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DRAWING ROOM KINKS

STANDARDIZATION OF JIGS AND FIXTURES

THE controlling reasons for making jigs and fixtures are so well known that it is unnecessary to mention them. Some of the important features of designing these special tools are, however, not so well appreciated.

Such a special tool must not only have all of the necessary elements of accuracy but must be quick in manipulation. Too often a designer seems completely to ignore this point, when a very slight modification in holding the work would increase the production enormously.

A tool designer should be intimately acquainted with the machine-tool equipment on which the special tools are to be used. This determines to a considerable extent the sequence of individual operations.

In many factories using a large number of jigs and fixtures special small tools, such as cutters, drills, reamers, taps, counterbores, etc., can be and often are standardized. This point should not be neglected, as it results in a direct and immediate economy.

Still another feature which lends itself to standardization is the design of jigs and fixtures, and their small parts. At first thought it may seem paradoxical to standardize such special tools, where usually only one is ever made from a particular design.

However, such standardization is possible to quite an extent, and to real advantage provided a large amount of tool work is carried on. For instance, a system of drill, reamer and tap bushings, both loose and fixed, can be determined upon. Screws for jigs and fixtures can be systematically designed for kind and size. Straps, or, at least, strap blanks, can be standardized, and carried in stock. Setting spots on milling and planing fixtures can be designed to use a very few standard setting blocks, except for formed work. Again, jig and fixture castcussion, there are certain fixed mechanical ideas that should be respected, and while one part can be drilled first to the best advantage, it is just as necessary to reverse the operations on another part, while still others can be carried through with equally good results by either order of operations. Some parts are of such an irregular shape that a positive location cannot be obtained except by means of drilled and reamed holes, which necessitates drilling first. On the other hand, with properly constructed jigs, there is less chance for error when locating from a planed, milled or ground surface. It has been proved that in many instances the parts can be located in the jigs and drilled from the planing or milling with a greater degree of accuracy than they can be planed or milled from the drilled holes. Again, the error in setting the tool or cutter is apt to be greater than in locating the part in the jig.

There are many good points in each argument, but the shape of the part and the nature of the operations must determine the order of the operations.

Width of Body.	Length of Body.	Hight of Base.
2 in.	3 in.	2 in.
3 in.	4½ in.	3 in.
4 in.	6 in.	4 in.
6 in.	9 in.	6 in.

Seats can be planed in the castings to suit each particular part; or, if a large number of parts are to be produced in a jig, it may receive

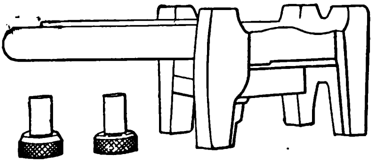


Fig. 1. — Standard Type of Open Jig.

a hardened-steel seat. Stops, screws and straps can be placed where needed, and steel bushings or linings can be inserted. These castings will be found very convenient in making jigs for small parts which are to be drilled from one surface only.

A convenient strap to use with these jigs is shown in Fig. 14. These straps should be made of bessemer steel and case-hardened after can be made to suit each part. Convenient sizes for castings are shown in above table.

The overhanging arm for the bushings should be cast long and cut off to the required length. The work should be clamped by means of a split

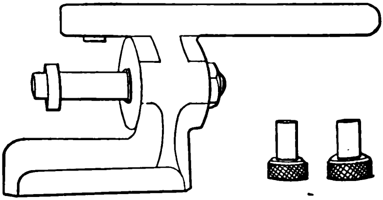


FIG. 3. — Another Standard Type.

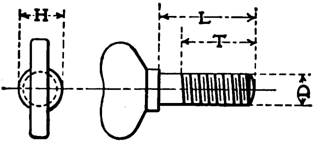
washer and set-screw in the end of the stud. Stops can be easily arranged to locate the work.

It is not to be understood that a standard stock of castings can be carried that will meet a majority of requirements, but if some are carried, it will be surprising to find the number of parts for which they can be adapted.

BINDING SCREWS

Binding screws should be made in various sizes and with threads to conform to the standard shown in Figs. 4 and 5. General standard dimensions are given. Of course screws can be made of any length desired.

When the work is to be held against the seat or a stop by means of a set-screw, such screws as



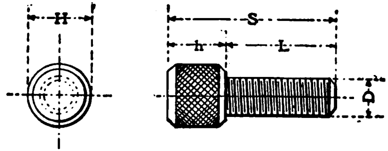
D	Thrd.	H	L	T
$\frac{1}{4}$	Shop Standard	$\frac{3}{8}$	1	$\frac{3}{4}$
$\frac{5}{16}$		$\frac{7}{16}$	1	$\frac{3}{4}$
$\frac{3}{8}$		$\frac{1}{2}$	$1\frac{1}{2}$	1

FIG. 5. — Winged Jig Screws.

shown in Figs. 6 and 7 will be found very useful. General dimensions are also given. If, however, the work is very light, a wing screw can be used.

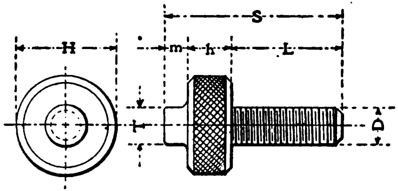
SUPPORTING SCREWS

Figs. 8 and 9 show screws that are very useful in supporting work against the thrust of drills



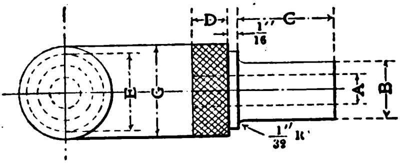
D	Thrd.	L	h	S	H
1/4	Shop Standard	3/4	3/8	1 1/8	1/2
5/16		1	1/2	1 1/2	9/16
3/8		1	9/16	1 9/16	5/8

FIG. 8. — Nurled Head Jig Screws.



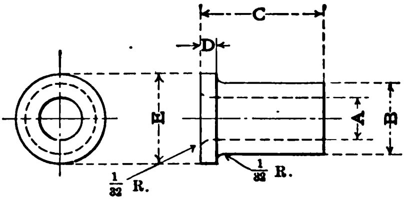
D	Thrd.	L	h	m	S	H	T
1/4	Shop Standard	3/4	5/16	3/16	1 1/4	3/4	1/4
5/16		1	3/8	7/32	1 19/32	7/8	5/16
3/8		1	7/16	1/4	1 11/16	1	3/8

FIG. 9. — Nurled Head Jig Screws.



A	B	C	D	E	G
No. 52	1/4	9/16	1/4	7/16	9/16
No. 30	5/16	5/8	1/4	1/2	5/8
No. 12	3/8	5/8	5/16	9/16	11/16
1/4	1/2	11/16	5/16	11/16	13/16
5/16	9/16	3/4	5/16	3/4	7/8
3/8	5/8	3/4	3/8	13/16	15/16
7/16	11/16	13/16	3/8	7/8	1
1/2	3/4	7/8	7/16	15/16	1 1/16
9/16	13/16	7/8	7/16	1	1 1/8
5/8	7/8	15/16	1/2	1 1/16	1 3/16
11/16	15/16	1	1/2	1 1/8	1 1/4
3/4	1 1/16	1	9/16	1 1/4	1 7/16
13/16	1 1/8	1 1/16	9/16	1 5/16	1 1/2
7/8	1 1/4	1 1/8	5/8	1 7/16	1 5/8
15/16	1 5/16	1 3/16	5/8	1 1/2	1 11/16
1	1 3/8	1 1/4	11/16	1 9/16	1 3/4

FIG. 11. — Loose Bushings for Jigs.



A	B	C	D	E
$\frac{1}{4}$	$\frac{7}{16}$	$\frac{11}{16}$	$\frac{3}{32}$	$\frac{9}{16}$
$\frac{5}{16}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{32}$	$\frac{5}{8}$
$\frac{3}{8}$	$\frac{9}{16}$	$\frac{13}{16}$	$\frac{3}{32}$	$\frac{11}{16}$
$\frac{7}{16}$	$\frac{5}{8}$	$\frac{13}{16}$	$\frac{3}{32}$	$\frac{3}{4}$
$\frac{1}{2}$	$\frac{11}{16}$	$\frac{7}{8}$	$\frac{3}{32}$	$\frac{13}{16}$
$\frac{9}{16}$	$\frac{3}{4}$	$\frac{15}{16}$	$\frac{1}{8}$	$\frac{7}{8}$
$\frac{5}{8}$	$\frac{7}{8}$	1	$\frac{1}{8}$	$1\frac{1}{16}$
$\frac{11}{16}$	$\frac{15}{16}$	$1\frac{1}{16}$	$\frac{1}{8}$	$1\frac{1}{8}$
$\frac{3}{4}$	1	$1\frac{1}{8}$	$\frac{1}{8}$	$1\frac{3}{16}$
$\frac{13}{16}$	$1\frac{1}{16}$	$1\frac{3}{16}$	$\frac{1}{8}$	$1\frac{1}{4}$
$\frac{7}{8}$	$1\frac{1}{8}$	$1\frac{1}{4}$	$\frac{5}{32}$	$1\frac{5}{16}$
$\frac{15}{16}$	$1\frac{3}{16}$	$1\frac{5}{16}$	$\frac{5}{32}$	$1\frac{3}{8}$
1	$1\frac{1}{4}$	$1\frac{5}{16}$	$\frac{5}{32}$	$1\frac{7}{16}$

FIG. 13. — Fixed Bushings for Jigs.

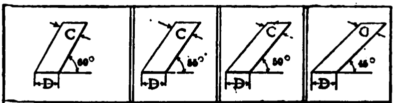
and *F*, which have to be determined for each particular case.

The standards which we have described for jigs and jig parts have been used in practice with good results, and the broad principle of such standardization is one that can well receive attention in a shop doing a large amount of tool work.

DIMENSIONING DOVETAIL SLIDES AND GIBS

THE tables, Figs. 15 and 16, were figured for machine-tool work, so as to enable one to tell at a glance the amount to be added or subtracted in dimensioning dovetail slides and their gibs, for the usual angles up to 60 degrees. The column for 45-degree dovetails is omitted, as *A* and *B* would of course be alike for this angle.

In the application of the table, assuming we have a base with even dimensions, as in the sketch Fig. 17, and we wish to obtain the dimensions *x* and *y* of the slide, allowing for the gib which we will assume to be $\frac{1}{4}$ inch thick, the perpendicular depth of the dovetail being $\frac{5}{8}$ inch, and the angle 60 degrees, we look under column A for $\frac{5}{8}$ inch and find opposite this that B is 0.360 inch, which subtracted from 2 inches



C	D	D	D	D
1/8"	.144"	.152"	.163"	.176"
3/16"	.216"	.228"	.244"	.264"
1/4"	.289"	.305"	.326"	.353"
5/16"	.361"	.381"	.407"	.442"
3/8"	.433"	.457"	.489"	.530"
1/2"	.577"	.610"	.652"	.707"
5/8"	.721"	.762"	.815"	.883"
3/4"	.866"	.915"	.979"	1.060"
7/8"	1.010"	1.067"	1.142"	1.237"
1"	1.154"	1.220"	1.305"	1.414"

FIG. 16. — Table for Gibs.

gives 1.640 inches, the dimension x. To find y we first get the dimension 1.640 inches, then looking under the column for 60-degree gibs, find D (where C is $\frac{1}{4}$ inch) to be 0.289 inch, which is to be added to obtain 1.929 inches.

In practice we usually make this dimension a little larger, say to the nearest 64th, to allow for fitting the gib.

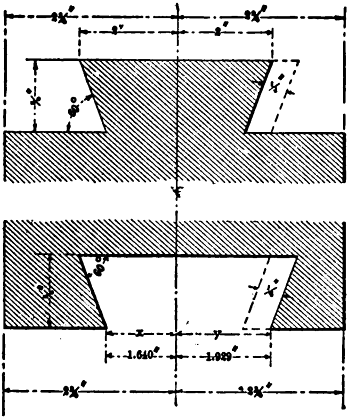


FIG. 17. — Dovetail Slides and Gibs.

HANDLES, BALL-CRANKS AND HAND WHEELS

WHEN a person, before he settles down, forms the acquaintance of a dozen or more machine shops of all denominations and characters, he will notice the chaotic styles and forms of handles, ball-cranks and hand-wheels. Even in one and the same concern, you often find, like all shapes of legs, cabinets, fillets and roundings, every imaginable form of these three simple machine parts.

The handle itself is a very plain machine part. But still it ought to fill the requirements of being easy in your hand; it ought to look well, and all that are made in one shop should be of the same style. It can be comfortable only when the ball part of it rests in the hollow of the hand and all the fingers take hold of it, as is indicated in Fig. 18. It is a bad practice to cut off the pointed end, as shown in the dotted line, which takes away the resting place for the little finger.

One concern makes a handle such as is shown in Fig. 19, and the poor fellow who has to use it wishes the firm could be compelled to monopolize the handling of them. If L, Fig. 18, denotes the length of the handle, good proportions will be obtained by making $d = .38L$, $r = .15d$, $r' = 1.5d$ and $r'' = 1.5d + 1$ inch, and all the other dimensions as indicated on the drawing.

Ball-cranks should, besides having a good appearance, be so proportioned that they as nearly as possible balance from the center hole when the handle is driven into the small ball. As they very often go into places where parts of the machine have to be cleared, it is best to make both ends, measured from the center to the outside of the balls, of equal length. If L is again the length, Fig. 20, $d = .175L + .5$ inch, and $d' = .1L + .5$ inch will give a good appearance and about balance the proportionate handle. The sizes for the shank are indicated on the drawing. These proportions are for drop forgings or cranks made from the bar. While cast-iron cranks never break through usage, many are broken in transit and by accident, and for that reason alone they should be made of steel. Besides, with proper forming tools, they can be produced cheaper than cast-iron ones, and add by their lightness a good deal to the pleasing appearance of the machine.

It is understood that hand-wheels very often have to be designed to suit the conditions, and therefore general rules cannot be very well applied. The dimensions given in Fig. 21, and making $d = .1D + .3$ inch and $r = .2D - \frac{1}{8}$ inch, where D is the diameter of the wheel, give a good shape, in the range from 4½ to 12 inches diameter. Of late, the flat or clearance on the inside of the rim, to save hand work in finishing, is often carried to a semicircle. This is very uncomfortable for the hand and looks too much like skimping. Bent arms are often preferable over straight ones and save the knuckles and skin in case a nut or friction knob is applied in the center.

All the dimensions obtained by these formulas rounded off to the nearest sixteenth will answer. These rules are the result of experience and comparison.

MACHINE TOOL HANDLE CHART

In the chart, Fig. 22, the results obtained by working out the formulas for handles as given in the preceding article have been arranged in graphical form.

ANOTHER MACHINE HANDLE STANDARD

The handles in this system are made in strict proportion throughout the set, and are designated by the size of shank or stem, this being the unit in all cases.

Construction lines are shown in Fig. 23 by which the proportions may be traced out. The

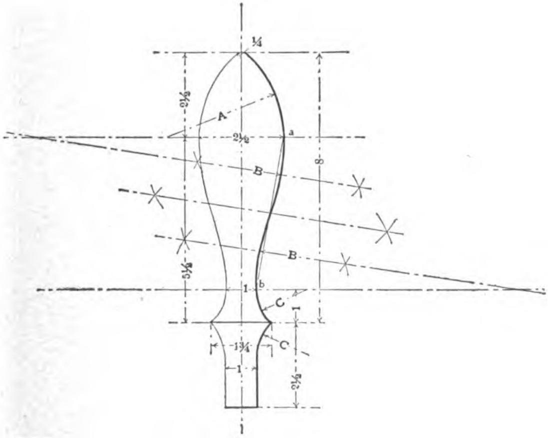


FIG. 23. — Standard Machine Handles.

figures simply designate the proportion of the particular dimension indicated compared with the size of the stem; that is, if the stem is 1 the neck of the handle will be 1, and this neck would be the distance of 1 or the diameter of the shank from the shoulder, the length of the handle measured from the shoulder out would be eight times the shank, and so on. If the diameter of the shank is ¼, the other dimensions would be one-fourth of the figures shown, or if it is ½ they would be one-half of the dimensions given, and so on.

The curves are all found with compasses and are simply arcs connecting points and drawn tangent to lines of the circle, the radius *A* being on a line at right angles to the axis passing through the point of the largest diameter and tangent to the small arc at the extreme end of the handle.

To find the radii *B B*, after the swell and neck are located, draw the straight line *a b*, divide it into four equal parts and erect perpendiculars at the points of division. The points where the outer perpendiculars intersect the neck and swell diameter lines extended determine the radii *B B*, which are, of course, equal to one another, the arcs struck with them forming a reversed curve.

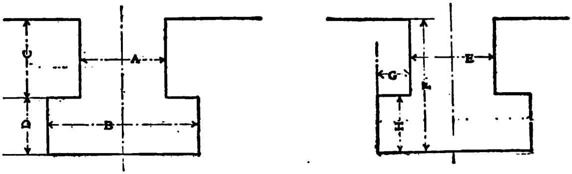
Radii *C C* are also equal to one another and are found by placing the dividers on the diameter line of the neck extended, the distance out being

N	360°/N	180°/N	Sin. 180°/N	N	360°/N	180°/N	Sin. 180°/N
	° ′ ″	° ′ ″			° ′ ″	° ′ ″	
1	360 0 0	180 0 0	1.	51	7 3 32	3 31 46	.06156
2	180 0 0	90 0 0	1	52	6 55 23	3 27 42	.06038
3	120 0 0	60 0 0	86603	53	6 47 33	3 23 46	.05922
4	90 0 0	45 0 0	.70711	54	6 40 0	3 20 0	.05814
5	72 0 0	36 0 0	58799	55	6 32 44	3 16 22	.05709
6	60 0 0	30 0 0	.50000	56	6 25 43	3 12 51	.05607
7	51 25 43	25 42 51	.43388	57	6 18 57	3 9 28	.05509
8	45 0 0	22 30 0	38268	58	6 12 25	3 6 12	.05414
9	40 0 0	20 0 0	.34202	59	6 6 6	3 3 3	.05322
10	36 0 0	18 0 0	.30902	60	6 0 0	3 0 0	.05234
11	32 43 38	16 21 49	.28173	61	5 54 6	2 57 3	.05147
12	30 0 0	15 0 0	.25882	62	5 48 23	2 54 12	.05065
13	27 41 32	13 50 46	.23931	63	5 42 51	2 51 26	.04985
14	25 42 51	12 51 26	.22252	64	5 37 30	2 48 45	.04907
15	24 0 0	12 0 0	.2-791	65	5 32 18	2 46 9	.04831
16	22 30 0	11 15 0	.19509	66	5 27 17	2 43 38	.04758
17	21 10 35	10 35 18	.18375	67	5 22 23	2 41 12	.04688
18	20 0 0	10 0 0	.17365	68	5 17 39	2 38 49	.04618
19	18 56 50	9 28 25	.16454	69	5 13 3	2 36 31	.04551
20	18 0 0	9 0 0	.15643	70	5 8 34	2 34 17	.04486
21	17 8 34	8 34 17	.14904	71	5 4 14	2 32 7	.04423
22	16 21 49	8 10 55	.14233	72	5 0 0	2 30 0	.04362
23	15 39 8	7 49 34	.13616	73	4 55 53	2 27 57	.04303
24	15 0 0	7 30 0	.13053	74	4 51 53	2 25 57	.04245
25	14 24 0	7 12 0	.12533	75	4 48 0	2 24 0	.04188
26	13 50 46	6 55 23	.12055	76	4 44 13	2 22 6	.04132
27	13 20 0	6 40 0	.11609	77	4 40 31	2 20 16	.04079
28	12 51 26	6 25 43	.11197	78	4 36 55	2 18 27	.04026
29	12 24 50	6 12 25	.10812	79	4 33 25	2 16 43	.03976
30	12 0 0	6 0 0	.10453	80	4 30 0	2 15 0	.03926
31	11 36 46	5 48 23	.10117	81	4 26 40	2 13 20	.03878
32	11 15 0	5 37 30	.09801	82	4 23 25	2 11 42	.03830
33	10 54 33	5 27 16	.09506	83	4 20 14	2 10 7	.03784
34	10 35 18	5 17 39	.09227	84	4 17 9	2 8 34	.03739
35	10 17 8	5 8 34	.08963	85	4 14 7	2 7 4	.03695
36	10 0 0	5 0 0	.08716	86	4 11 10	2 5 35	.03652
37	9 43 47	4 51 54	.08510	87	4 8 17	2 4 8	.03610
38	9 28 25	4 44 13	.08258	88	4 5 27	2 2 44	.03569
39	9 13 51	4 36 55	.08047	89	4 2 42	2 1 21	.03529
40	9 0 0	4 30 0	.07846	90	4 0 0	2 0 0	.03490
41	8 46 50	4 23 25	.07655	91	3 57 22	1 58 41	.03446
42	8 34 17	4 17 9	.07473	92	3 54 46	1 57 23	.03414
43	8 22 20	4 11 10	.07300	93	3 52 15	1 56 8	.03378
44	8 10 55	4 5 27	.07134	94	3 49 47	1 54 54	.03342
45	8 0 0	4 0 0	.06976	95	3 47 22	1 53 41	.03307
46	7 49 34	3 54 47	.06825	96	3 45 0	1 52 30	.03272
47	7 39 34	3 49 47	.06679	97	3 42 41	1 51 20	.03238
48	7 30 0	3 45 0	.06540	98	3 40 24	1 50 12	.03205
49	7 20 49	3 40 24	.06407	99	3 38 11	1 49 5	.03172
50	7 12 0	3 36 0	.06279	100	3 36 0	1 48 0	.03141

Table of Sines of Angles of an Equally Divided Circle whose Radius is 1.

T-SLOT DIMENSIONS

The average draftsman thinks his drawing is completely dimensioned when he can copy it without scaling it. In most cases this does *not* give the dimensions in the best way for the workman. T-slots are one of the most common



Figs. 24 and 25.—T-Slot Dimensions.

sources of trouble in this respect. Fig. 24 shows the almost universal method. To use this drawing the planer hand has first to add dimensions *C* and *D* to get the whole depth to run down his square-nose tool; then he has to subtract *A* from *B* and divide by 2 to get the distance to cut under. Both these operations involve fractions, and that is where he is lost. Suppose, as in a case recently seen, *B* is $1\frac{9}{16}$ inches and *A* $\frac{7}{8}$ inch; then $\frac{1\frac{9}{16} - \frac{7}{8}}{2} = \frac{11}{32}$. But

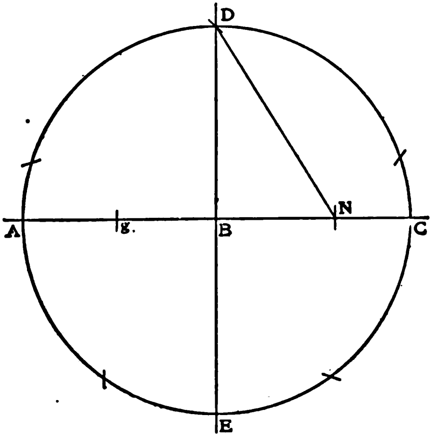


Fig. 26. — Dividing the Circle into Five Parts.

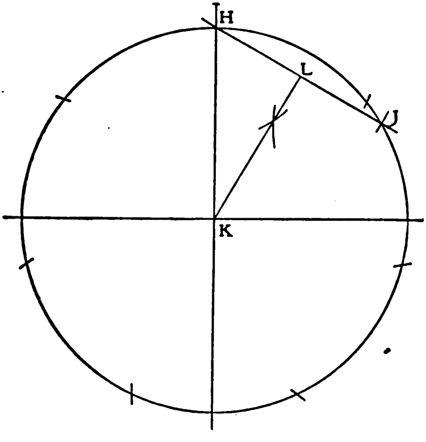


Fig. 27. — Dividing the Circle into Seven Parts.

A TRIANGLE FOR DIVIDING CIRCLES

FIG. 28 is a very handy triangle for draftsmen, patternmakers and others. It is made of No. 14 gage sheet steel, or it may be of wood or other material. The hole marked *B* is for a thumb tack or a needle point. The small holes indicate the number of parts a circle may be divided into. Hole marked 5 is 72 degrees, hole marked 6 is 60 degrees from edge *A*, and so on. Fig. 28 shows the method of using the instrument for dividing a circle into five parts.

A SIMPLE METHOD OF FINDING THE AREA OF IRREGULAR FIGURES

ALTHOUGH there are a great many ways of finding the area of an irregular figure, it is often a great advantage to know a very simple way by which one can form a close approximation.

Suppose that it is required to find the area of the figure given in Fig. 29. To do this we make a tracing on some thin paper and fold it along the line 2—2, adjusting it so that the areas on each side balance one another, the position when adjusting it so that the excess and deficiency areas of the lower half balance one another, the result being that each section of the lower half represents one quarter of the original area and it only remains to find the area of one of these sections and multiply it by four to obtain the total area. This can readily be done by adopting the same principle and folding the paper on the line 4—4, making area c = area d + e and giving the equivalent triangle.

In the example given the two sides of the triangle measure respectively 1.85 and 1.30 inches. Instead of multiplying the area of this triangle by four we multiply the two dimensions together and then multiply by two, which will of course give the same result:

$$1.85 \times 1.30 = 2.4050$$

$$2.4050 \times 2 = 4.81$$

= area of original figure in square inches.

If the tracing is made on squared paper no scale will be needed and the calculation can be easily and rapidly made.

TABLE 1 — FACTORS OF 3.1416.

3.1416 DIVIDED BY

2 = 1.5708	68 = 0.0462	561 = 0.0056
3 = 1.0472	77 = .0408	616 = .0051
4 = 0.7854	84 = .0374	714 = .0044
6 = .5236	88 = .0357	748 = .0042
7 = .4488	102 = .0308	924 = .0034
8 = .3927	119 = .0264	952 = .0033
11 = .2856	132 = .0238	1,122 = .0028
12 = .2618	136 = .0231	1,309 = .0024
14 = .2244	154 = .0204	1,428 = .0022
17 = .1848	168 = .0187	1,496 = .0021
21 = .1496	187 = .0168	1,848 = .0017
22 = .1428	204 = .0154	2,244 = .0014
24 = .1309	231 = .0136	2,618 = .0012
28 = .1122	238 = .0132	2,856 = .0011
33 = .0952	264 = .0119	3,927 = .0008
34 = .0924	308 = .0102	4,488 = .0007
42 = .0748	357 = .0088	5,236 = .0006
44 = .0714	374 = .0084	7,854 = .0004
51 = .0616	408 = .0077	10,472 = .0003
56 = .0561	462 = .0068	15,708 = .0002
66 = .0476	476 = .0066	5,280 = .000595

Similarly $\frac{\pi}{4}$ or 0.7854 (which, multiplied by the square of the diameter of a circle, gives its area) is the product of the factors $2 \times 3 \times 7 \times 0.11 \times 0.17$, and is divisible, without remainder, by thirty numbers, as shown in Table 2.

MULTIPLYING BY .7854

THE interesting number of factors into which the commonly used value of Pi can be split, as just given, may derive additional interest from the short method of multiplication given below. It sometimes occurs that tables are not available when needed, and if we can reduce the labor of such a mechanical operation as multiplication, we minimize the chances of error.

When finding the area of a circle in the usual way four multiplications are required, one for each digit. The following method requires only one.

Example: To find the area of a circle of 3.7 inches diameter.

$$3.7 \times 3.7 = 13.69$$

```
          13.69
          .7854
          -----
          9583
           9583
           19166
            19166
         --------
Area =  10.752126
```

Multiply top line by seven, repeat one place to the right, double the above, repeat as before.

Proof of the foregoing:

```
   7
    7
   14
    14
  ----
  7854
```

If the proof only is memorized, the method is fixed in the brain forever.

THE ADDITION OF BINARY FRACTIONS

Nothing surprises one more when going into drafting rooms than to find draftsmen laboriously adding dimensions given in binary fractions by the use of their thumb nails on a drafting scale or, in some cases, by reducing to a common denominator after the regulation method with vulgar fractions in general.

Binary fractions form a class by themselves and have little in common with vulgar fractions in general, except the form in which they are

A glance back over the process will give us a new respect for the simplicity of binary fractions, for, counting up the partial additions that have been made in summing both kinds of fractions, we find a total of 7 in the case of the binary and 20 in the case of the decimals. What the average ratio is would not be easy to determine, but it will usually be found in favor of the binary factions and heavily so when, as in this case, the decimals are the equivalents of binary sizes.

The draftsman who will become familiar with this method by a little practice will never go back to the thumb-nail-and-drafting-scale plan again.

HOW TO FIND THE UNKNOWN FIGURE ON DRAWINGS

THE illustration Fig. 33 represents a nest of figures such as one often strikes on drawings. It will be seen that the dimensions are given at all places except that shown at *x*, which we will suppose is a very important dimension, as for instance the distance from one planed surface to another. The scheme is to start at one extremity difference between the + and the − columns will be equal to x.

We will begin with the lower extremity of x and go up; by taking one figure after the other, we have: $+x$, $+\frac{13}{32}$, $-5\frac{1}{2}$, $+9$, $-3\frac{7}{16}$, and so on as arranged in the following columns:

−	+
$5\frac{1}{2}$	x
$3\frac{7}{16}$	$\frac{13}{32}$
$\frac{1}{2}$	9
$3'-1$	$1'-5\frac{1}{4}$
$\frac{13}{16}$	$3\frac{1}{4}$
	$1'-1\frac{3}{8}$
$3'-11\frac{1}{4}''$	$3'-7\frac{9}{32}''$
$3'-7\frac{9}{32}$	

Hence $x = 3\frac{31}{32}$

When the dimensions run horizontally, the method is the same. The + sign represents dimensions going to the right and the − sign those to the left.

This little method will save a wonderful amount of time and energy, not only for the machinist, but for the draftsman and the engineer as well.

with waterproof ink and then shellacked on the outside to keep clean. The three escutcheon pins are not to keep the paper in place, but to make it easy to pick up. It is universal with the exception of the portion *A B C D*, which varies with the practice of every office. It is useful for lettering and for making tables. To use the gage for marking a drawing where the paper or cloth is cut to size, place *A* on the edge of the sheet and mark off the distance from *A* to *B* by pressing lightly on the paper, except at the bottom of the sheet where you allow the gage to rotate between the thumb and forefinger until you have *B*, *C* and *D* marked off. For ordinary work, as lettering on detail sheets, use the $\frac{1}{8}$ or $\frac{5}{32}$ inch space as you desire. For table work, repeat until you have the sheet ruled off. If you do much table work, you can make the gage with first a small space, then the hight of the letter and then the small space again, as shown at *F*. The light lines are pencil lines and the heavy are those that space the sheet off. The beauty of this gage is that it does not punch a hole in the paper, but makes an impression in it which can be readily seen. The gage is about $2\frac{1}{2}$ inches outside diameter, with a $\frac{3}{8}$-inch hole in the center.

ANOTHER LETTERING GAGE

THE type of gage shown in Figs. 39 to 43 consists of a small piece of rectangular bar steel, with a series of parallel grooves cut in one face, and the ends beveled off, as shown, after which the piece is hardened and tempered. When the points become dull from use, the gage may be sharpened, as shown in reduced scale in Fig. 42, by laying it on its side on the table of a disk grinder, and grinding the beveled face. The gage is held as in Fig. 43 when in use, *D P* representing the drawing paper.

The spaces for which the gages are made, are to a large extent a matter of taste with the user. The gage we have like Fig. 39 is made with $\frac{1}{16}$ inch spaces, and can, of course, be used for laying off both the horizontal and vertical guide lines. Fig. 40 has the lower space $\frac{1}{16}$ inch wide and the upper space $\frac{1}{32}$ inch. Fig. 41 has the outer

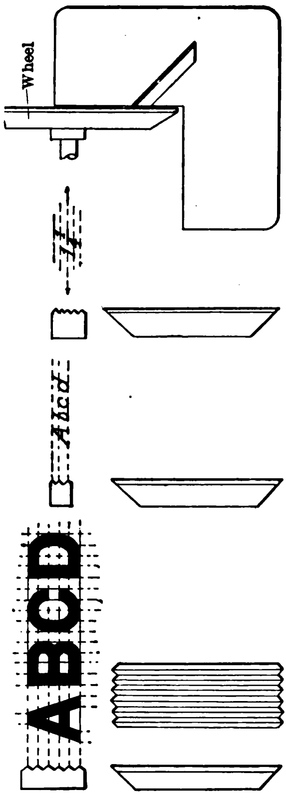


FIG. 39 FIG. 40 FIG. 41 FIG. 42

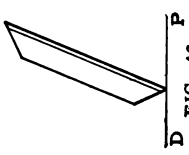


FIG. 43

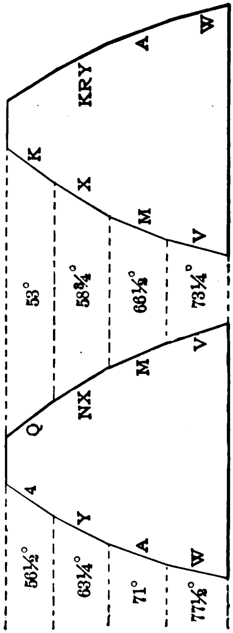


FIG. 44 FIG. 45

Another Lettering Gage.

also has a few more useful angles added, which are very often required, such as 5, 10, 15 degrees, etc.

HANDY DRAWING INSTRUMENT

At the works of The Straight Line Engine Company they have evolved the handy little device shown in Fig. 47. It is for drawing

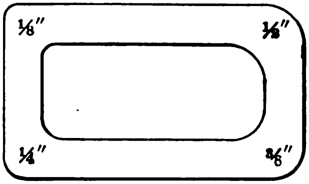


FIG. 47

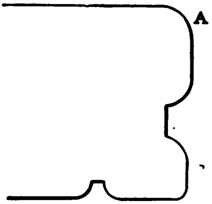


FIG. 48

A Handy Instrument.

round corners and fillets of various sizes, and for those purposes it is far more convenient than compasses; radii are marked, the outside ones made enough smaller and the inside ones enough larger so that corners when drawn with a pencil or inking pen will be the size indicated. They can be of various other radii, and if the draftsman wishes to mark what the radius of his curve is, he has the figures before him.

The instrument may be of any sheet metal nickel-plated or of celluloid, and if $\frac{1}{16}$ inch thick, beveled on one side, used flat side down for the pencil and the other side for the inking pen, it will be found a great convenience.

Fig. 48 shows its application, the curves *A* and *B* being drawn by using the outside corners and the others by using the inside.

A GRADUATED CURVE FOR DRAFTSMEN AND PATTERNMAKERS

In a certain drafting room the irregular curve is quite an important tool, but a difficulty which was ever present in the pattern department was for the patternmaker to get a duplicate of any curve (irregular) which appeared on a drawing. After a trip to the draftsman to get the curve which was used, it usually took from ten to fifteen minutes to pick out the right one. This inconvenience and loss of time suggested the idea of which the sketch Fig. 49 is explanatory. We accordingly had procured for the pattern department a set of curves the same as those used in the drafting room, and graduated and numbered them as shown. The method now used is to specify between two points on any curve on a drawing between exactly what graduations the curve was drawn, as "From $2\frac{1}{8}$ to $8\frac{3}{4}$, Curve

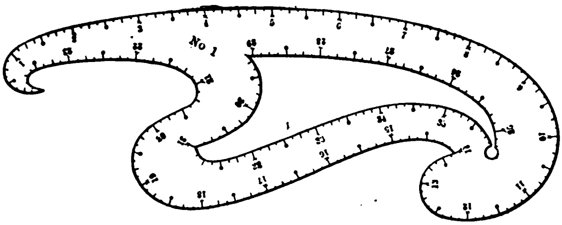


FIG. 49. — A Graduated Curve.

No. 1." This overcomes all difficulties in our case, but a still better plan for the average draftsman is to have the curve graduated alike on both sides, so as to be able to reverse it in order to put the same curve on each side of a center line. Most draftsmen, after drawing a curve, mark the curve on the edge so as to be able to reverse it, but the graduations are better.

FINDING THE CENTERS OF FILLETS AND CORNERS

EVERY draftsman has some home-made tools. Fig. 50 shows two views of one which has been

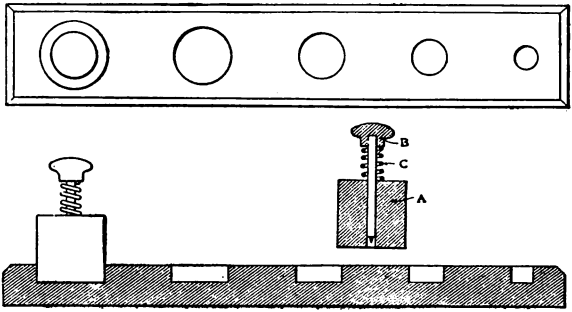


FIG. 50.—Tool for Finding Centers of Fillets and Corners.

found a time-saver where many round corners are required on a machine. The tool consists of the body *A*, in which a hole is drilled to fit a compass needle point. The button *B* is driven on the upper end of the needle point, and a coiled spring *C* is placed between the body *A* and the button *B* to keep the needle point off the paper when not in use. The lower part of the illustration shows a wooden base for holding a set from $\frac{1}{4}$ to $\frac{3}{4}$ inch diameter, advancing by eighths.

The method of using is as follows: The body *A* is held by the thumb and middle finger and is placed tangent to the lines to be connected by the arc of a circle — generally, of course, a quadrant; then the needle point is forced into the paper by the forefinger, locating the required center. After locating the centers for all corners the arcs are drawn in the usual manner.

AN INSTRUMENT FOR DRAWING SCREW THREADS

WE believe that the simple device Fig. 51, for laying out screw threads, will be interesting to draftsmen who do not like to do this kind of work and who are justified in using conventional forms wherever possible: File a series of 60-degree notches in a triangle, making the width at the top equal to 1 inch divided by the pitch and leaving a small point to stop the pencil. We use, 4, 6, 8, 10, 12 and 16 pitch, making the notches $\frac{1}{4}$, $\frac{1}{6}$, $\frac{1}{8}$, $\frac{1}{10}$, $\frac{1}{12}$, and $\frac{1}{16}$ inch wide. To use

AN ERASING MACHINE

THE drafting department of the Laclede Gas Company, St. Louis, keeps records of streets, plat books, insurance books, main records, etc., and as these records must be continually changed on account of new pipes being laid in place of old ones, there is a great deal of erasing to be done.

To reduce the large amount of time and work necessitated in erasing by hand and yet permit of the work being done carefully, the following scheme was devised to do this erasing mechanically.

An ordinary dental engine, such as is used by dentists for drilling teeth, was procured, and a circular ink eraser attached to the chuck by means of a small screw. The flexible shaft to which the eraser is attached allows considerable movement, and all the draftsman has to do is to guide the eraser by means of the handle. Anyone trying this machine should watch the following points:

Keep the machine at a good speed, and do not

PHOTOGRAPHING BLUE-PRINTS

In photographing blue-prints the print is first placed in a tray containing a dilute solution of ammonia, say about 5 per cent. strong aqua ammonia in water, upon which the blue color will slowly fade, disappearing altogether in the paler portions, and remaining a faint pink in the deeper parts.

After the blue color is entirely gone the print should be washed well in clean water, and then placed in a tray containing a weak solution of tannic acid, whereupon the whole detail of the print will return in a non-actinic red, the depth depending upon the time of immersion, and which can be watched and arrested as desired. The print should then be washed and dried, and can be photographed with perfect success. A blue-print of a line drawing thus treated will give a negative having black lines upon clear glass, and this can then be backed with white paper and used for copy for a line engraving by the zinc or copper photo-engraving process.

MARKING NEGATIVES

A GOOD way to mark negatives is as follows: Use round paper disks, ¾ inch in diameter, and on these punch the numbers with a check perforating punch. The film is scratched off the negative for a space of about ⅜ x ⅝ inch, and the number, being previously soaked in water, is pressed on in position, sufficient moisture being in the paper to soften the gelatine on the negative and cause the number to adhere firmly to the plate when dry. A blue-print of each negative is then kept in a scrap-book divided off under different heads, such as electric cranes, locomotive cranes, motors, etc., and subdivided into different parts of the various machines, making it very easy for anyone to pick out the photograph required to show exactly what is wanted in each particular case much more readily than could be done by reading over a description which could not be detailed sufficiently to cover everything shown on the photograph. The negatives are kept in a case, ten to a division, the divisions being marked 10, 20, etc., up. The corner of the photograph, Fig. 52, shows the mode of numbering.

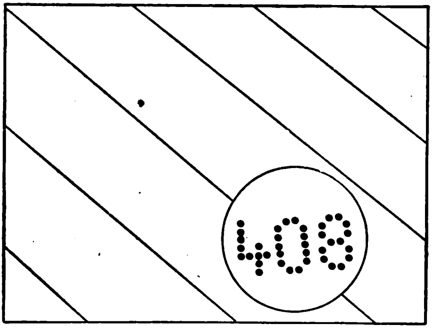


FIG. 52. — Marking Negatives.

A GLASS-COVERED DESK

THE following device will save many minutes each day for such engineers and draftsman as can apply it. This time-saver consists of a piece of plate glass large enough to cover one's desk or table-top, and a piece of drawing paper the same size to which various pages of formulas, tables and other oft-referred-to data are pasted. The paper, with the attached data, is spread out like a large desk-pad on the desk, and the glass laid on top of it. Some of the advantages of this device are that it affords an excellent surface on which to write; the data most needed are always in plain sight or easily referred to; the data are preserved, being none the worse for their constant use; new matter may be easily inserted.

RUBBER STAMPS IN THE DRAWING ROOM

A GREAT many times a draftsman could use a rubber stamp in his work if it were not for the fact that the ordinary stamp does not leave a line heavy enough to make a good, clear blueprint from, but leaves a faint mark which, if not looked for very closely, could easily be overlooked. A very satisfactory and also quick way to overcome this trouble is to use your stamp, and while the ink is still wet take an ordinary writing-pen and with plenty of ink (regular drawing ink) run over the stamped letters or figures quickly. You will find that the wet stamp ink will readily be followed by the other ink, and thus you will have a stamp mark in just as good condition as the rest of your drawing.

STIPPLING DRAWINGS

This is a process which has been used for many years for indicating stone-work on tracings. Pour a few drops of drawing ink into a saucer and by thoroughly smearing a round bristle brush about $\frac{3}{8}$ inch in diameter in this ink imitate the foundation, not by spattering but by *stippling* with the end of the brush. By using considerable ink on the brush and not much on the tracing an effect is produced which considerably resembles stone-work. It looks well and, what is more to the point, it prints well. To keep the stippling within proper limits, one of our acquaintances devised an adjustable shield. This consists of two pieces of heavy paper in the shape of a letter *L* with a slot cut in one leg of each piece through which the other leg is inserted. This makes the shield adjustable in all directions, as shown in Fig. 53. If made out of thin sheet brass or copper, it can be cleaned by washing and will last for years.

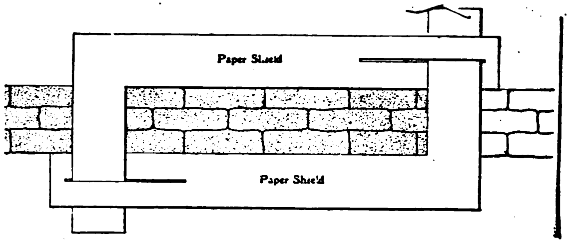


FIG. 53. — Adjustable Shield for Stippling Drawings.

DIMETRIC PROJECTIONS

EVERYBODY is familiar with isometric drawing as an easy and effective method of producing approximate perspective views, especially in cases when the object to be represented does not exist in reality, but is given, perhaps, by working drawings in ordinary rectangular projection. The facts that in isometric drawing all the straight lines are measured by the same scale and that the ordinary 30-degree triangle is used are undeniable advantages of the method. On the other hand it will be admitted that isometric views sometimes look awkward and unnatural.

vantage. As in isometric drawing, circles, of course, appear as ellipses. The centers of the circular arcs approximating these are easily located with the help of the instrument, as will appear from the sketches.

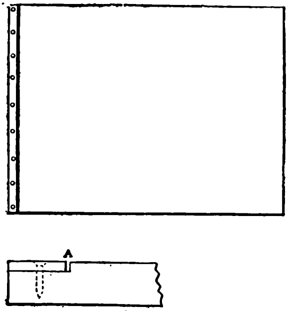
A DRAWING TABLE OF GAS PIPE

A STIFF and serviceable drawing table may be made out of gas pipe without much expense either for labor or material. Fig. 55 shows such a table, the legs and cross braces being of ½-inch gas pipe for a small table. The only castings for which special patterns are needed are the A-shaped pieces into which the legs are screwed and the segments which serve the double purpose of stiffening the wood top and also of affording room for a row of holes into which a pin may engage to fasten the top at any angle. The top turns on a ⅜-inch rod which runs the whole length of the table through a piece of pipe which acts as a separator, a nut on each end of the rod binding the whole together. The fastening device is a spring pin at the right-hand end of the friction and keep the paper taut. The end is put true with the line marked 8 and a strip cut off with a roller glass cutter. This strip is rolled up and partly inserted in the box and the edges adjusted to coincide with the rectangle marked 8x5 and cut off. This process is repeated five times on each strip of this size. In the same way the larger sizes are cut without any waste.

This method works very well and is quick and accurate and the edges true and smart. The cutter has a movable spindle, so that the wheel can be sharpened when necessary.

DRAWING BOARDS WITH A STEEL EDGE

Drawing boards are frequently made, as in Fig. 58, with a steel bar along the working edge, which is presumed to be ground straight within small limits of error. This presumption may be justified as regards the bar itself, but when attached to the board in the manner shown it is refinement thrown away. The bars should be heavy and broad enough to be sufficiently rigid when fastened by the end screws only, and these are all that should be used. The bar will then maintain its straightness and not follow the



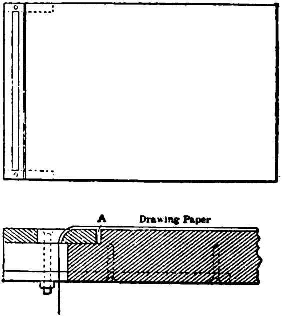


Fig. 58. Fig. 59.

Steel Edges on Drawing Boards.

warping and twisting of the board due to atmospheric changes. There should be a slight clearance, as shown at *A*, so that the wood cannot bear against the straight-edge and curve it outward.

The slotted bar shown in Fig. 59 is designed to admit of long drawings being made on a short board. These bars are frequently fastened by screws at short intervals along the inner edge, but the shrinkage of the wood is sufficient to spring the outer edge of even a bar of this form, and it is much better when attached by only a single bolt at each end. Short steel bars are screwed to the under side of the board, projecting outward to support the straight-edge, as the slot in the latter must clear the end of the board.

A PRACTICAL SECTION LINER

FIG. 60 shows a practical section-liner which anyone with any mechanical ability can make. The little triangle in the center can be made of a piece of an old triangle or of a thin piece of wood. The length of notch 1 should be about 1.54; of 2, about 1.57, and of 3, about 1.60 inches. The length of A on the little triangle should be about 1.53; of *B*, about 1.52, and of *C*, about 1.51 inches, giving nine steps from one one-hundredth to nine one-hundredths inch, in steps of one one-hundredth inch. This makes quite a variety, but it can be doubled by making two small triangles instead of one. Those who have never marginal line one inch from the edge, thus enclosing a space 8 x 13 inches. These sheets may be purchased of standard size and quality, marginal line and all, having the words "Witnesses," "Inventor," and "Attorney" in their respective positions at the bottom of the sheet.

A space of 1¼ inches is reserved at the top of the sheet, and will be filled in at the Patent Office. When beginning a drawing, rule off this reserved portion the first thing, and be careful about encroaching thereon, for neglect of this rule will bring a request for a new drawing.

Before beginning on the drawing, size up the device to be illustrated to determine what views will be required to show best the different parts in operation; what scale to make them; and how many sheets will be required. Fig. 1 is usually a view of the whole device, showing its general appearance as an entirety. A perspective view will often be most acceptable for Fig. 1, as it introduces the device to the attorney and to the examiner in a manner that appeals to them, for, as a rule, the people the Patent Office draftsman deals with are men not used to reading drawings.

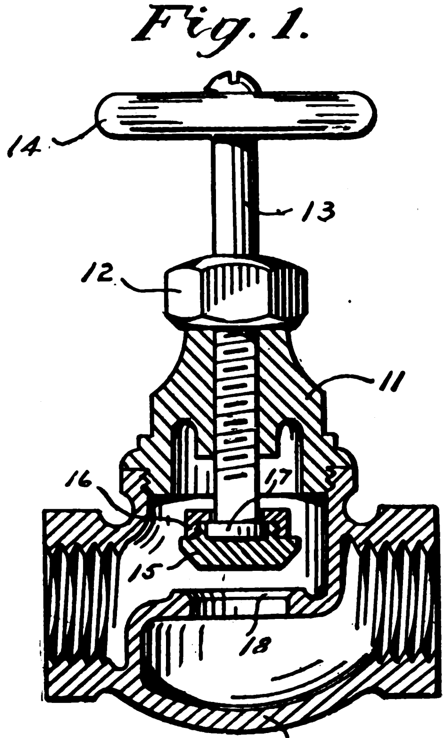


Fig. 62.—Patent Office Drawing.

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