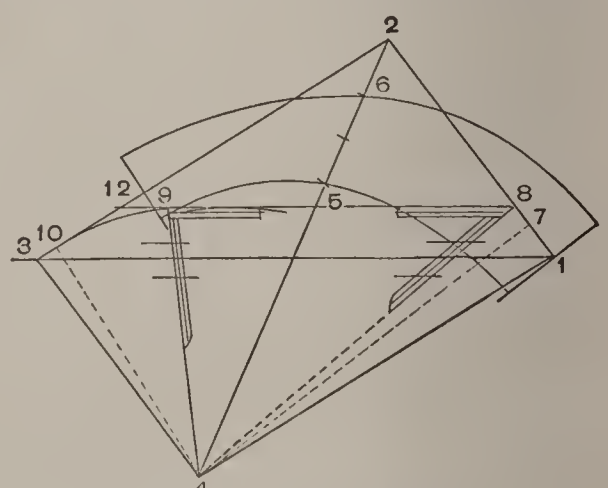
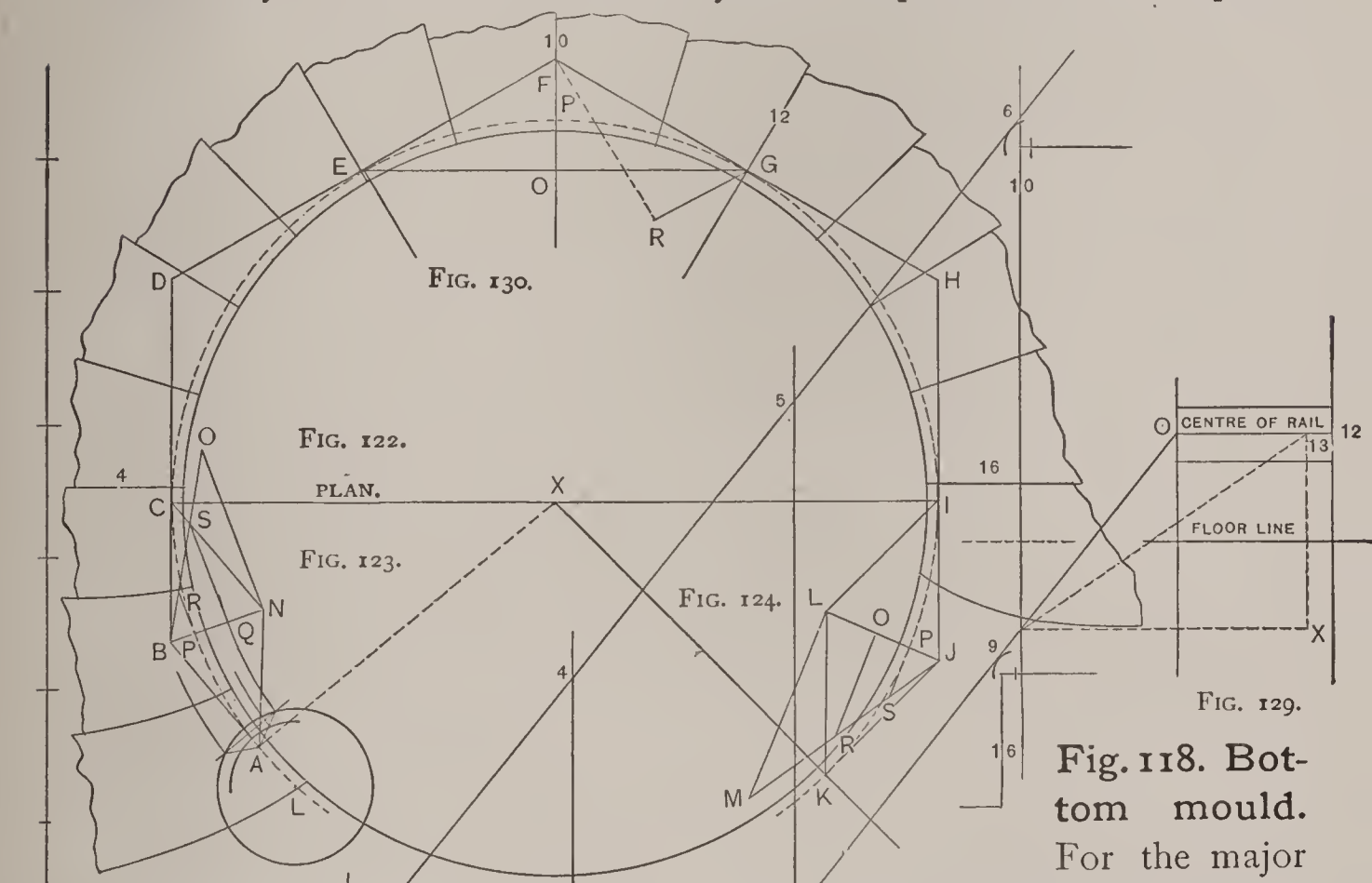
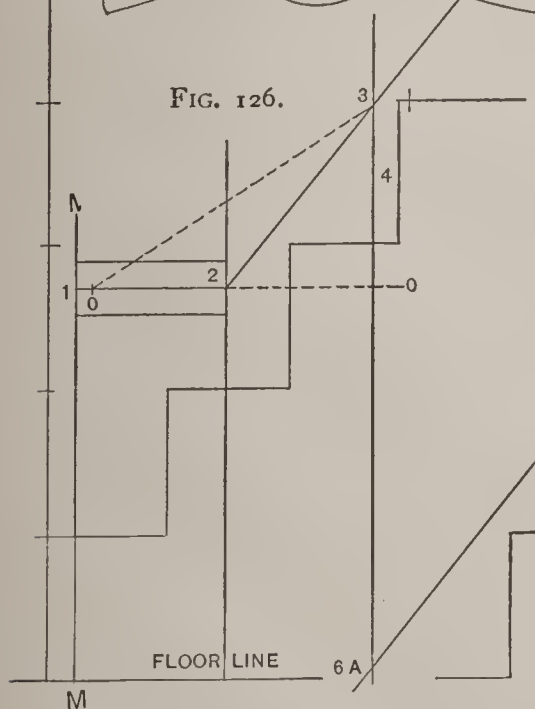


FIG. 121.—THE MOULD.

draw the tangent touching the curve at E 5, which will be the point at which to make the joint. Proceed in the same manner as described for H I 3. Let F 6 B 2 equal D 4 E 5 on the ground plan. Complete the parallelograms on the ground plan in the usual way by extending the short tangent equal to the long one, as before described in the elliptical problems. They will be marked without any further explanation in this respect.





FIGS. 122, 123, 124, 126, 129 AND 130.—CIRCULAR PLAN WITH LOCATION OF JOINTS AND ELEVATION.

Fig. 118. Bottom mould. For the major length of the mould let C 3 G 7 equal A 6 on the ground plan. At G 7 erect a perpendicular, extending to tangent line H 8. Let G 7 I 9 equal 6 E 5 on the ground plan, and connect I 9 H 8, giving the length required. For the minor length, let 9 10 on the ground plan equal G 7 H 8 of the elevation, and connect 10 D 4, giving length required. Mark the width of the mould on this line in the usual way, as X X O O.

To draw the mould, let 1 3 equal 1 9 H 8, 1 2 and 3 4 equal B 2 H 8, and 1 4 and 3 2 equal B 2 and F 6. Connect 2 4, making 4 5 6

equal to 10 x x 0 0. For the bevels, from 4, draw the parallel line equal to A 9 E 5 on the ground, and 4 8 equal 4 7. The angle at 8 will be the bevel for the upper end. Let 4 10 equal 4 9. The angle at 10 will be the bevel for the wide or level end. Find the width of the mould at the end by the bevels in the usual way. To joint the mould at its proper point let 2 12 equal B 2 J 9, and complete by drawing the curve.

Fig. 119. This will also be for the opposite end, and will cover the ground plan at I R B. From K O draw the dotted line at right angles to the perpendiculars indefinitely. Let 13 14 equal 13 K O. From 14 drop a perpendicular cutting the tangent line at 15. For the major length of the mould, let 14 16 equal 5 H on the ground plan, and connect 15 16, giving length required. Let 1 3 equal 15 16, 1 2 and 1 4 equal K O 17, 3 2 and 3 4 equal 15 17, and connect 2 4. Let 4 5 equal 12 18, and mark the width of the mould from 18 as the centre. For the bevel, from 4 draw the parrallel line equal to the distance between 12 and the tangent line A P, and let 4 6 equal 4 7. The angle at 6 will be the bevel for both ends. To joint the mould at its proper point let 2 8 equal 17 J 9. Find the width of the mould at the ends in the usual way by the bevel. Complete by drawing the curve.

Fig. 120. Draw this from the minor length. Let 2 4 equal Q 19 of the ground plan. Let 2 1 and 2 3 equal T W, and 41 and 43 equal T K O. From 4 draw the parallel line 5 6 equal to the distance between 19 and the tangent 1 Q on the ground plan. Find the bevel in the usual manner. Also the width for the mould at the ends. Complete the mould by drawing the curve.

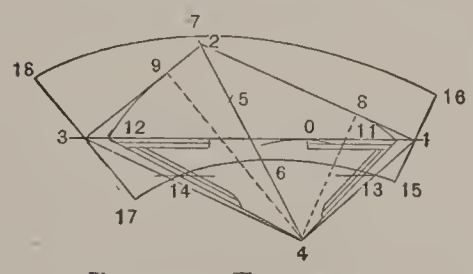


FIG. 125.—THE MOULD.
FIG. 123.—THE PLAN.
FIG. 126.—THE ELEVATION.

Fig. 121. Find the major length for the mould at the top of plan, Fig. 117. Let Y 20 equal Y B 2. From 20 drop a perpendicular touching the tangent line at 21. Let 20 22 equal 3 4 on the ground plan, and connect 21 22, giving length required. For the minor length let 7 8 equal 20 21, and connect 2 8, giving length required. Mark on this line the width of the mould in the usual manner, as indicated at 23 24. To draw the mould, let 1 3 equal 21 22, 1 2 and 3 4 equal 2 3, 1 4 and 3 2 equal Y 21 and connect 2 4. Let 4 5 6 equal 8 23 24. From 4 draw the parallel line equal to the distance 7, and the tangent line 4 2. For the bevels let 4 8 equal 4 7. The angle at 8 will be the bevel for the level or wide end of the mould. Let 4 9 equal 4 10. The angle at 9 will be the bevel for the

small end. Joint the mould at its proper place, letting 2 12 equal Y 25. Find the width of the mould for the ends by the bevels in the usual manner. Complete by drawing the curve.*

Circular plan with seventeen risers, giving the centre line of rail, requiring five pieces in the rail, and three moulds to be drawn. Scale ¾ inch to the foot.

Fig. 122. Plan. With X as centre describe the curve for the face of the string, also the dotted line as the centre of the rail. Let L be the centre of the newel to describe the cap, draw the mitre, as described in Fig. 94. Let A be the point of the mitre, at right angles to X A, draw the tangent A B, and draw C B in the same manner. From C to I mark off for as many spaces as it is desired to have pieces in the rail; in this case we have three, as the joint occurs at C E G I. Through these joints draw the tangents. With the square at E X draw E D, then at X C draw C D. In like manner draw the other tangents. The location of J and the joint K will be found after the elevation is drawn, as in Fig. 117.

Proceed to draw the elevation thus: Draw the perpendicular at the left with ten risers in hight, and draw at the bottom the horizontal line as the floor line. Space off from the perpendicular M M as many divisions as there are on the plan, Fig. 122, from A to F, erecting perpendiculars at each division as indicated. Locate the 4th and the 10th risers. From the centre of the short baluster, as the bottom line of rail, set off half the thickness of the rail, and through these points draw the tangent line 2 6. Draw 1 2 level equal to A B, Fig. 123, PLAN. From 1 to 6 gives the length and pitch of the tangents, equal to A F, Fig. 122. At the perpendicular 4 7, locate the 12th rise, also locate the 16th. From the centre of the short baluster set off half the thickness of the rail and draw the tangent 6 A to 9 extended. From the floor line set up four inches to the bottom of the rail and half the thickness of the rail added, as 12 O. At the intersection at O is the length for the tangents, 1 J, on the plan. Draw J K at Fig. 124, PLAN, equal to O 12, completing the location and the length of all the tangents.

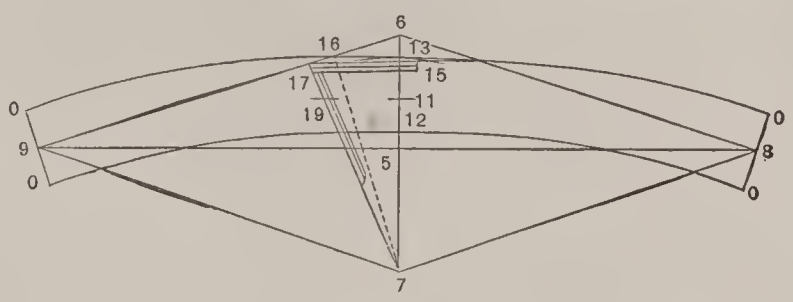


FIG. 127.—THE MOULD, COVERING PLAN FROM C TO I.

* NOTE.—On the margin at the left is the hight of 13 risers contained in the plan of stairs, with the floor lines and the center line of rail on the levels as shown on the elevation.

Fig. 125. To draw the mould, PLAN, Fig. 123, ELEVATION, Fig. 126, let 0 0 equal A C, and connect 0 3, giving the major length required. Let 1 3, Fig. 125, equal 3 0; 1 2 and 3 4 equal 3 2, 1 4 and 3 2 equal 1 2, in Fig. 126, and complete the parallelogram. For the width of the mould on the minor length proceed as follows: From the point N, Fig. 123, erect a perpendicular N 0 equal to 0 3, Fig. 126, and connect 0 B, giving the minor length. At P Q erect perpendiculars, cutting the minor length at R S. Let 4 6 5, Fig. 125, equal 0 S R, 5 7 equal 5 6; then 6 7 is the width for the mould. To find the bevels, let 4 0 equal the distance between N and the tangent A B, which, in this instance, is on the major length. Let 4 11 equal 4 8; then the angle at 11 is the bevel for the joint at 1. Let 4 12 equal 4 9, the angle at 12, which is the bevel for the end at 3. For the width at the ends draw 13 14 parrallel to 1 3 and equal to P Q, and at the cutting with the bevels, giving the width for the ends, let 1 15 and 1 16 equal 11 13, and 3 17 and 3 18 equal 12 14. Complete the mould by drawing the curve through the points thus indicated.

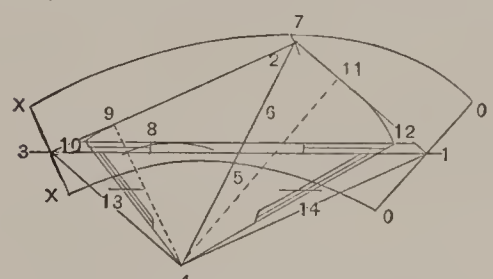


FIG. 128.—THE MOULD COVERING PLAN, FIG. 124, AND ELEVATION, FIG. 129.

Fig. 127. To draw the Mould. Plan, Fig. 130. This mould is drawn from the minor length thus: Draw the horizontal line indefinitely, also draw the vertical line. Let 5 6 and 5 7 equal 0 F, Fig. 130. From 6 and 7 let all sides of the parallelogram equal the tangents 4 5 and 5 6, as shown, 8 9 being the major length, as produced from the minor length. For the centre and the width of the mould, let 5 11 equal 0 P, and from 11 as the centre of the mould mark off the width 12 13. For the bevel let 7 15 equal F R, draw parallel to 8 9, and let 7 17 equal 7 16; the angle at 17 is the bevel for both ends. For the width at the ends, from 11 as the centre, draw 11 19, parallel to 8 9; then 17 19 is half the width at the ends, as 8 0 0 and 9 0 0. Complete the mould by drawing the curve.

Fig. 128. For the mould. Plan, Fig. 124. Elevation, Fig. 129. For the major length let 9 X elevation equal 1 K of Fig. 124. From X erect a perpendicular cutting the centre line of rail 0 12 at 13, and connect 9 13, giving the length required. Find the minor length at Fig. 124 by producing the point L in the parallelogram. At L drop a perpendicular L M equal to X 13, elevation, and connect M J, giving the length required. From P as the centre of the rail and 0

as half the width, drop perpendiculars, cutting the minor length at R S. Let 1 3, Fig. 128, equal 9 13, Fig. 129. Let 1 2 and 3 4 equal 0 12, complete the parallelogram and connect 2 4 as the minor length equal to M J. For the width on minor length, let 4 5 6 equal M R S, and 6 7 equal 6 5, giving 5 7 as the width required. For the bevels let 4 8 equal the distance from L to the tangent J K, and draw parallel to 1 3. Let 4 10 equal 4 9; then the angle at 10 is the bevel for the end at 3. Let 4 12 equal 4 11; then the angle at 12 is the bevel for the end at 1. For the width of the mould at the ends draw 13 14 parallel to 10 12, the distance between to equal half the width of the rail as O P, Fig. 124. Let L O O equal 12 14, 3 X X equal 10 13, and complete the mould by drawing the curve.

We now show the principles of Forced Easements, which it is necessary to employ under certain conditions, where, if the mould were drawn in the usual way, the proper hight would not be retained. Figures 131 to 137 illustrate the text and make the principle plain. Scale, ¾ inch to the foot.

Fig. 131. Ground plan for an easement having two pitches. The full lines in both, this figure and the elevation, are used. Fig. 133 shows the easement as it appears in position, as drawn from the mould, Fig. 134. Fig. 132 will accomplish the same result. The dotted lines in this figure are used, as also in the elevation. Fig. 135 is the mould, and when applied and worked will be the same as shown at Fig. 133. Fig. 136 shows the landing

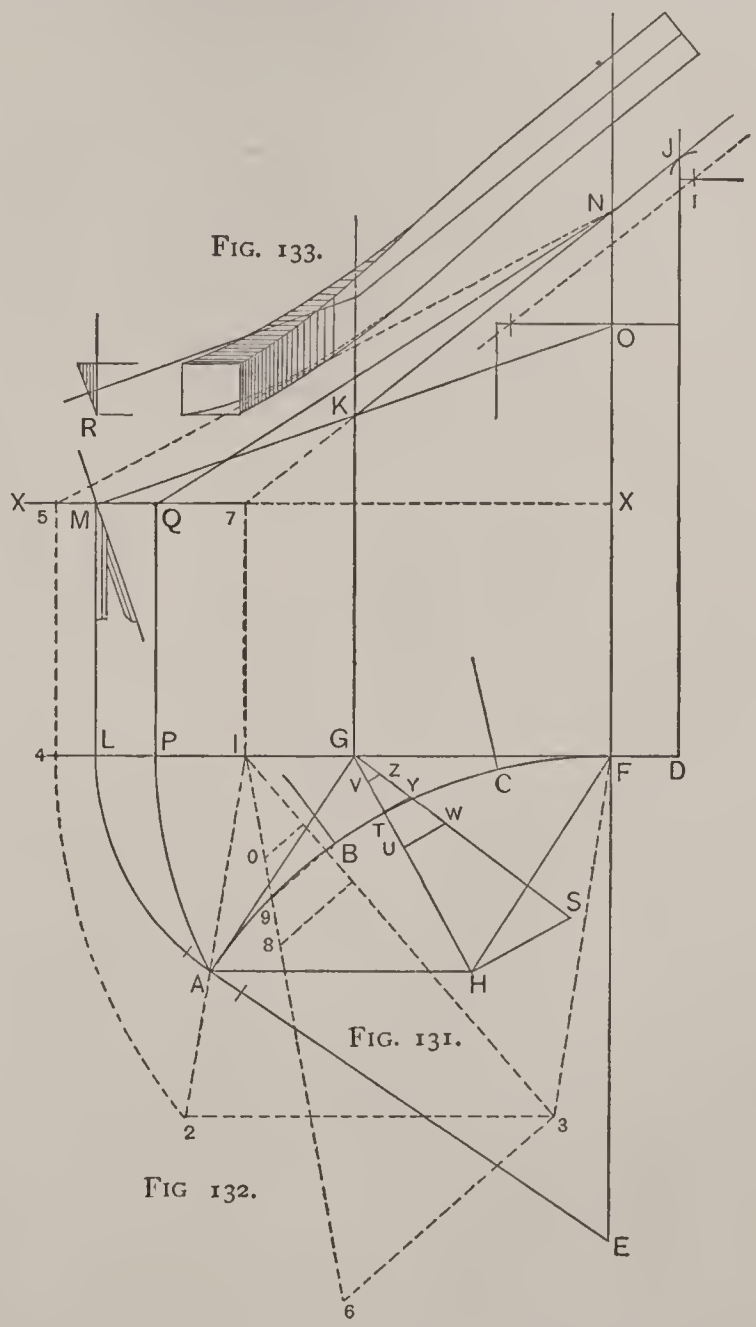


FIG. 133.

FIG. 131.

FIG 132.

FIGS. 131, 132 AND 133.—GROUND PLAN AND ELEVATION POR BOTTOM FORCED EASEMENTS.

of a straight flight, with a quarter cylinder, and the landing rise placed near the back of the cylinder. In order to get up to the proper hight this figure has been introduced. Fig. 137 shows the mould as drawn.

Fig. 132. Let E be the centre from which to describe the curve F A as the centre line of rail; A B C D, the location of the risers; connect G D, extended, as a base line. At D erect a perpendicular equal to four risers, as at I. At G also erect a perpendicular indefinitely. From the centre of the short baluster at I find the centre of the rail as at J, and apply the pitchboard, cutting the perpendiculars from G at K. From G as centre describe A L, and at L erect a perpendicular, cutting the line X X. At M connect M K and K N, giving the length and pitch of tangents, to draw the mould, Fig. 134. Extend M K to O, and from F as centre describe A P. At P erect a perpendicular, cutting the line X X at Q, and connect N Q, giving the major length. Find the minor length, draw the parallelogram producing H, connect H G, and at H erect a perpendicular H S, equal to O N. Connect S G, giving the minor length. Let T be the centre of rail, U V the width, and erect perpendiculars cutting the minor length at W Y Z.

Fig. 134. Let 1 3 equal N Q, 1 2 and 3 4 equal K N, 1 4 and 3 2 equal M K, and connect 2 4. Draw 5 6 parallel to 1 3, and let the distance from 4 equal the distance from H to the tangent line G F. To find the bevels, let 4 6 equal 4 7, when the angle at 6 will be the bevel for the end at 1. Let 4 5 equal 4 8, when the angle at 5 will be the bevel for the end at 3. For the width of the mould on the minor length, let 4 9 O 11 equal S W Y Z; then 9 11 is the width. For the width at the ends draw 12 13 parallel to 6 5 and equal to half the width of rail. Let 14 15 and 14 16 equal 6 13, and 3 17 and 3 18 equal 5 12. Complete the mould by drawing the curve. Fig. 133 will be squared on the inside, after which the end will be cut to make the joint by applying the bevel at R. This bevel is found by drawing at right angles to the pitch M K and the perpendicular M L, giving the bevel as at M, and applied at R.

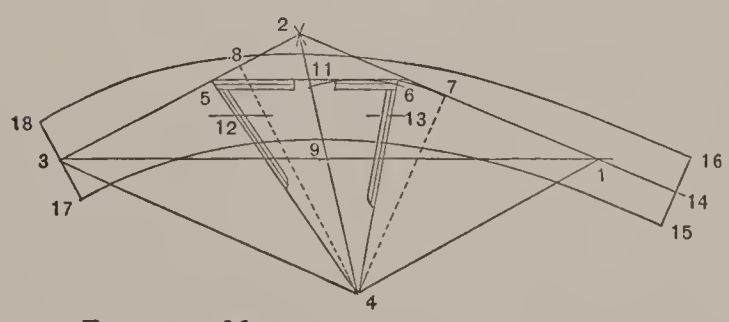


FIG. 134.—MOULD COVERING PLAN, FIG. 131.

Fig. 132. Let F 1 2 3 be the parallelogram. From F as centre describe 2 4, at 4 erect a perpendicular, cutting the line X X at 5, and connect 5 N, giving the major length. For the minor length, at 3 erect a perpendicular, 3 6 equal to N X, and connect 6 1, giving the length

required. At 1 erect a perpendicular to 7, connect 7 N, giving length and pitch of tangent. Find the width on the minor length, as shown at 8 9 0.

Fig. 135. Let A C equal 5 N, A B and C D equal N 7, A D and C B equal 1 2, and connect B D. Let D E F G equal 6 8 9 0, draw H I parallel to A C, and from 4 equal to the distance 3 and tangent 1 2. For the bevel let I D equal D J; then the angle at I is the bevel for the end at A. Let D H equal D K; the angle at H is then the bevel for the end at L. Let B L equal I A, and make joints. Find the width at the ends in the same manner as for Fig. 134. Complete the mould by drawing the curve.

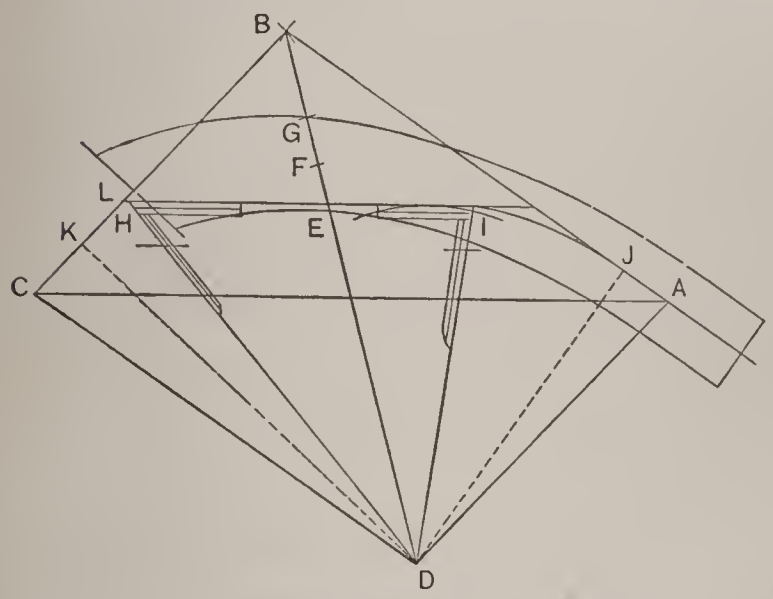


FIG. 135—MOULD COVERING PLAN FIG. 132.

Fig. 136. From A, centre of the quarter, describe the curve B C. Let D C E be the risers. The centre line of rail only is shown here. From A and B erect perpendiculars indefinitely. Draw the elevation of steps and risers, and from the floor at F set up four inches and a half, the thickness of the rail, as at G. At D, the centre of the short baluster, locate the position of the rail. From the centre of G draw the tangent to any point desired to form the ramp, as at H. This is left to the judgment of the workman. At right angles to G H make the joint or cut for the twist as I J. At right angles to D H mark the joint proper, as K L.

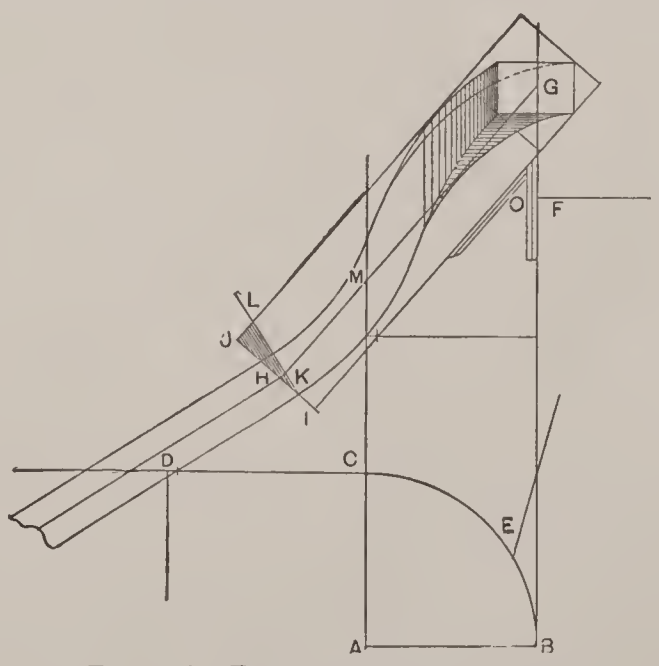


FIG. 136.—FORCED EASEMENT OVER A LANDING QUARTER.

Fig. 137. For the mould. Let 1 2 equal G M, and 2 3 equal A C. Add the straightwood 1 4 equal to M H. Let 5 6 equal J L, as the distance to mark the joint in the operation of squaring the twist. The

thickness required for the twist is found at I J. The bevel for squaring is at O. In working the twist mark the joint K L ; also mark the thickness for the rail and square in from the joint, giving the direction for the straight rail. Mark the top end and apply the mould for the curve on the inside. Dress the inside out, then take it to a width, after which form the easement, squaring the top side first, using taste in the execution, so as to give it the appearance of an ogee. This will be found to give a graceful appearance, and is better than making it in two pieces, as is generally done.

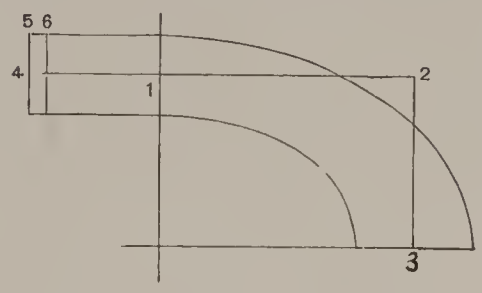


FIG. 137.—THE MOULD.

SPLAYED WORK.

The seven figures following have been introduced for the purpose of showing how to find the mitres of splayed work, such as sills, boxes and hoppers, the mitering of timbers in stairs at any angle or pitch, rafters, &c.; also to cut the front string of stairs, applying the bevel to cut the mitre from the pitch.

Fig. 138. A right angle plan with splayed sides, giving the side cut, butt and mitre. Let A B be the line of bottom, extended, D the angle in plan, B C the incline or splay of sides, C F the thickness of the sides, and D M the mitre in plan. From B as centre describe C L. From L draw parallel to B D, cutting the line of the side E M at R, and connect R D. The angle at R is the bevel to cut the sides. Draw J G parallel to A B, cutting the outside edge of side at F. From F draw parallel to L R, cutting the line of mitre in plan at H. From H erect the perpendicular H O. Draw G N parallel to F H, cutting the perpendicular at O, and connect O S. The angle at O is the bevel for the mitre. From J draw parallel to B D, cutting the line of mitre in plan at K. From K erect the perpendicular, cutting the line G O at N, and connect N S. The angle at S is the bevel for the butt joint.

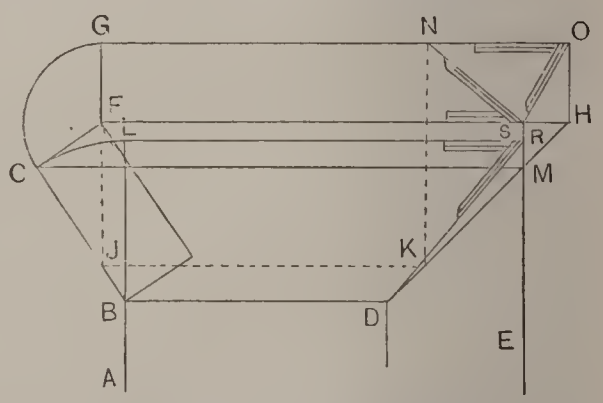


FIG. 138.—RIGHT ANGLE, GROUND PLAN, WITH SPLAYED SILES.

Fig. 139. Another method, producing the same result from plan, the same as that of Fig. 138. Let A B be the line of bottom, B C the splay of sides, and C F the thickness of the sides. From

B as centre erect the perpendicular and describe C D. From C erect the perpendicular C R, draw D R parallel to G C, and connect R B. The angle at R is the bevel to cut the sides. Draw J G parallel to B D. From C as centre describe G S, cutting the splay of side B C, and at S connect S F. The angle formed at S is the bevel of the butt joint. From F as centre describe J O, and connect O S. The angle at O is the bevel for the mitre.

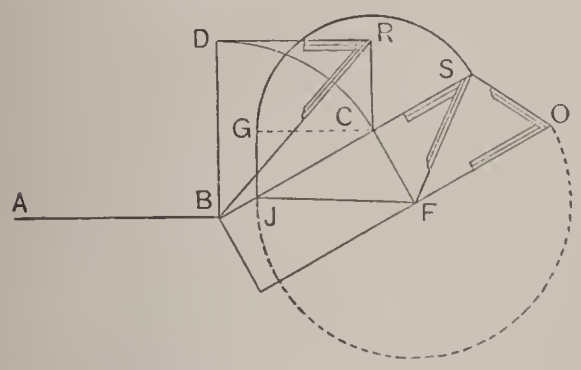


FIG. 139.—RIGHT ANGLE, GROUND PLAN, IN DIFFERENT FORM.

Fig. 140. An obtuse angle in plan with splayed sides, giving the side cut, butt and mitre for the same. Let A B be the line of bottom, and B C the splay of the sides, C F the thickness of the sides, and D the angle in plan. Draw C M parallel to B D, and E M parallel to D U, being equal to the splay. Connect D M, extended, for the mitre in plan. From B as centre describe C L. From M erect a perpendicular. From L draw parallel to C M, cutting the perpendicular from M at R, and connect R D. The angle at R is the bevel for the sides. From F as centre describe C G. From H erect a perpendicular. From G draw parallel to F S, cutting the perpendicular from H at O, and connect O S. The angle at O is the bevel for the mitre. The butt joint will be found as indicated by the dotted lines thus: Extend G F to J, then draw to K, as it cuts the mitre in plan. From K draw parallel to the side M E, cutting the line F H at P, then square over to N, connect N S, and the angle at S will be the butt joint as required.

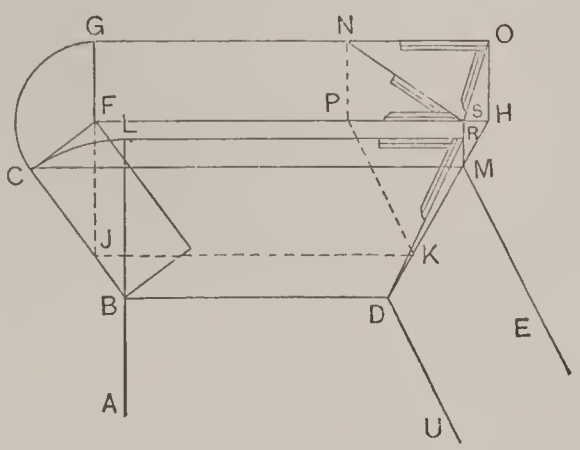


FIG. 140.—OBTUSE ANGLE, GROUND PLAN, WITH SPLAYED SIDES.

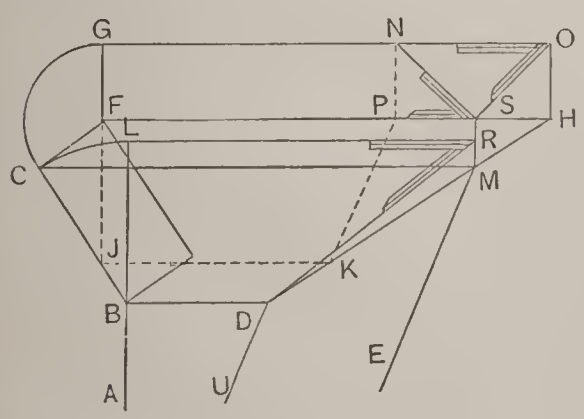


FIG. 141.—ACUTE ANGLE, GROUND PLAN, WITH SPLAYED SIDES.

Fig. 141 is an acute plan with corresponding points to Fig. 140, and will need no further explanations.

BEVELS AND MITRES.

Fig. 142. To find the mitre or bevel for timbers on the rake over a right angle, base or ground plan. Let A B and E F be the thickness of the timber to be cut. Let C D be the mitre or angle in plan, D L the hight and D A the run. Connect A L, giving the length and pitch. Let M N equal G D, and connect L N. The angle at L is the top bevel giving the mitre. The angle at M is the plumb or side cut, and at A is the bevel for the foot. In like manner let D O be hight and D F the run. Connect O F, giving the length and pitch. Let I J equal I K, connect O J, and giving the top or mitre bevel. The angle at I is the plumb or side bevel. At F is the bevel for the foot, and when cut will stand plumb over the ground plan B G E.

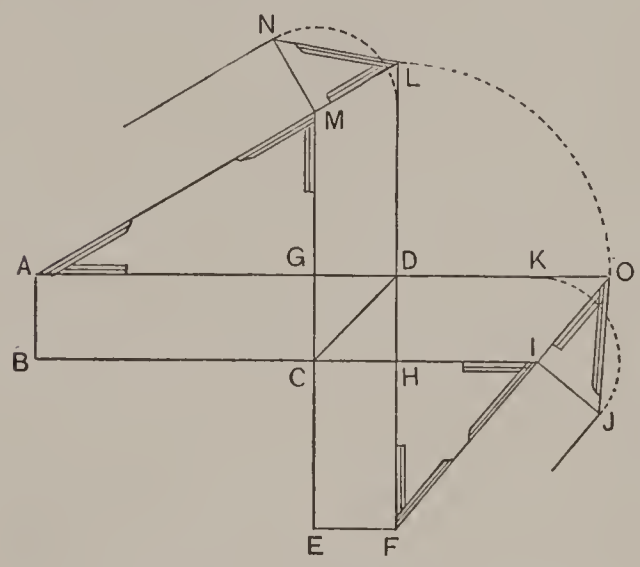


FIG. 142.—RIGHT ANGLE GROUND PLAN. TO FIND MITRE FOR TIMBERS ON RAKE.

Fig. 143 is an obtuse angle plan: one side only is shown in the elevation, as the opposite side will be the same. Let A B and R L be the thickness of timber to be cut, H G the line of cut in plan. At G erect a perpendicular the hight required as G I, and connect I L, giving the length and pitch. Draw H J parallel to G I, and let J K equal S H. Connect I K, giving bevel for the top or mitre. The angle at J is the plumb or side bevel, and L is the bevel for the foot.

Fig. 147 is an acute angle in plan. Let E F and R L be the thickness and C D the angle or mitre in plan. At D erect a perpendicular the hight required, as D P. Connect P L, giving the length and pitch. From C erect a perpendicular parallel to D P. Let M N equal C O, and connect P N, giving the top or mitre bevel. At M is the side or plumb bevel, and at L the bevel for the foot.

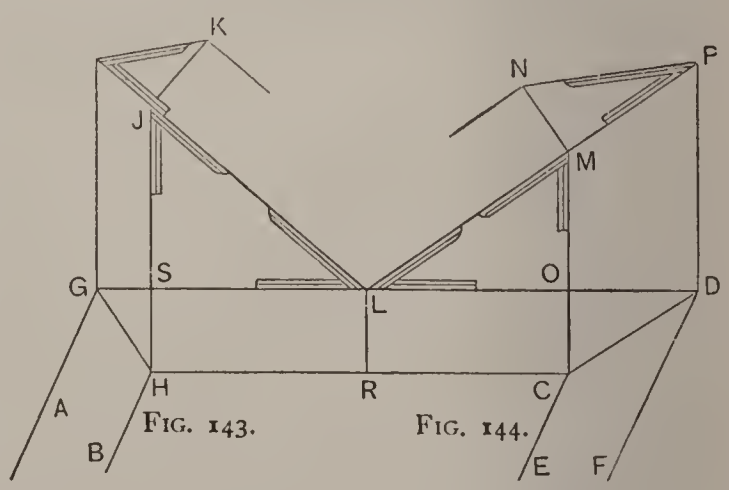


FIG. 143. FIG. 144.

FIG. 143.—OBTUSE ANGLE AND GROUND PLAN.
FIG. 144.—ACUTE ANGLE, GROUND PLAN. TO FIND MITRE FOR TIMBERS ON RAKE.

DETERMINING WIDTH OF MOULD IN SPECIAL CASES.

Figs. 145 and 146, showing how to find the width for the mould at the normal point. It is usual to make the mould the width of the rail, but in practice it is found necessary to have the mould wider, and the question arises, how much will be required? That will depend on the size of the cylinder and the thickness of the rail. For the smaller the cylinder and the thicker the rail, the wider will be the mould.

Fig. 145. Let A be the centre to describe the curve lines, and B G as the width of rail in plan. Draw the perpendicular through A and set off on each side half the width of rail, as at D E. At any convenient point apply the pitch of the major length. Through the point F draw the thickness of the rail, and at right angles to the pitch, draw the line cutting the thickness of the rail at H I. From the points thus established drop perpendiculars cutting the inside of the rail as at J L K; then L M will be the width required at the normal point. Let N O be the thickness for the plank, and P R will be the width for the ends.

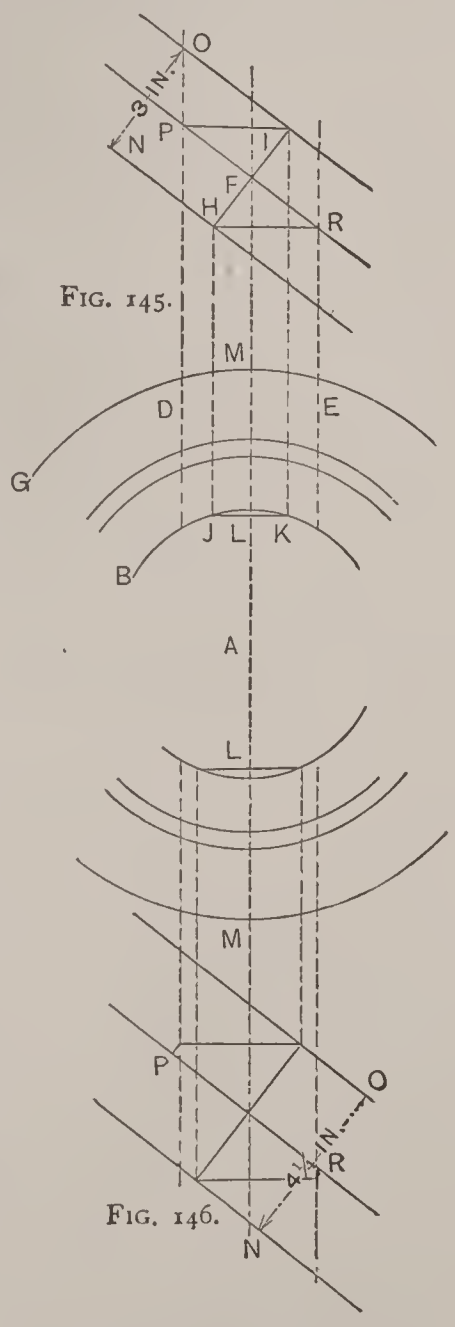


FIG. 145.

FIG. 146.

FIGS. 145 AND 146.—TO FIND WIDTH OF MOULD WHEN THICKNESS IS GREATER THAN WIDTH.

Note.—Draw the mould as explained in the previous problems, and add whatever is necessary to accomplish the desired result in width. After the twist is laid out on the plank, reduce the mould to its proper size ready to be applied in squaring the twist. It will be understood, by referring to J L K, that the extra width is on the inside only at the normal line, but at the ends it must be on the outside as well.

Fig. 146 is drawn in the same manner as Fig. 145, being the same in plan, width and thickness of rail equal (3½ x 3½). L M is the width necessary for the mould at the normal line, N O the thickness for the plank, and P R the width for the ends. It will be seen that a 3½ plank will not do to get out the rail for Fig. 146, while it is sufficient or Fig. 145, but it must be about ¾ of an in ch more, or 4¼ thick.

SLIDING THE MOULD.

Fig. 147 shows how to apply the bevels and slide the mould. In this case the bevels are alike, the tangents being of one length.

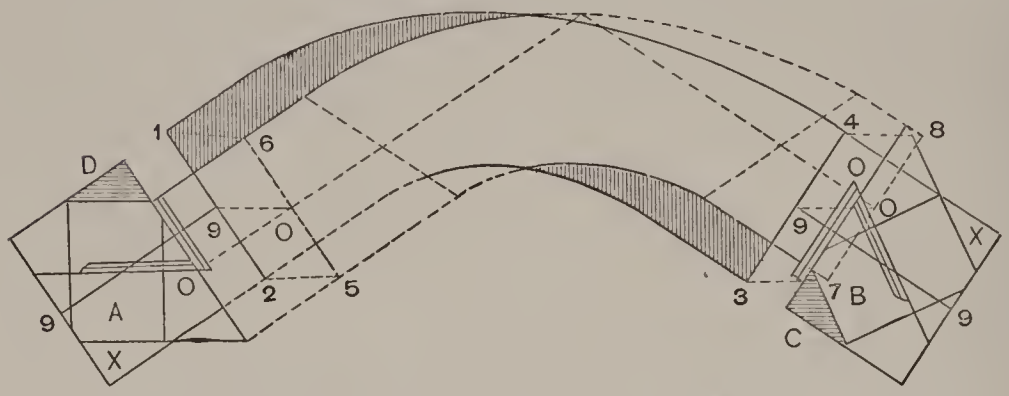


FIG. 147.—APPLICATION OF BEVELS AND SLIDING OF MOULD FOR QUARTER TURN, WITH BOTH PITCH TANGENTS.

Fig. 148. Sliding the mould and applying the bevels. This is a quarter with tangents of unequal length; consequently it has two bevels as well. The explanations for these two pieces are the same, both being lettered alike, and are laid out for right-hand stairs.

Note.—Dress the top side out of wind, and make the joints to the pattern. This is an important feature in rail working, for if it is done carelessly the rail will not be as it should, and no matter how well the moulds are drawn the draughtsman is sure to be blamed for carelessness or neglect in the working after the rail is hung.

Operation.—Lay the mould on the piece, keeping the joints even. Let 1 2 3 4 be the size of the mould and twist at 9 square through, as 9 9. With the stock of the bevel in the left hand, the blade to the right and the concave side of the twist also to the right, apply the bevel at A through the centre. Now turn the twist, letting concave side be to the left, but keep the bevel in the same position, applying it at B. In the same manner then mark the square of the rail as shown. Now at o, where the bevel touches the face, square over on the twist as the tangent, and show by the dotted lines. Then slide the mould along the tangent line as shown, until it covers the same points on the opposite end. Now the mould, as it is lying on the twist, is shown by 5 6 and 7 8. Mark the inside and outside along the edge of the pattern as shown by the dotted lines, and the overwood is shown by the shaded portion along the face and at the end, sections D and C. Now turn the twist over and repeat the operation from the

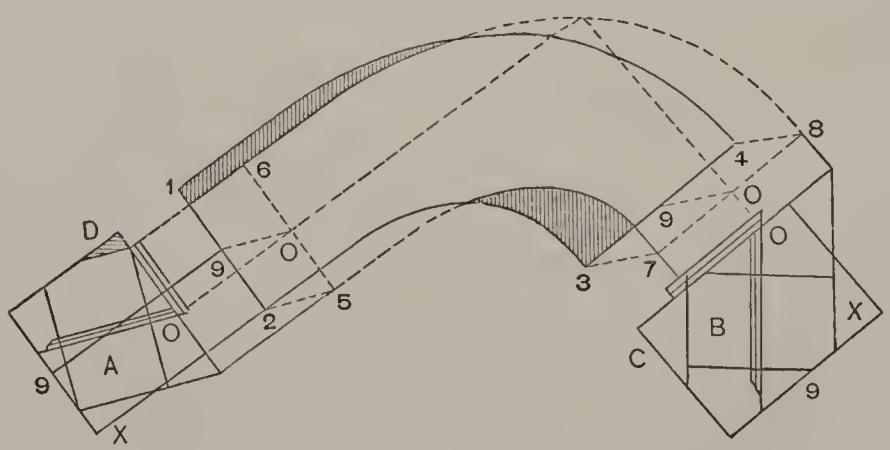


FIG. 148. LANDING OVER AN OBTUSE ANGLE.

opposite end, and x x will be the section to cut off. Now put the piece in the vise and with the ax or gouge and mallet remove the surplus wood, then with a plane dress out the inside, finishing up with a spoke shave. The outside will be done in the same manner. Now, having the twist to a width, mark the top line, using a strip of paste board, letting it lie close to the wood.

Note.—Fig. 147 has straightwood on both ends and Fig. 148 on one end, and must be squared in from the joint equal to the amount of straightwood intersecting with the line of the paste board, and forming an angle which must be eased. This is done according to the taste of the workman, and blending with the piece on which it will be jointed. A little practice will soon make the workman understand what is needed to make a good and graceful rail. Short and quick easements and too much straightwood are to be avoided, as they cripple the rail to the eye.

Now having the line for the top marked on the inside and outside, remove the overwood and finish off with a spoke shave; after which guage to thickness, using your fingers as calipers through the centre, as it is quite certain to be thick in the centre, and when moulded giving a clumsy appearance, which is to be avoided.

Fig. 149 is a starting easement or turnout piece. This is laid out for the left hand and the overwood is marked on the back edge. Both bevels are applied from the same side, and the stock to the back or outside of the piece. A B C D is the twist, and the mould 5 5 is the centre line of the stuff and tangent. E F is the section of the size of rail, o o the tangent as marked on the piece from the bevel as it comes to the face, and is shown by the dotted lines. This mould will slide on the bottom joint as A B, giving its new position as shown by 1 2 and 3 4. On the upper end 5 o is the distance the mould has moved. Repeat the operation on the other side, and J L will be the inside portion to remove. After the inside is dressed out the easement will be formed by its own lines, as they occur along its face, and will need no further explanation.

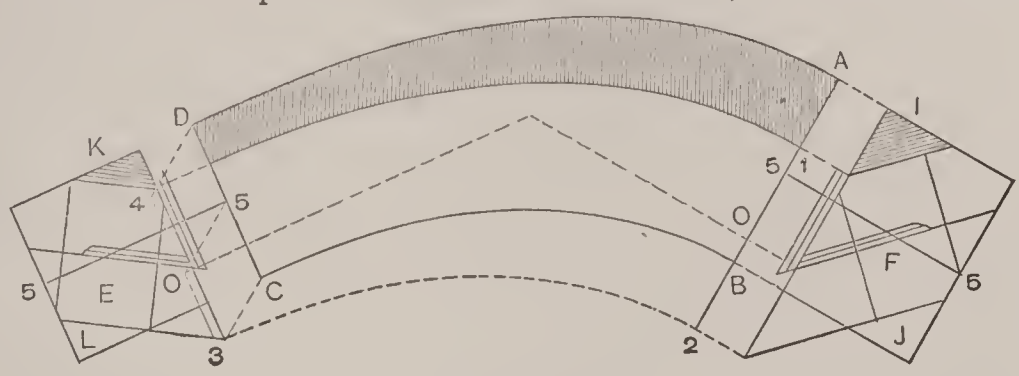


FIG. 149.—TURNOUT.

THE NONPAREIL SYSTEM IN ITS BRIEFEST FORM.

Fig. 150. A quarter circle ground plan, with tangents in elevation of one pitch. Let A B C D be the ground of tangents, and A B F the stretchout of the tangents on the base line. Let A 1 be the hight and 1 2 F the tangents in elevation. From A as centre and A C as a radius, produce E, and connect E 1, giving the major length. Now find the position of the tangents for the mould. From 1 as centre and 1 E as a radius, describe the curve indefinitely; then from 2 as a centre and 2 F as a radius, describe the curve touching at 3. Connect 2 3, giving the required form for the mould. Produce the point 4 in the usual way. To find the bevel, set the compasses the length of the dotted line o o, set one foot in 4 and describe the segment. Then square from the tangent, touching the point 4. Now, from the intersection with the tangent draw a line touching the segment, and the angle thus formed is the bevel to be applied at both ends of the twist.

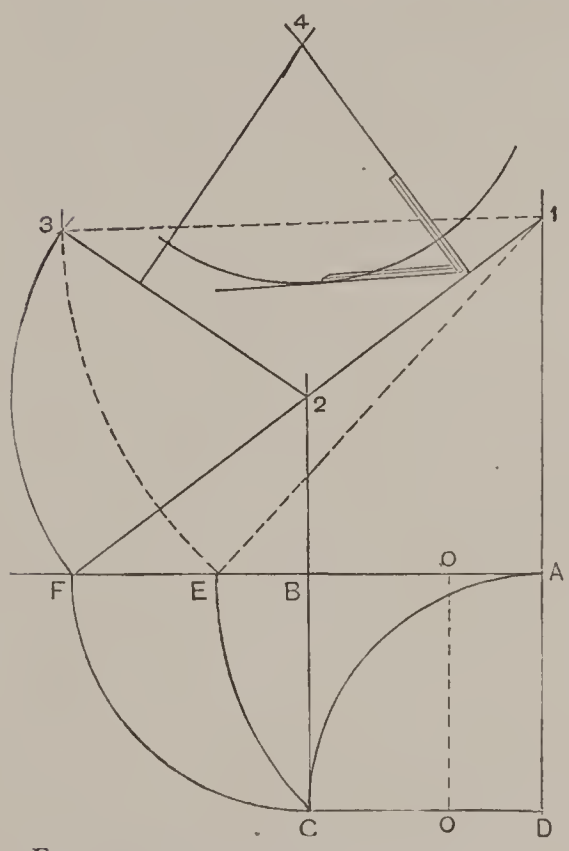


FIG. 150.—RIGHT ANGLE, GROUND PLAN, ELEVATION TANGENTS OF MOULD AND BEVEL.

Fig. 151 is drawn from the same base line as that of Fig. 150, this having tangents of different pitches. Find all points in this in the same manner as for Fig. 150, all letters and numbers being the same. The two bevels will be found from the two tangents by drawing a line touching the segment.

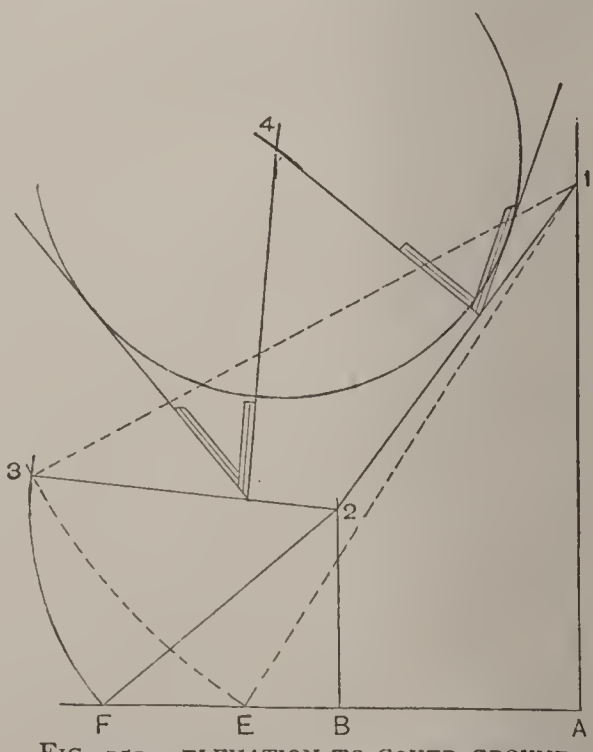


FIG. 151.—ELEVATION TO COVER GROUND PLAN OF FIG. 150, WITH TANGENTS AND BEVELS FOR SAME.

Fig. 152. A segment of a

circle with tangents of different pitches in elevation. Let A B C D be the ground plan, A B F the stretchout of the tangents on the

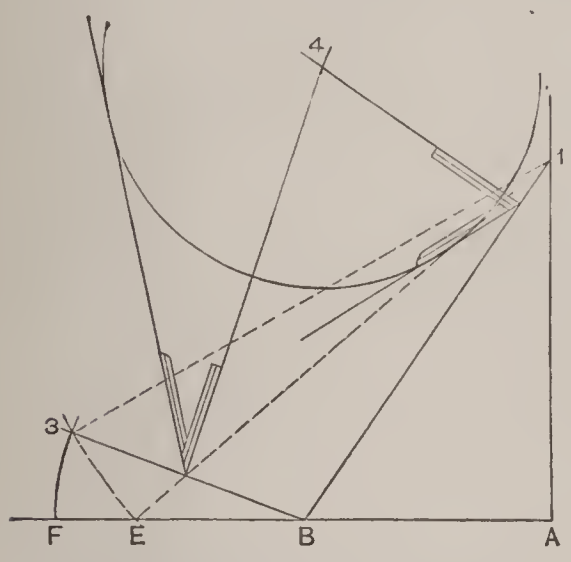


FIG. 153.—ELEVATION, RAKE AND LEVEL TANGENTS, AND BEVELS TO COVER GROUND PLAN OF FIG. 152.

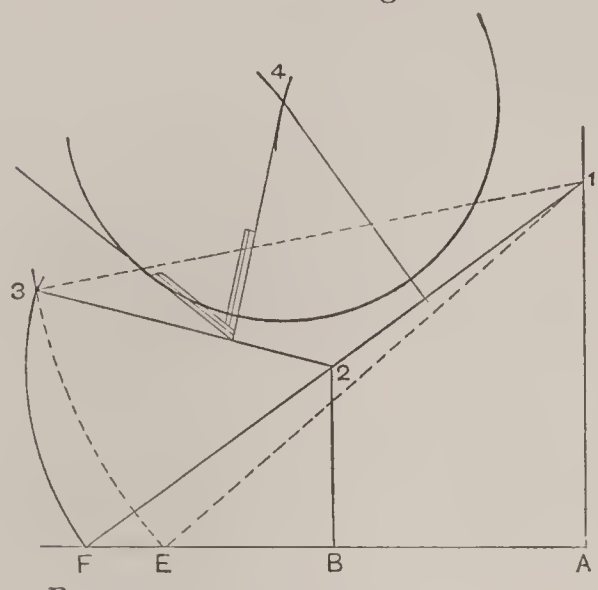


FIG. 154.—ELEVATION, BEVEL AND TANGENTS OF ONE PITCH, TO COVER GROUND PLAN OF FIG. 152.

base line, A I the hight, and I 2 F the tangents in elevation. From A as centre and A C as a radius, produce E. Connect E I, giving the major length. Now find the position of the tangents for the mould. From

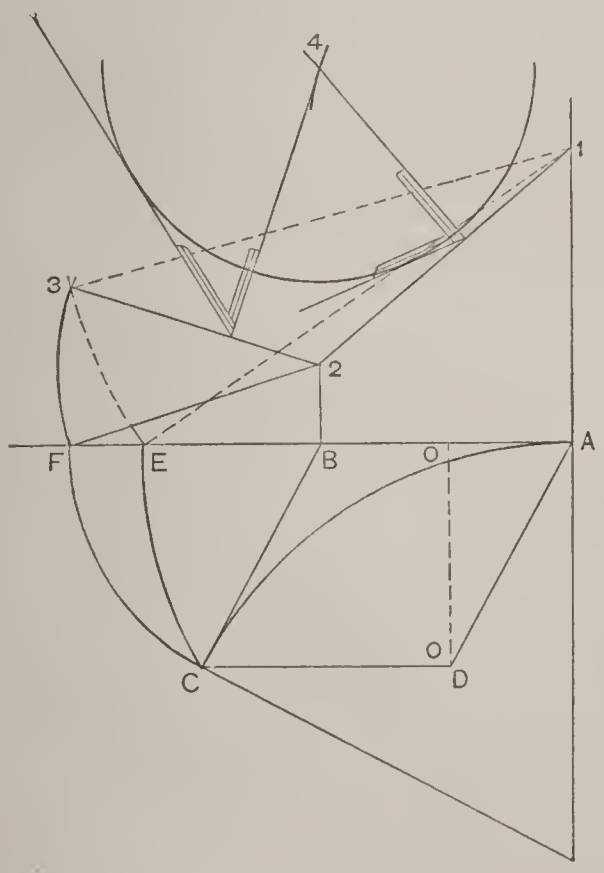


FIG. 152.—OBTUSE PLAN BEVELS, AND DIFFERENT PITCHT ANGENTS.

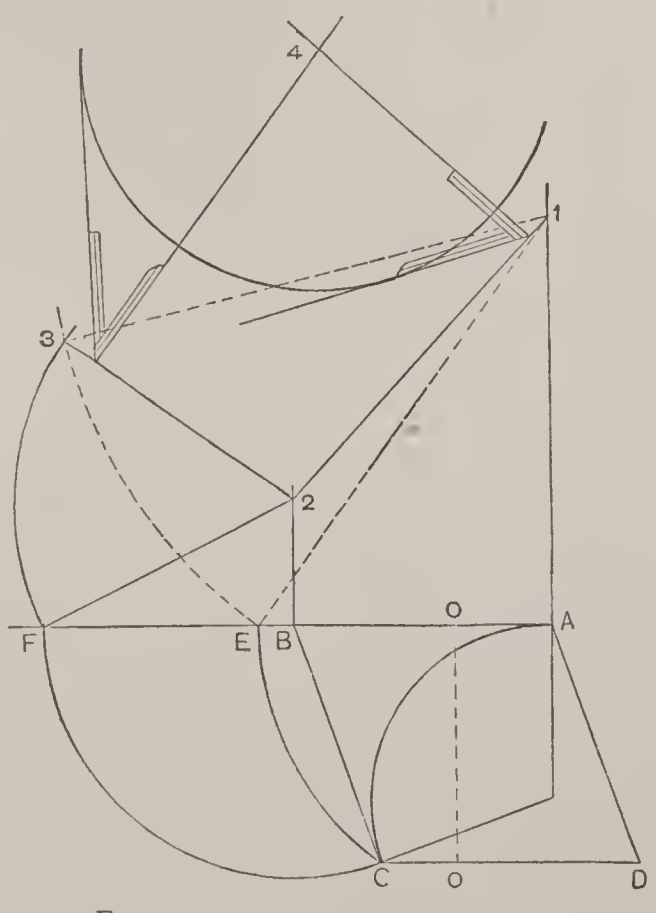


FIG. 155.—ACUTE PLAN, BEVEL AND TANGENTS OF DIFFERENT PITCH.

I as a centre and I E as a radius describe the curve indefinitely; then from 2 as centre and 2 F as a radius describe the curve touching

at 3, and connect 2 3, giving the required form for the mould. Find the point 4 in the usual manner. For the bevels set the compasses the length of the dotted line o o, set one foot in 4 and describe the segment. Find the bevel by squaring from the tangents, touching at 4. From the intersection with the tangents draw a line touching the segment, and the angles thus formed give the bevels.

Fig. 153 is drawn from the same base line as Fig. 152, having one pitch and one bevel tangent. Find all points and

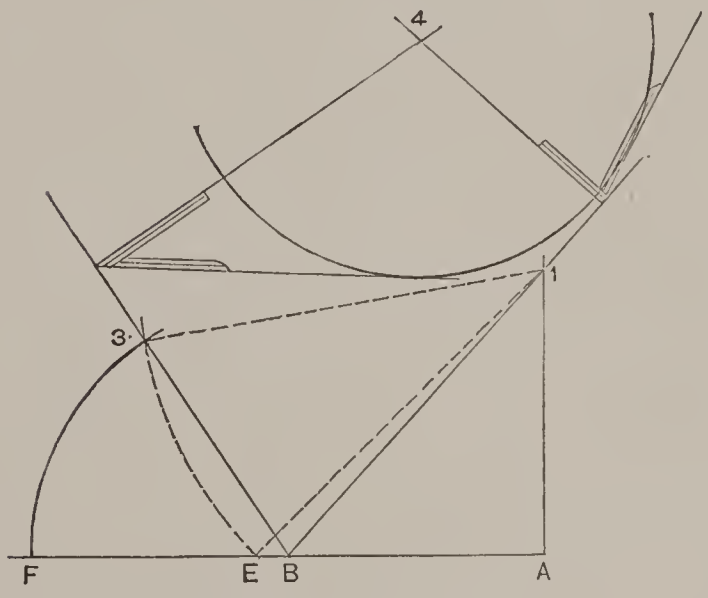


FIG. 156.—ELEVATION, BEVEL, RAKE AND LEVEL TANGENTS, TO COVER GROUND PLAN OF FIG. 155.

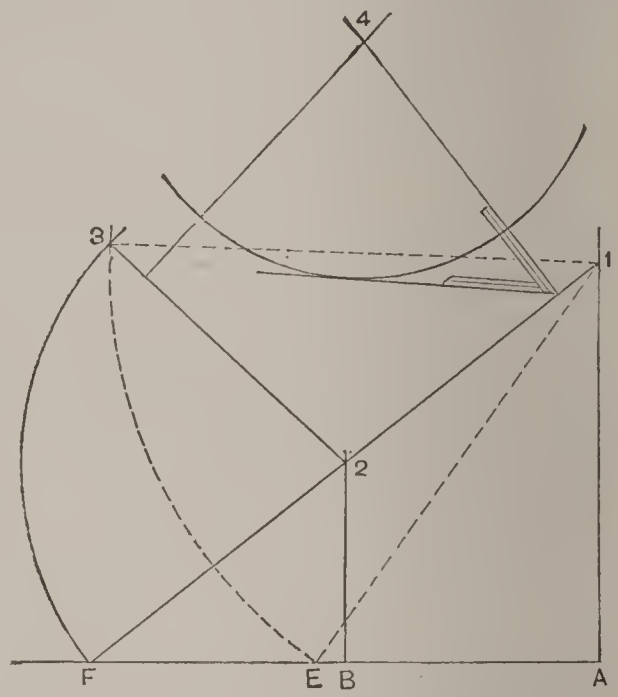


FIG. 157.—ELEVATION, BEVEL, TANGENTS OF ONE PITCH, TO COVER GROUND PLAN OF FIG. 155.

positions in the same manner as in Fig. 152. 1 3 is the length of the mould and 1 B 3 the position of the tangents in the mould.

Fig. 154. This also is drawn from the same base line, having its tangents of the same pitch, requiring but one bevel, and will be found in the same manner as Figs. 152 and 153.

Figs. 155, 156 and 157. These figures are drawn in the same manner as those already described, and will all stand over the ground plan (Fig. 155). All descriptive letter press being the same, it will need no further explanation, as the system is universal—NONPAREIL IN MINIMUM.

INDEX.

GEOMETRICAL PROBLEMS.

HAND-RAILING.

ILLUSTRATIVE PROBLEMS.

GENERAL PRACTICE.

SPLAYED WORK.

BEVELS AND MITRES.

DETERMINING WIDTH OF MOULD IN SPECIAL CASES.

SLIDING THE MOULD.

THE NONPAREIL SYSTEM IN ITS BRIEFEST FORM.