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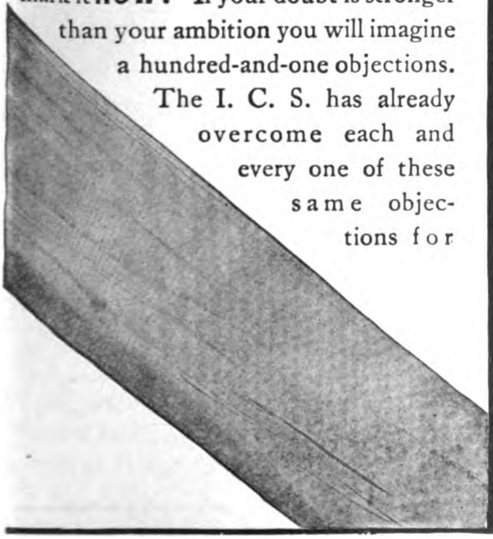

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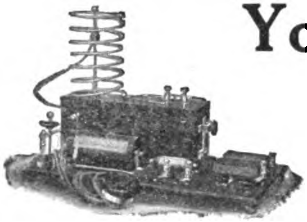

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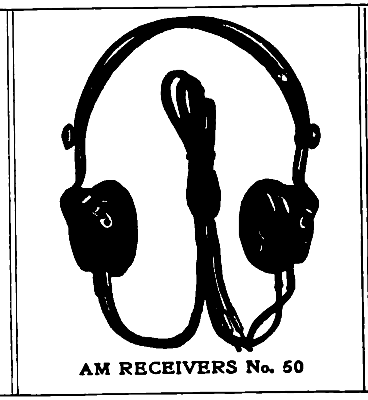

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Published monthly by the SAMPSON PUBLISHING CO., Boston, Mass.

F. R. Fraprie, M.Sc.Chem.F.R.P.S.; A. E. Watson, E.E., Ph.D.; M. O. Sampson, *Editors*

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ELECTRICIAN AND MECHANIC may be obtained from all newsdealers and branches of the American News Co.

Entered as Second-class Matter July 13, 1906, at the Post Office at Boston, Mass., under the Act of Congress of March 3, 1879

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ELECTRICIAN & MECHANIC

VOLUME XXVI FEBRUARY, 1913 NUMBER 2

THE CALCULATION OF INDUCTANCE

A. S. BLATTERMAN

The function of inductance in high-frequency circuits, especially as applied to radiotelegraphy, is now rather well understood. The fact that it is one of the governing features in the determination of the frequency of oscillation (and necessarily of wave-lengths) has been pointed out before; and this relation has been repeatedly and explicitly shown by publishing the well-known formula:

$$\text{Wave-length} = 2 \times 3.1416 \times V \times \sqrt{LC}$$

where V=the velocity of light, L=the inductance and C the capacity in the circuit.

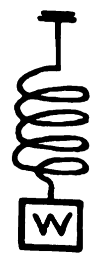
It seems never to have occurred to the authors of these articles, or if it has they have failed to meet the difficulty, that this formula is absolutely useless to the average experimenter in regard to any actual practical determinations; for, while he may be able to determine the value of capacity, and discover the velocity of light, there still remains the inductance to be calculated, which he finds is a thing quite beyond him with his available references.

It is in view of this fact, that articles on the calculation of this important factor, inductance, are at best a rarity, that the author has undertaken the methods of determining it for the several forms of circuits most met with in wireless telegraphy.

The inductance of an electric conductor may be defined as that quality of it in virtue of which magnetic energy is stored up in connection with the circuit in which a current is flowing. The practical unit of its measurement is called

magnetic flux of 10^8 lines when a current of 1 ampere flows through it.* This is simply definition and its only purpose is to point out that the phenomenon is magnetic in character.

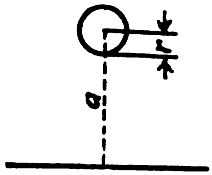
The dimension of an inductance on the electromagnetic system of measurement is a length. Hence the absolute unit of inductance in the electromagnetic system of measurement and in the C.G.S.



system is 1 centimeter. One henry is equal to 10^9 cms. and one millihenry to 10^6 cms.

In this article we shall be chiefly concerned with the measurement of small inductances which are conveniently measured in centimeters or else in millihenrys.

All conductors must have inductance, or, as it is sometimes called, self-induction, because all currents are surrounded by magnetic fields produced by the currents. An electric current cannot exist without producing a magnetic field, and the production of this field creates an e.m.f. in the circuit in the opposite direction to the e.m.f. driving the causing current. This back voltage of course tends to decrease the effects of the original current. The whole effect is exactly analagous to the property of inertia in mechanical considerations. Let us suppose a weight spring may be compared to an electrical circuit. The weight possesses inertia, corresponding to the inductance of the electrical circuit, and the dimensions of the spring govern the effects produced by the inertia of the weight, exactly as do the dimensions and form of a conductor in an electrical circuit govern the inductance and its effects in the circuit. If the spring be made longer, other things being kept constant, the time required for the weight to oscillate from its highest to its lowest position will be increased, and *vice versa*. The same holds true in the case of an oscillatory electric circuit. If the inductance coil is made larger, the time period of the circuit is increased; and if the inductance coil is made smaller, the time period is diminished.



A great many formulas have been given for calculating the self-inductance of the various cases of electrical circuits occurring in practice. Some of these formulas have been shown to be wrong, and of those which are correct and applicable to any given case there is usually a choice, because of the greater accuracy or greater convenience of one as compared with the others. Of course, this article being restricted as to space, and also to radiotelegraphic relations, omits all but a very few of these formulas, and those which are discussed have been chosen, following their extended use by the author, on account of their merit.

The first case of importance occurring in practice is that of a straight cylindrical wire whose length is l, and whose diameter is d. Both of these dimensions are in centimeters. The inductance of such a conductor is given by the formula

$$(1) \quad L = 2 \times l \left(2.3026 \log_{10} \frac{4 \times l}{d} - 1\right)$$

Thus suppose we have a straight cylindrical wire 100 ft. long and .1 in. in diameter. These dimensions reduced to centimeters are

$$l = 100 \times 30.48 = 3048 \text{ cm.}$$

$$d = .1 \times 2.54 = .254 \text{ cm.}$$

Substituting these values in the above formula

$$L = 2 \times 3048 \left(2.3026 \log_{10} \frac{4 \times 3048}{.254} - 1\right)$$

$$= 6096\ (2.3026 \times 4.68124 - 1)$$

$$= 59611.0 \text{ cm., or } 0.0596 \text{ mh.}$$

The second form of circuit occurring very frequently is that of a circle. This is quite often one turn of a sending helix. The formula for calculating the inductance of such a circle is

$$L = 4 \times 3.1416 \times a \left\{ \left(1 + {}^{3}\!/_{16} \frac{r^2}{a^2}\right) \log_e \frac{8a}{r} - \frac{r^2}{16a^2} - 2 \right\}$$

which can be put into the form

$$(2) \qquad L = 4 \times 3.1416 \times a \left\{ 2.3026 \left(1 + {}^{3}\!/_{16} \frac{r^2}{a^2}\right) \log_{10} \frac{8a}{r} - \frac{r^2}{16a^2} - 2 \right\}$$

When r = radius of wire in centimeters.
Where a = radius of circle in centimeters. See Fig. 2.

Suppose it is desired to determine the inductance of one turn of a sending helix whose dimensions are $a = 15$ cms. and $r = .3$ cms. Formula (2) enables us to compute the inductance of the circle by substituting the given values of a and r.

$$L = 4 \times 3.1416 \times 15 \left\{ 2.3026 \left(1 + {}^{3}\!/_{16} \frac{.09}{225}\right) \log_{10} \frac{120}{.3} - \frac{.09}{16 \times 225} - 2 \right\}$$

The best way of carrying out the indicated computations is to use logarithms to at least five places.

$$\frac{.09}{16 \times 225} = ?$$

Log .09	=	8.95424 − 10
Colog 16	=	8.79588 − 10
Colog 225	=	7.64782 − 10
		25.39794 − 30

$$\frac{.09}{16 \times 225} = .000025$$

$$\text{Log}_{10}\frac{120}{.3} = \log_{10} 400 = 2.60206$$

$$\left(1 + \tfrac{5}{16} \times \frac{.09}{225}\right) = 1.000075$$

Log 1.000075	=	0.00003
Log 2.3026	=	0.36222
Log 2.60206	=	0.41532
		0.77757

$$2.3026\left(1 + \tfrac{5}{16} \times \frac{.09}{225}\right)\log_{10}\frac{120}{.3} = 5.9920$$

$$\left\{2.3026\left(1 + \tfrac{5}{16} \times \frac{.09}{225}\right)\log_{10}\frac{120}{.3} - \frac{.09}{16 \times 225} - 2)\right\} =$$

$$5.9920 - 0.000025 - 2 = 3.991975$$

Log 4	=	0.60206
Log 3.1416	=	0.49175
Log 15	=	1.17609
Log 3.991975	=	0.60118
Log L	=	2.87648
L	=	752.45 cms.

THE SELF-INDUCTANCE OF SINGLE LAYER COILS

By far the most important and most frequently encountered circuits in radio-telegraphic work are those in which the wire is wound in the form of single layer solenoids. This construction is adhered to almost without exception, both in the transmitting circuits and in the receiving circuits, and a means of determining the inductance of such coils is important. It is understood that this article deals only with air core coils such as are used only in direct connection with the high-frequency oscillatory elements of the apparatus. More particularly, it concerns the calculation of the inductance of helices, tuners, loading coils, wavemeters, etc.

The following formulas and tables will be found to be quite convenient for the forms of circuits under consideration and will yield very accurate results. I shall first give the formulas and the tables pertaining to them together with an explanation of their use, and afterwards will take up definite examples to illustrate thoroughly the calculations and methods involved.

The following formula and tables are due to Nagaoka:

$$L_s = 4 \times 3.1416^2\, a^2\, n^2 b\; K \qquad (3\ )$$

Where

a = radius of solenoid to center of wire in centimeters.

n = number of turns of wire per centimeter length of coil.

b = length of coil in centimeters.

K = a constant (to be obtained from following table).

TABLE I

Nagaoka's Table of Values of the End Correction K as a Function of the Ratio $\frac{\text{Diameter}}{\text{Length}}$

Diam./Length	K	D_1	D_2	Diam./Length	K	D_1	D_2
0.00	1.000000	-4231	24	.24	.905290	-3641	25
.01	.995769	-4207	26	.25	.901649	-3616	23
.02	.991562	-4181	24	.26	.898033	-3593	24
.03	.987381	-4157	25	.27	.894440	-3569	23
.04	.983224	-4132	25	.28	.890871	-3546	24
.05	.979092	-4107	25	.29	.887325	-3522	24
.06	.974985	-4082	26	0.30	.883803	-3498	22
.07	.970983	-4056	24	.31	.880305	-3476	24
.08	.966847	-4032	24	.32	.876829	-3452	23
.09	.962815	-4008	26	.33	.873377	-3429	23
0.10	.958807	-3982	25	.34	.869948	-3406	22
.11	.954825	-3957	24	.35	.866542	-3384	24
.12	.950868	-3933	23	.36	.863158	-3360	22
.13	.946935	-3910	26	.37	.859799	-3338	23
.14	.943025	-3884	27	.38	.856461	-3315	22
.15	.939141	-3857	23	.39	.853146	-3293	23
.16	.935284	-3834	23	0.40	.849853	-3270	22
.17	.931450	-3811	26	.41	.846583	-3248	23
.18	.927639	-3785	24	.42	.843335	-3225	21
.19	.923854	-3761	24	.43	.840110	-3204	21
0.20	.920093	-3737	24	.44	.836906	-3183	23
.21	.916356	-3713	24	.45	.833723	-3160	21
.22	.912643	-3689	25	.46	.830563	-3139	22
.23	.908954	-3664	23	.47	.827424	-3117	21
.24	.905290	-3641	25	.48	.824307	-3096	21
.49	.821211	-3075	21	.76	.745191	-2554	17
0.50	.818136	-3054	21	.77	.742637	-2537	18
.51	.815082	-3033	21	.78	.740100	-2519	17
.52	.812049	-3012	21	.79	.737581	-2502	16
.53	.809037	-2991	20	0.80	.735079	-2486	19
.54	.806046	-2971	21	.81	.732593	-2467	16
.55	.803075	-2950	20	.82	.730136	-2451	16
.56	.800125	-2930	20	.83	.727675	-2435	16
.57	.797195	-2910	20	.84	.725240	-2419	17
.58	.794285	-2890	20	.85	.722821	-2402	16
.59	.791395	-2870	20	.86	.720419	-2386	16
0.60	.788525	-2850	19	.87	.718033	-2370	15
.61	.785675	-2831	19	.88	.715663	-2355	16
.62	.782844	-2812	20	.89	.713308	-2339	17
.63	.780032	-2792	19	0.90	.710969	-2322	14
.64	.777240	-2773	19	.91	.708647	-2308	16
.65	.774467	-2754	19	.92	.706339	-2292	15
.66	.771713	-2735	19	.93	.704047	-2277	16
.67	.768978	-2716	19	.94	.701770	-2261	14
.68	.766262	-2697	18	.95	.699509	-2247	15
.69	.763565	-2679	18	.96	.697262	-2232	15
0.70	.760886	-2661	18	.97	.695030	-2217	15
.71	.758225	-2643	19	.98	.692813	-2202	14
.72	.755582	-2624	17	.99	.690611	-2188	14
.73	.752958	-2607	18	1.00	.688423	10726	344
.74	.750351	-2589	18	1.05	.677697	-10382	330
.75	.747762	-2571	17	1.10	.667315	-10052	316
.76	.745191	-2554	17	1.15	.657263	-9736	303
1.20	.647527	-9433	290	3.10	.421687	-7219	275
1.25	.638094	-9143	278	3.20	.414468	-6944	260
1.30	.628951	-8865	266	3.30	.407524	-6684	245
1.35	.620086	-8599	255	3.40	.400840	-6439	230
1.40	.611487	-8343	244	3.50	.394401	-6209	220
1.45	.603144	-8099	236	3.60	.388192	-5989	207
1.50	.595045	-7863	224	3.70	.382203	-5782	195
1.55	.587182	-7639	215	3.80	.376421	-5587	186
1.60	.579543	-7424	208	3.90	.370834	-5401	174
1.65	.572119	-7216	198	4.00	.365433	-5227	168
1.70	.564903	-7018	190	4.10	.360206	-5059	161
1.75	.557885	-6828	184	4.20	.355147	-4898	152
1.80	.551057	-6644	176	4.30	.350249	-4746	141
1.85	.544413	-6468	170	4.40	.345503	-4605	138
1.90	.537945	-6298	161	4.50	.340898	-4467	134
1.95	.531647	-6137	154	4.60	.336431	-4333	125
2.00	.525510	-11809	580	4.70	.332098	-4208	118
2.10	.513701	-11229	539	4.80	.327890	-4090	115
2.20	.502472	-10690	499	4.90	.323800	-3975	102
2.30	.491782	-10191	465	5.00	.319825	-18321	2227
2.40	.481591	-9726	434	5.50	.301504	-16094	1830
2.50	.471865	-9292	405	6.00	.285410	-14264	1524
2.60	.462573	-8887	378	6.50	.271146	-12740	1283
[illegible]	.453686	-8509	355	7.00	.258406	-1145[illegible]	1090
				7.50	.246949	-1036[illegible]	937

TABLE II

Values of Correction Term "A," depending on the ratio $\frac{d}{P}$ of the Diameters of Bare and Covered Wire on the Coil

$\frac{d}{P}$	A	$\frac{d}{P}$	A	$\frac{d}{P}$	A
1.00	0.5568	.80	0.3337	.60	0.0460
.99	.5468	.79	.3211	.59	.0292
.98	.5367	.78	.3084	.58	.0121
.97	.5264	.77	.2955	.57	-.0053
.96	.5160	.76	.2824	.56	-.0230
.95	.5055	.75	.2691	.55	-.0410
.94	.4949	.74	.2557	.54	-.0594
.93	.4842	.73	.2421	.53	-.0781
.92	.4734	.72	.2283	.52	-.0971
.91	.4625	.71	.2143	.51	-.1165
.90	.4515	.70	.2001	.50	-.1363
.89	.4403	.69	.1857		
.88	.4290	.68	.1711	.50	-.1363
.87	.4176	.67	.1563	.45	-.2416
.86	.4060	.66	.1413	.40	-.3594
.85	.3943	.65	.1261	.35	-.4928
.84	.3825	.64	.1106	.30	-.6471
.83	.3705	.63	.0949	.25	-.8294
.82	.3584	.62	.0789	.20	-1.0526
.81	.3461	.61	.0626	.15	-1.3403
.80	.3337	.60	.0460	.10	-1.7457

K is a function of the ratio of the diameter of the coil in question to its length, and in the determination of *K* for any particular case the method of procedure is as follows:

Measure *b*, the length of the coil, and 2*a*, its diameter, dividing the latter by the former and finding the decimal equivalent of the ratio $\frac{2a}{b}$. In the table look under the column headed "$\frac{\text{Diameter}}{\text{Length}}$" for the decimal just found, and in the same horizontal line and under the column headed "*K*," find the required value of *K*. It will always be less than 1. In the event that the value of the ratio $\frac{2a}{b}$ lies between two of the values given in the table, the value of *K* may be found by interpolation for which purpose columns "D_1" and "D_2" are given. The interpolation formula to be used is

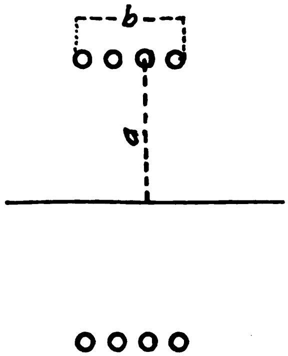
$$K = K_1 + cD_1 + \frac{c(c-1)D_2}{2}$$

where *K* is the value sought. K_1 is the value of *K* given in the table corresponding to the value of the ratio $\frac{2a}{b}$ next lower

$$L_s = 4 \times 3.1416 \times a \times n^2 \left\{ 2.3026 \log_{10} \frac{8 \times a}{b} - \frac{1}{2} + \frac{b^2}{32a^2} \left(2.3026 \log_{10} \frac{8a}{b} - \frac{1}{4}\right) \right\}$$

h is the remainder above the value of the ratio $\frac{2a}{b}$ given in the table, and d is the increase in the value of the same ratio given in the table. D_1 and D_2 are found opposite the value of $\frac{2a}{b}$ just lower than the true value. A definite illustration of the use of this formula will be given later in the solution of a complete problem.

The above formulas and tables are most satisfactory for the determining of the inductance of coils longer than about one-fifth of their diameter. For shorter solenoids the following formula should invariably be used. It is adaptable to helices and may even be used to compute the inductance of a single turn of wire with the greatest accuracy. It is due to Rayleigh and Niven, and is as follows:



Where
n=whole number of turns,
a=the radius in centimeters.
b=the length in centimeters (see figure).

The self-inductance L_s is, however, not the actual self-inductance of the coil, but what is called the current sheet value; that is, it is the value of the self-inductance if the winding were of infinitely thin tape, so that the current would cover the entire length b. To get the actual self-inductance L for any given case it is necessary to correct L_s by the next formula.

It has been shown that the above two formulas, *viz.*, (3) and (4), apply accurately only to a winding of infinitely thin strip which completely covers the solenoid (the successive turns being supposed to meet at the edges without making electrical contact) and so realizing a uniform distribution of current over the surface. A winding of insulated wire or of bare wire wound in a screw thread may have a greater or less self-inductance than that given by the current sheet formulas above, according to the ratio of the diameter of the wire to the pitch of the winding. Putting L for the actual self-inductance of a winding and L_s for the current sheet value given by one of the above formulas,

$$L = L_s - DL$$

The correction DL is given by the following expression:

$$DL = 4 \times 3.1416 \times a \times n \; (A + B)$$

where a=radius in centimeters, and n=whole number of turns, and A and B are constants given in Tables II and III.

The correction term A depends on the size of the bare wire (of diameter d) as

TABLE III

Values of the Correction Term "B," depending on the Number of Turns of Wire on the Single Layer Coil

No. of Turns	B	No. of Turns	B
1	0.0000	50	0.3186
2	.1137	60	.3216
3	.1663	70	.3239
4	.1973	80	.3257
5	.2180	90	.3270
6	.2329	100	.3280
7	.2443	125	.3298
8	.2532	150	.3311
9	.2604	175	.3321
10	.2664	200	.3328
15	.2857	300	.3343
20	.2974	400	.3351
25	.3042	500	.3356
30	.3083	600	.3359
35	.3119	700	.3361
40	.3148	800	.3363
45	.3169	900	.3364
50	.3186	1000	.3365

compared with the pitch P of the winding; that is, on the value of the ratio $\frac{d}{P}$. For values of $\frac{d}{P}$ less than 0.58, A is negative, and in such cases when the numerical values of A are greater than those of B, which is always positive, the correction DL will be negative, and hence L will be greater than L_s. The use of the tables II and III will be understood from the examples illustrating formulas (4) and (3), which, as above stated, also suffer correction.

EXAMPLES

Example 1

Nagaoka's formula.

$$L_s = 4\pi^2 a^2 n^2 b K$$

let $a = 27$ cms.
$b = 32$ cms.
$h = 10$ turns per centimeter.

To find K, first determine $\frac{2a}{b}$.

$\frac{2a}{b} = \frac{54}{32} = 1.6875$, and looking in Table I under column $\frac{2a}{b}$, we find that 1.6875 lies between the values 1.65 and 1.70 in the table.

Referring now to the interpolation formula

$$K = K_1 + cD_1 + \frac{c(c-1)D_2}{2},$$

we have the following substitutions to make

$K_1 = .572119$ $\qquad c = \frac{h}{d} = \frac{1.6875 - 1.65}{1.70 - 1.65} = \frac{.0375}{.05}$

$D_1 = -7216$

$D_2 = +198$ $\qquad c = .75$

whence $\qquad K = .572119 - (.75 \times 7216) + \frac{.75(.75-1)\ 198}{2}$

$= .572119 - .005412 - .000018$

$= .566689$

So that $\qquad L_s = 4 \times \overline{3.1416^2} \times \overline{27^2} \times 100 \times 32 \times .566689$

$= 52,187,700$ cms.

This is the current sheet value and must be corrected by formulas (10) and (11). The diameter of the bare wire is $d = .0193$ cms.

$P = .1000$ cms.

$\frac{d}{P} = .913$ and from Table II $\quad A = .4658$

n = whole number of turns = 320

From Table III. $\qquad B = .3345$

$DL = 4 \times 3.1416 \times 27 \times 320 \times (.4658 + .3345)$
$= 86912$ cms.

$L = L_s - DL$
$= 52187700 - 86912 = 52100788$ cms.
or .052100788 henrys,

which is the true value of the inductance.

Example 2

Let us suppose a coil wound with the same kind of wire as that in the previous example. And let its other dimensions be the same with the one exception that b is now 4 cms.

Let us compute the inductance by the formula of Rayleigh and Niven.

$$L_s=4 \times 3.1416 \times 27 \times 1600 \left\{ 2.3026 \log_{10} \frac{216}{4} - \frac{1}{2} + \frac{16}{32 \times \overline{27^2}} \left(2.3026 \log_{10} \frac{216}{4} + \frac{1}{4}\right) \right\}$$

$$=4 \times 3.1416 \times 27 \times 1600 \left\{ 2.3026 \times 1.73239 - \frac{1}{2} + \frac{1}{2 \times 729} \left(2.3026 \times 1.73239 + \frac{1}{4}\right) \right\}$$

$=4 \times 3.1416 \times 27 \times 1600 \times 3.4919$
$=1{,}895{,}480$ cms.
which must be corrected as in the previous example:
$\frac{d}{P}=.913$ as before and $A=.4658$
$h=40$ and from Table III $B=.3148$
$DL=4 \times 3.1416 \times 27 \times 40\ (.4658 + .3148)$
$=10{,}594$ cms.
$L=L_s - DL=1895480 - 10594=1884886$ cms.

As an extreme test of the accuracy of this formula we may calculate the inductance of a single turn of wire whose dimensions are those given in the example illustrating formula (2) *i.e.*,

$a=15$ cms.
$b=.6$ cms.
$n=1$

Substituting

$$L_s=4 \times 3.1416 \times 15 \left\{ 2.3026 \log_{10} \frac{120}{.6} - \frac{1}{2} + \frac{.36}{32 \times 225} \left(2.3026 \log_{10} \frac{120}{.6} + \frac{1}{4}\right) \right\}$$

$$=60 \times 3.1416 \left\{ 2.3026 \times 2.30103 - \frac{1}{2} + \frac{.36}{32 \times 225} (5.5483) \right\}$$

$=904.5$ cms.

Correcting this current sheet value, $\frac{d}{P}=1$,

$A=.5568$ and $B=0$
$DL=4 \times 3.1416 \times 15 \times .5568$
$=104.95$ cms.
$L=L_s - DL=904.5 - 104.95=799.55$ cms.

The value obtained from formula (2) is 752.45 cms. The discrepancy is due to the fact that formula (2) gives the inductance for infinitely high frequencies, while in the above example the value obtained is for very low frequency or, more correctly, for steady currents only. The exact predetermination of the inductance of conductors at high frequency is very complicated—if, indeed, it is possible at all—and only in the simplest forms of circuits can close approximation to the desired value be obtained.

The following formula will serve to correct values of inductance calculated for zero frequency, or direct current to any frequency n, though it is only applicable to copper wires which are straight or very slightly bent. L is the direct current inductance, l is the length, and d the diameter of the conductor (all in centimeters).

$$L_1=L-l\left(\frac{1}{2}-\frac{40}{3.1416 \times d\sqrt{n}}\right)$$

It is seen that when n becomes very large, the second term in the brackets becomes 0, so that a very approximate correction is applied by simply subtracting from

(*Continued on page* 87)

THE PRODUCTION OF ACCURATE SCREW-THREADS IN THE LATHE
Part II—Testing and Gauging

FRANCIS W. SHAW

Now arises the question of gauging the work, both during progress and after completion. The attainment of accuracy in lead will rest almost wholly on accuracy of machine and alignments. Heating of the work may account for some error; but this is avoidable by allowing the work to cool down before taking final finishing cuts. If the machine guide-screw be accurate in lead and ordinary care is taken at all points, any check needed would be to ascertain accidental slips. An ordinary screw-pitch gauge would be sufficient for this purpose. To check the form of thread before completion it would be impossible to employ standard ring or plug-gauges.

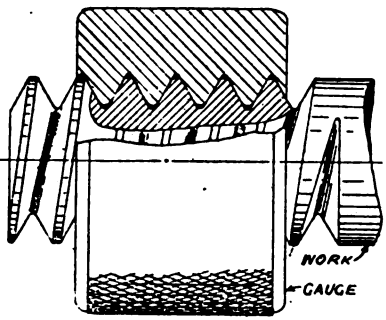


Fig. 11—Showing Clearance at Bottom of Spaces in Ring Gauges to clear Flat Tops of Work Threads

As a final test, these are, of course, useful, and if made as shown in Figs. 11 and 12, they can be used before the final rounding off of the thread, the gauge threads being cut deeper as shown. Previous to rounding off, some form of adjustable gauge is advisable. The Brown & Sharp micrometer (Fig. 13*A*) is a convenient tool, used in the manner shown. It will be noticed that the points are cut away in such a manner that they do not interfere with the tips or roots of the thread. Hence, measurement is made of what is termed the angular diameter of the thread, which is, of course, the part of the thread which should regulate the fit. In this micrometer, when the points are in contact, as shown at *B*, the micrometer reading is at

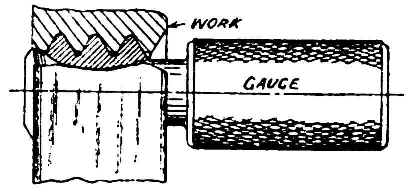


Fig. 12—Showing Clearance at Bottom of Spaces in Plug Gauges to clear Flat Tops of Work Threads

For this reason, an amount equal to twice the addendum must be added to the reading to arrive at the outside diameter. For the Whitworth standard the amount to be added to the reading amounts to 0.640—pitch (p). The following table presents these amounts worked out for the various pitches:

READING OF B.&S. MICROMETER FOR WHITWORTH THREADS

Diameter	Threads per inch	Micrometer Reading	—
d	p	$d - \frac{.640}{p}$	$\frac{.640}{p}$
Inches			
¼	20	.2180	.0320
5-16	18	.2769	.0355
⅜	16	.3350	.0400
7-16	14	.3918	.0457
½	12	.4467	.0533
9-16	12	.5092	.0533
⅝	11	.5668	.0582
11-16	11	.6293	.0582
¾	10	.6860	.0640
13-16	10	.7485	.0640
⅞	9	.8039	.0711
15-16	9	.8664	.0711
1	8	.9200	.0800
1⅛	7	1.0336	.0914
1¼	7	1.1586	.0914
1⅜	6	1.2684	.1066
1½	6	1.3934	.1066
1⅝	5	1.4970	.1280
1¾	5	1.6220	.1280
1⅞	4½	1.7328	.1422
2	4½	1.8578	.1422
2⅛	4½	1.9828	.1422

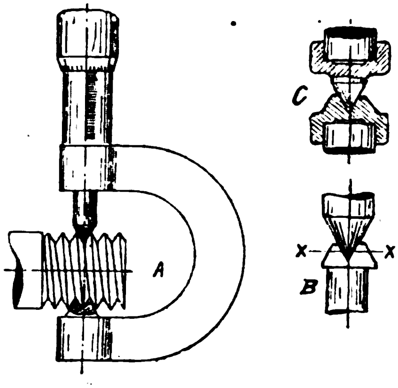


Fig. 13—Measuring Angular Diameter of Screw

Whitworth form is used on screws of different diameters than standard.

C, Fig. 13, shows attachments for converting an ordinary micrometer. The table of readings may be employed by adding the initial reading of the micrometer when the gauging points are in contact to the tabulated figures.

In screw-cutting the first process will be the cutting of the thread with a V-tool in the manner already indicated. This will leave the top of thread flat. During this process, the diameter will be checked by the thread micrometer, Fig. 13. If tools are sharp, accurate and accurately set, the thread flanks may be accurately finished by the tool itself, nothing being left to be removed by the chaser. If means are not at hand for insuring the necessary tool accuracy, about .005 should be left on the diameter for finishing with the chaser. However, it is recommended that an attempt be made to secure the necessary tool accuracy and avoid chasers, which are apt to be cut out of pitch, due to distortion in hardening.

THREAD ROUNDING

Assuming that the correct angular diameter of the thread being produced has been attained, all that remains is the rounding of the tip of the thread. To do this a simple tool, easily made, is that shown in Fig. 14. The thread rounder itself is made from rectangular steel, and is held in a holder, as clearly shown. In order to get the radius of the cutting portion correct, a hole, slightly smaller in *radius* than the radius of the thread-tip is drilled near to the end of the short piece of steel, as shown. This hole is countersunk to reduce the depth of the cutting-edge, and so avoid undue interference in use. The cutter is now hardened and tempered to suit the nature of the steel, and the hole lapped out to size with a piece of copper wire charged with diamond dust or emery, to a gauge already prepared by grinding to correct size a piece of hardened steel wire. It is possible at times to make use of a needle or even a piece of music-wire carefully chosen by micrometer measurement for this purpose.

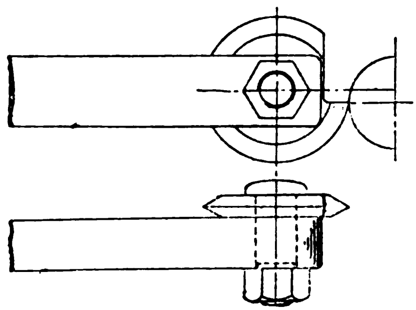
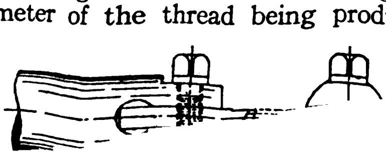


Fig. 15—Circular Threading Tool

After lapping, the end of the cutter is ground off (note the dotted lines) to the correct angle. At *A* is shown how an internal thread-rounder is prepared. In using these tools, care must be exercised in setting in relation to the thread-angles. This is best done by adjusting the tool sidewise until by the aid of a magnifying-glass the ends of the arc are seen to coincide with the thread-angle. These tools are ground on the top surface only.



of the tool results in a plan shape of elliptical form. The difference from a true circle is, however, quite inappreciable.

CIRCULAR THREADING TOOL

Fig. 15 shows a simple threading tool, whose particular virtues consist in that it is cheaply produced, readily ground and has a long life. It will be noticed that the putting face is below the line of centers to avoid interference with the thread flanks. This may be used for right- or left-hand threads. Where the lead-angle is large, it will be necessary to tilt the tool. If the plan angle of the tool be made slightly less than standard, the resultant thread form will be more nearly correct. For extremely accurate threads this tool will do for roughing out only. This will be apparent from a study of Fig. 9.

Now, let us consider the particular difficulties which beset the Square and Acme thread forms, as shown in Fig. 16. The proportions of these threads are given in the following formulas and table:

Formulas

l = lead = the amount of movement of a nut due to one turn of the screw.

p = pitch = the distance from center to center of adjacent turns of thread. (In a single-threaded screw, $p=l$).

t = thickness of top of thread in an "Acme" thread, and thickness of thread in a square thread.

d = depth of thread.

c = clearance between top of thread in screw and bottom of space in nut, or between bottom of space in screw, and top of thread in nut.

$$\text{Acme } t = \frac{l \times .3707}{\text{number of leads}} = .3707p$$

$$\text{Square } t = \frac{1 \times .5}{\text{number of leads}} = .5p$$

Acme $d = .5p + .010$ in all leads

Square $d = .5p + c$ ...

ACME STANDARD THREADS

Proportion in Inches

Pitch $= p$	Depth $= d$	Thickness of Top of Thread $= t$	Thickness of Bottom of Thread	Width of Top of Space	Width of Bottom of Space
1	.5100	.3707	.6345	.6293	.3655
2	.2600	.1853	.3199	.3147	.1801
3	.1767	.1235	.2150	.2098	.1183
4	.1350	.0927	.1625	.1573	.0875
5	.1100	.0741	.1311	.1259	.0689
6	.0933	.0618	.1101	.1049	.0566
7	.0814	.0529	.0951	.0899	.0478
8	.0725	.0463	.0839	.0787	.0411
9	.0655	.0413	.0751	.0699	.0361
10	.0600	.0371	.0681	.0629	.0319

EFFECT OF SPRING IN TOOLS

In cutting threads of any form, a trouble experienced is that of the commencing portion of the thread being cut rather thicker than normal. This is due to the fact that when the tool first meets the work, the pressure is taken by the leading side of the tool, causing it to yield. Backlash in the slides and inherent

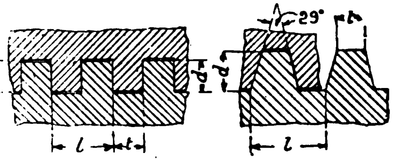


Fig. 16—Square and Acme Standard Threads

weaknesses in the job and the machine tend to the same end. As the tool proceeds in its travel, the other side of the tool receives a pressure tending to balance that on the first entering side, with the result that the tool ultimately returns to its normal position. Thus the lead is a slightly variable one, seen particularly in the case of very fine square or "Acme" threads, where the difference is very acute. The first point needing attention is the tool itself, which should be as still as possible. A square thread tool, made as shown in Fig. 17, will be

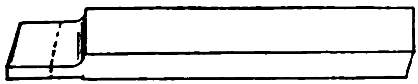


Fig. 17—Square Thread Tool

of the slide-rest should be adjusted so as to move rather stiffly. Again, see that the work itself, if of a flimsy character, be well stayed, and the spindle of the headstock neatly adjusted. One source of trouble is frequently due to lack of care in centering the work. The centers should be deep, and conform in angle to the headstock centers. Then when extreme accuracy is needed, the material in the work must have attention. The removal of metal from the outside of a bar results in the releasing of internal stresses due to the rolling, hammering, or cooling. Hence, as the exterior portion of the material is subject to the most severe of these stresses, ample allowance must be made for machining. Oftentimes it is necessary to release the inherent stresses by a process of annealing prior to screw-cutting, and even after roughing out the thread. The amount of such attention, will, of course, vary with the refinement of accuracy demanded. A point worth noting is that any straightening necessary should be done prior to annealing, and care taken in annealing by careful packing in the furnace—to prevent distortion during this process. Material should also be carefully chosen. Steel of a very soft nature is very "luggy" in the cutting, and there is a great tendency for the tool to seize the material. Such steel may be more readily cut under ample lubricant—lard-oil for preference.

This point of yield in the tool, due to one-sided pressure, is an important one—so important, in fact, that where the work must be accurate, each side of the thread must be cut independently, after initially roughing out—very carefully—with a tool narrower than the space. Not only so, but it is better to feed in the tool at the angle of the thread-flank than to tool is fed direct into the work, the total width of cut as the thread nears completion is considerable. As a consequence of this, the pressure on the tool and the reaction on the work is also considerable; hence, there is a great tendency for both work and tool to yield. The work, as a rule, if frail in structure, mounts the tool, which in common parlance, digs in. This may to some extent be mitigated by using a spring tool, in which any extra pressure forces the tool out of the work. This is the procedure adopted in thread-cutting lathes where the work is done automatically, and in which it would be impossible or impracticable, at least, to make (automatically) the changes in tool position needed to work on the step-by-step lines advocated above. Obviously, a spring tool, if it fulfils its "spring" function, must result in imperfect work. If it does not spring, then it is no better than a non-spring tool.

GRINDING THREADING TOOLS

Much depends on accuracy of tools: hence it will not be out of place to mention some of the methods adopted to insure accuracy. Modern engineering concerns have now abandoned the methods which left the grinding of tools in the hands of the individual workman. A tool-grinding department, whose duty is to dole out the necessary tools, collect and regrind them at intervals, is the regular order of things. This department is now fitted up with special machines, in which tools may be fixed and controlled in their movements in relation to the grinding wheel. Thus, a threading tool either for V, Acme or square threads, would be fixed in a holder and constrained to travel in such a relation to the grinding-wheel as to produce the required angles with precision. Accurate gauges are provided to check not only the angles, but the widths of tools. Attention has been particularly paid to cutting and rake angles. As a rule these machines are accompanied by a board beaof slides capable of being tilted to any desired angle to the grinding wheel. The writer has arrived at the same result by mounting tools in an ordinary slide-rest on the lathe, using the swivel to give the necessary angular movements, an emery wheel being mounted between the lathe-centers.

This short description of grinding methods will suffice to give a few hints on the subject. To deal adequately with the subject of grinding tools would need considerable space, and is not really germane to the art of screw-cutting.

In conclusion, the manufacture of accurate screws is by no means a simple affair—the manufacture of precision screws, most difficult. What has been said—although relating to some extent to precision screws—is intended rather to deal with those screws used in machinery—machine tools in particular—for controlling feeds, etc., and to apply to the manufacture of ordinary screwing tackle, and, generally, to screws comparatively short in length. The production of what is termed a precision screw needs methods almost entirely different. The production of a screw, say, 5 ft. long, within a limit of variation in pitch of half a thousandth of an inch per foot is a serious undertaking. As a matter of fact, but two or three firms exist who are capable of tackling such a job.

A Telephone Time Saver

What looks like a good suggestion is a device noted in a recent number of the *Electrician*, an invention designated as a telephone time saver. This device consists of a sound-magnifying trumpet, of flattened form, similar to certain types of motor horns, behind which is a platform adapted to support the telephone receiver. Upon receiving or making a call upon the 'phone and being asked to "hold the line," the user, instead of "holding on" with the telephone receiver pressed to his ear, an arrangement which restricts his movements and prevents him from giving his attention to any other matter, merely drops the receiver onto the platform of the "time saver," where it automatically slides into position with the earpiece against the small end of the spiral trumpet. The user is then free to go on with his work until the voice from the trumpet shows him that the person at the other end is speaking. Conversation can then either be carried on using the loud-speaking trumpet, with the advantage of leaving the user's hands both free for the purpose of turning up references, taking down a message from dictation, etc., or the receiver may be lifted off the instrument and used in the ordinary way. The loud-speaking telephone's "voice" is very similar to that

Bare Aluminum Wires for Coils

The conductivity of aluminum is about 60 per cent. of that of annealed copper. Accordingly, an aluminum conductor must be considerably larger in cross sectional area than a copper conductor if the two are to carry the same amount of current. Aluminum wire is always coated with a thin oxide which serves as an insulator. This insulation is enough, according to some European manufacfacturers, to permit of using bare aluminum wire in the coils of magnets. As the oxide film is of inappreciable thickness, a coil of fine wire thus constructed would be no bulkier, if as bulky, as a coil wound with insulated copper wire. H. F. Stratton, writing on this subject in the *Electrical World*, states that he has been unable to secure sufficient insulation when depending upon the aluminum oxide film as it naturally occurs in the commercial product. In order to increase this oxide, some European manufacturers wet the coil and then heat it. This he thinks hardly sufficient, but he has produced very successful results by passing the wire through sodium hydroxide, and then drying the coil by passing a current through it.

Lady (engaging cook)—"This reference

MECHANICAL DRAWING

P. LEROY FLANSBURG L. BONVOULOIR

ORTHOGONAL PROJECTION

Orthogonal or orthographic projection is a science based on solid and descriptive geometry. It may be best described as the art of representing objects or magnitudes on two or more suitably chosen planes. Usually these planes are taken at right angles to each other and the projection of the object on the planes exactly represent the object by showing its form, dimensions and the relation of its lines and surfaces to each other. The science is of great interest and importance to the draftsman, since upon it are based all architectural and mechanical working drawings.

In mechanical drawing the object is represented on two planes, which are termed the horizontal plane of projection and the vertical plane of projection. These two planes are taken perpendicular

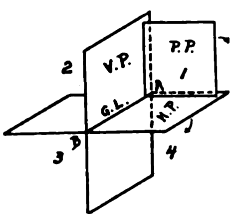


Fig. 1

to each other and intersect in a line called the ground line. While these two planes will in some cases be sufficient to properly and clearly represent the object, yet there are many times when a third plane, called a profile plane, is needed. This third plane is taken perpendicular to the other two planes.

Fig. 1 shows the arrangement of the three planes of projection. *VP* is the

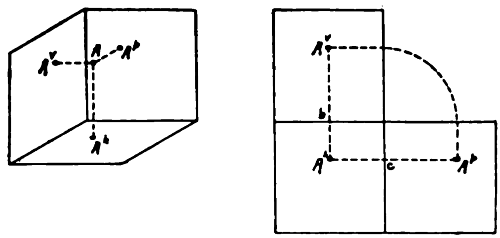


Fig. 2

When a third view of the object is needed it is shown on the profile plane *PP*, and this view of the object is called a side view or side elevation. It is important to notice that the different views of the object derive their names simply from the plane on which they are shown and not from the face of the object represented.

The *VP* and *HP* form four angles which have been numbered, in Fig. 1, as 1st, 2d, 3d and 4th angle, respectively. That is, if the object is assumed to rest on the horizontal plane, and in front of the vertical plane its projection is said to be a 1st angle projection; if the object is assumed to be beneath the horizontal plane and behind the vertical plane its projection is a 3d angle projection, etc. Usually in making the working drawings of any object, the object is considered to be in either the 1st or 3d angle.

Fig. 2 shows the point *A*, located in the 1st angle. This point is above *HP*, in front of *VP* and in front of *PP*. The projections of the point are A^h, A^v and A^p; the small exponents simply indicating upon which plane the projection is taken. The left-hand drawing in Fig. 2 shows the point in space and its relation to the three reference planes, while the right-

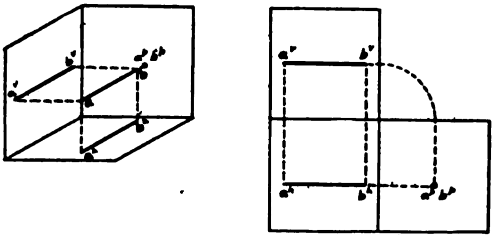


Fig. 3

Since both *VP* and *PP* are perpendicular to *HP*, it is evident that cA^p must equal bA^v.

Fig. 3 is the projection of a straight line which is parallel to both *VP* and *HP*. As in Fig. 2, and in most of the following figures, two drawings are given, the one being the projections of the line or lines upon the three reference planes as they might appear in space, and the other showing the projections as they appear when drawn on a flat surface. The line *ab* is located in the 1st angle, and its projections on the reference planes are found by first locating the projections of the extremities of the line and then joining, by means of straight lines, the points which have just been located. It should be noticed that the point *a* projects upon the reference planes giving the points a^v, a^h and a^p. The projection of the point *b* upon the reference planes gives the points b^v, b^h and b^p. Joining the points a^v and b^v, a^h and b^h gives the projection of the line *ab* upon *VP* and *HP*; but since the line *ab* is taken parallel to *VP* and *HP*, it is perpendicular to *PP*, and, therefore, its projection upon *PP* is a point.

Fig. 4 shows the projections of a line *ab* which makes an angle with each of the three reference planes and intersects *VP* and *HP* in the points *a* and *b* respectively. Projecting the point *b* upon *VP* and joining this point b^v with *a* by means of a straight line gives the projection of the line *ab* upon *VP*. Similarly by projecting the point *a* upon *HP* and joining the points a^h and b^h gives the projection of

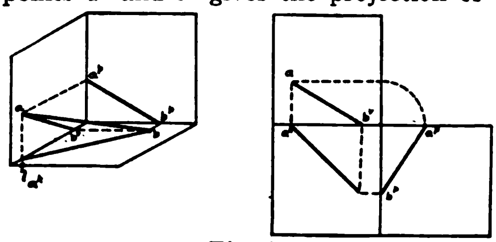


Fig. 4

the line *ab* upon *HP*. To obtain the projection of *ab* upon *PP*, it is necessary to project both the points *a* and *b* upon this plane and then, as was done in each of the previous cases, join these projected points by a straight line. It should be noticed that all points are projected vertically upon the various planes.

Fig. 5*A* is the projection of a straight line which is parallel to both *HP* and *PP*. It will be noticed that the line

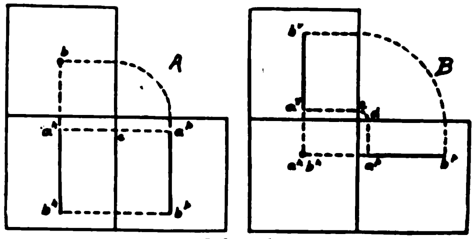


Fig. 5

will project upon *VP* as a point and the distance ca^p will be the actual height of the line above *HP*, while the distance ca^h will be the actual distance which the line is in front of *PP*.

Fig. 5*B* is the projection of a straight line drawn parallel to both *VP* and *PP*. Since the line is perpendicular to *HP*, its horizontal projection will be a point, while as in the previous case the distances da^p and ca^v will be the actual distance of the line in front of *VP* and *PP*.

Fig. 6 shows the projection of the plane *A* taken parallel to *VP* and perpendicular to *HP* and *PP*. In order to find the projections of a plane, it is necessary to

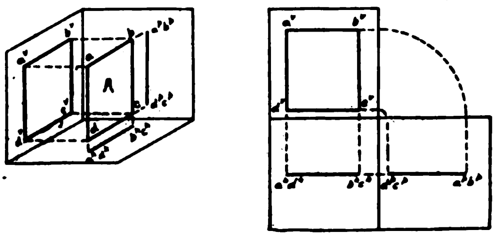


Fig. 6

find the boundary lines of the plane. It is true that a plane is of infinite extent, but since it is usual to work with but a portion of the plane, it is necessary to consider simply this limited area. The plane *A* is bounded by the lines *ab*, *bc*, *cd* and *da*. The projections of the points *a*, *b*, *c* and *d* give the projections of the four lines, and the projections of the four lines give the projections of the plane.

Since the plane is parallel to *VP*, its vertical projection will show the true size and shape of the plane. As the plane is perpendicular to both *HP* and *PP*, its horizontal and profile projections will be simply straight lines. This is, of course, true, since the points *b* and *c* project upon *HP* as a single point, and the points *a* and *d* project upon *HP* as a single point. Similarly the projections of the points *a* and *b* and *d* and *c*, upon *PP* are single points.

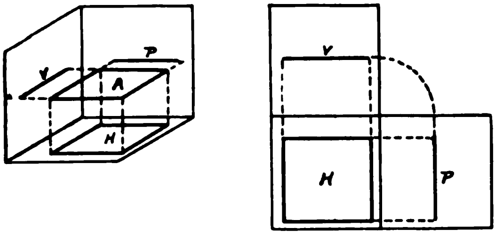


Fig. 7

Fig. 7 shows the projections of the plane *A* which is parallel to *HP* and perpendicular to the other two reference planes. As in the case of Fig. 6, the plane projects in its true size and shape upon the plane to which it is parallel, while its profile and vertical projections are but straight lines. For the sake of simplicity all lettering which can, has been omitted, and the projections of the plane *A* are designated simply by means of the letters *V*, *H* and *P*.

Fig. 8 shows the projections of the plane *A* which is inclined to *HP* at an

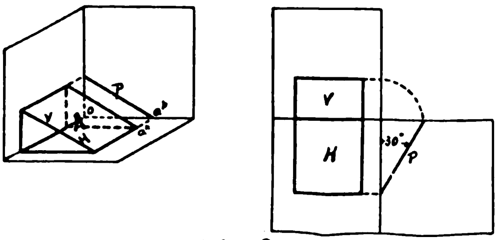


Fig. 8

angle of 30 degrees, and which is perpendicular to *PP*. It will be seen that the plane cuts *HP* and *VP* in straight lines, and these straight lines are called the horizontal and vertical traces of the

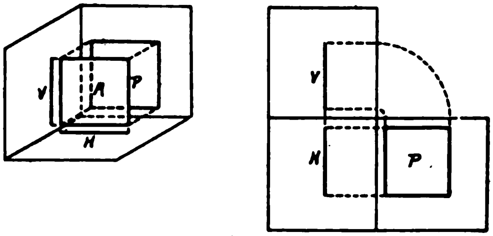


Fig. 9

show the true size and shape of the plane *A*, although the projection upon *PP* shows the true length of the plane, and the horizontal and vertical traces show the true width of the plane.

Fig. 9 shows the projections of a plane *A* which is parallel to *PP*. It will be an interesting and instructive exercise for the student to actually draw the projections to scale, and for this reason the location of the plane with respect to the various reference planes is given. The plane *A* is bounded by lines each of which is $\frac{15}{16}$ in. long and which make angles of 90 degrees with each other. The plane is located $\frac{3}{4}$ in. in front of *PP*, and its lower and left-hand boundary lines are each $\frac{1}{8}$ in. above and in front of *HP* and *VP* respectively. In drawing the projections of this plane or any other plane or figure, it is simply necessary to draw the projections as they would appear drawn upon a flat surface.

Fig. 10 is given to show the method of representing planes in descriptive geometry. This method does not require a profile plane, and the projections are not as self-evident as in the case of working drawings. The plane *Q* is inclined to both *VP* and *HP*, and intersects these planes in the lines *VQ* and *HQ* respectively. These lines are the vertical and horizontal traces of the plane and each trace makes an angle with the *GL*. The vertical trace is inclined at an angle of 60 degrees with the *GL*, and the horizontal trace makes an angle of 30 degrees with the *GL*. In descriptive geometry the

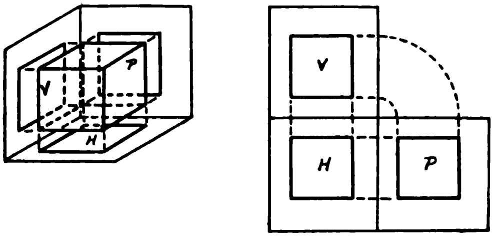


Fig. 11

planes are usually assumed to be of infinite area, but in mechanical drawing the planes are of limited area, since they form the faces of some actual object.

Fig. 11 shows the projections of a cube whose base is parallel to *HP*, and which has two faces parallel to *VP*, and two faces parallel to *PP*. Each of the faces of the cube is a square, and it should be noticed that each of these faces is a plane of limited area. To find the projections of the cube, it is simply necessary to find the projections of its faces, and the projections of its faces are found in the manner just described, when finding the projections of a plane of limited area. Because of the location of the cube with respect to the three reference planes, each of the projections of the cube will show the true size and shape of its faces. Since this is a treatise on Mechanical Drawing, the vertical projection of the figure should be spoken of as the front view, the horizontal projection as the plan and the profile projection as the side view.

Fig. 12*A* shows the projections of a parallelopiped. Each of the sides of this object is a rectangle and its ends are squares. The figure is so placed that its ends are parallel to *PP*, and two of its sides are parallel to *HP*, and two of them are parallel to *VP*. Because of the location of the object, it is evident that the projections of its sides and ends will show these sides and ends in their true size and shape.

the projections of a right cylinder. The axis of this cylinder is perpendicular to *VP*. The cylinder will project upon *HP* as a rectangle and similarly upon *PP*. The vertical projection or front view of the cylinder will show the true size and shape of the cylinder, and will be a circle.

Fig. 13 shows the projections of a pyramid whose base lies in *HP* and whose axis is perpendicular to *HP*. The base of this pyramid is a square, and each of its faces is a triangle. Since the base lies in *HP*, its horizontal projection will show

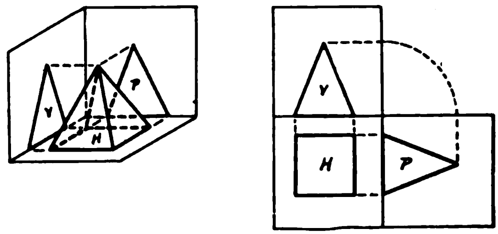


Fig. 13

its true size and shape, but as all of its faces are inclined to *VP* and *PP*, these faces will not appear in their true size and shape in either the *VP* projection or the *PP* projection.

To obtain the true size and shape of the faces of the pyramid, it is necessary to project the face upon a plane which is parallel to the face.

Such a plane is called an auxiliary plane. Auxiliary planes are very largely used in descriptive geometry, since by projecting the object upon such planes, it is possible to obtain a view of one of

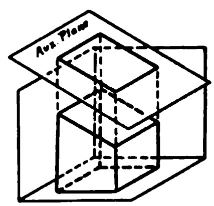


Fig. 14

its faces in which none of the lines are

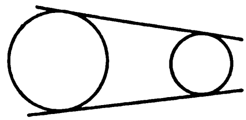


Fig. 15

object will project in their true size and shape, but the upper face being inclined to both *VP* and *HP* at an angle other than 90 degrees will not appear in its true size or shape in any of the ordinary views. However, by the use of a plane parallel to this face, called the auxiliary plane, it is possible to obtain a projection of the face which will show its true size and shape.

The authors of this department, believing that the only way to successfully learn mechanical drawing is by actually doing original work and by solving problems, have decided to include a certain number of study questions or problems at the end of each article. In some cases partial constructions of the problems will be given and the student allowed to

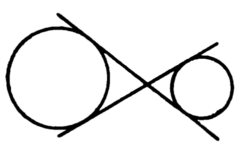


Fig. 16

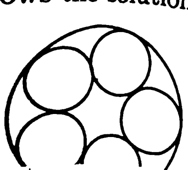
complete the solution. In other cases, however, the problem will be simply stated in words and the entire solution left to the student. It will be possible many times to solve the problems by "cut and try," or "short-cut" methods, but this should not be done, since each of the problems is intended to emphasize certain basic principles of drawing.

The problems which are given with this instalment are to be solved entirely by geometrical methods.

STUDY PROBLEMS

PROBLEM 3. *To draw a line tangent to two given circles exteriorly.*

Fig. 15 shows the solution of the problem, and the method of obtaining this solution is left to the student.



PROBLEM 4.—*To draw a transverse tangent to two given circles.*

Fig. 16 shows the solution of this problem.

PROBLEM 5.—*To inscribe within a given circle, five similar circles, the circles touching the given circle interiorly, and each other exteriorly.*

Fig. 17 shows the solution of this problem.

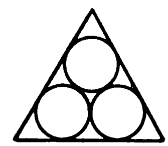


Fig. 18

PROBLEM 6.—*To inscribe within a given equilateral triangle, three similar circles, so that each of these circles will touch each of the other two, and also the sides of the triangle.*

Fig. 18 shows the solution of this problem.

The authors will be very glad to answer any questions which may occur to the readers, and to criticise any mechanical drawing work submitted, provided all communications are addressed to the Mechanical Drawing Department of the ELECTRICIAN AND MECHANIC, and return postage is enclosed.

The Calculation of Inductance

(*Concluded from page* 77)

the value of L one-half the length of the conductor in centimeters. This gives the value for very high frequency. If this is applied in the last example where $L=799.55$ cms. and $l=2 \times 3.1416 \times 15=94.248$ cms., we find that L^1, the high frequency inductance, is

$$L^1 = L - \frac{l}{2}$$

$$= 799.55 - \frac{94.248}{2}$$

$$= 752.43 \text{ cms.,}$$

which checks very closely with the value obtained directly from formula (2).

The above formulas and tables will be found very helpful in the design of high-

HOW TO PRODUCE THE ULTRA-VIOLET RAYS, AND SOME EXPERIMENTS WITH THEM

G. G. BLAKE

Any amateur who possesses a coil capable of producing a 1-in. spark can, without much trouble or expense, fit up and work an ultra-violet ray apparatus.

Fig. 1 shows a diagram of the apparatus: *A*, switch; *B*, battery; *C*, coil; *D*, condenser (or Leyden jar); *E* and *E* are two small steel rods; *F*, box of wood or cardboard; *G*, hole cut in the side of box; *H*, coil of stout copper wire.

The battery, coil and switch need, I think, no further description, so I will pass on to describe the condenser *D*. There are various ways of making this. The figure shows it made of a square piece of window glass 14 in. square, coated on each side with tin-foil, to within about 1 in. of the edge. This is best stuck on with shellac paste, made by dissolving shellac in methylated spirits, and it is just as well, while using the shellac, to coat the edges of the glass with it, so as to prevent condensation of the moisture in the air from settling on the glass, as it is so likely to do.

Another form of condenser which would serve the purpose almost equally well is the old-fashioned Leyden jar. A very serviceable one can be made out of a tumbler coated inside and out to within about 1 in. of its edge, with tin-foil, and the remaining exposed glass coated with shellac as in the last case.

Whichever form of condenser is used, one of the wires leading from the secondary of the coil *J* is connected to one coating of foil, *K* and wire J^1 from the other secondary terminal is connected to the other coating of the condenser *M*. *H* is a coil of stout copper wire about 4 in. in diameter and 10 in. long (see Fig. 2). It consists of only one single layer of wire. This should be quite uninsulated and of such a thickness that after it has been coiled into shape (round the body of a wine bottle, or anything cylindrical in shape) it will retain its shape when the bottle is afterwards removed.

The two ends of this coil, *P* and *Q*, are connected to the two coatings of the condenser by wires *N* and *O* respectively, and are also joined by wires *R* and *S* to the two steel rods *E* and *E*. These steel rods are made out of two pieces of stout steel wire about ⅛ in. in diameter, and the two ends *E* and *E* are nicely rounded with a file.

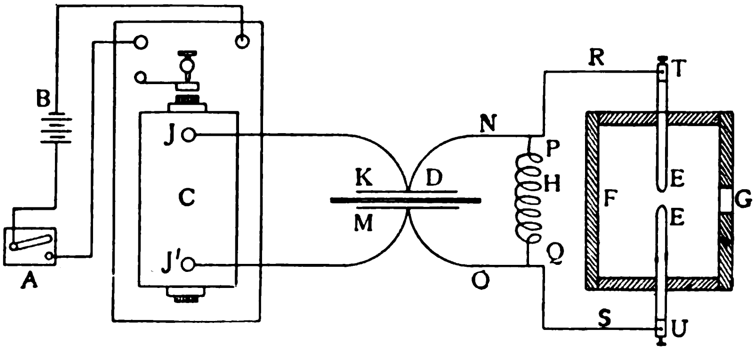


Fig. 1—Diagram of Apparatus

Box *F* can be made either of wood or cardboard. About 4 in. square is a convenient size (see Fig. 3). The steel rods *E* and *E* push in and out through holes in the sides of the box, so that the size of the spark gap between them can be regulated. On the other ends of the rods are soldered terminals *T* and *U*. *G* is a hole in the box 1½ in. in diameter, opposite the spark gap.

EXPERIMENT I

Procure a small piece of willemite (it is a natural silicate of zinc, any chem-

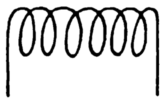


Fig. 2—Coil

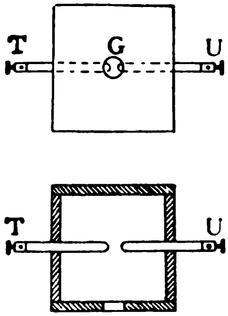


Fig. 3—Box

ist will probably be able to get this for you for a few cents) and place it in front of the opening of the box *G*, and in a perfectly dark room start the coil working. A bright blue spark will be seen between the rods *E E*, which makes a loud snapping noise, and the willemite will be seen to fluoresce a beautiful green color. If a small crumb of willemite be looked at under a microscope while it is fluorescing, it is especially beautiful. When a fairly large coil is used to work the apparatus, the willemite can be made to fluoresce, even when several yards separate it from the window *G*. If a piece of thin glass be now put in front of the opening *G*, the willemite will no longer fluoresce, but if a piece of quartz (say an old quartz lens from a pair of spectacles) be put in front of the opening, it will fluoresce quite as well as it did in the first case. This experiment proves the presence of the ultra-violet rays (which are invisible to the unaided eye), for if it had been the visible light rays which caused the willemite to fluoresce, the glass would not have stopped the fluorescence. And it also shows that whereas glass is opaque to the rays, quartz is quite transparent. Ice is also found to be transparent, and a small piece can be substituted for the quartz, with the same result.

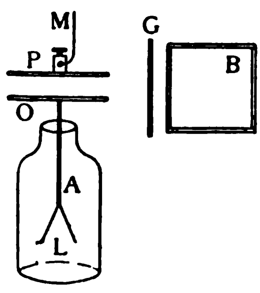


Fig. 4—Gold Leaf Electroscope

EXPERIMENT II

Several other substances also fluoresce under the action of the ultra-violet rays. Silicate of soda fluoresces blue, and it is especially noticeable with this chemical that the fluorescence continues for 5 or 6 seconds after the apparatus has stopped working. Should the reader happen to possess a platino-cyanide of barium X-ray screen, he will see that this will also fluoresce under the action of the ultra-violet rays.

EXPERIMENT III

Another proof of the existence of the ultra-violet rays produced from the spark between the steel rods is their power to discharge an electroscope. Fig. 4 shows a gold leaf electroscope charged either negatively or positively, so that the two gold leaves *L* are wide apart. *P* is a disc of brass the same size as the disc *O*,

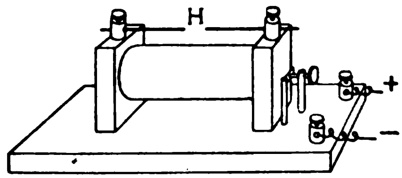


Fig. 5—Spark Coil and Gap

belonging to the electroscope, *P* is suspended by a wire *M* about 1½ in. above *O*, and is connected to the earth by wire *M*. A gas or water pipe makes a splendid earth connection. *B* is the ultra-violet ray box, and *G* is a piece of glass in front of the window between it and the electroscope. On the rays being generated nothing happens to the electroscope while the blue light coming through the glass passes between the plates *P* and *O*, but directly the glass is removed, and the ultra-violet rays are allowed to play on the air between the two plates, the air becomes a partial conductor, and all the electricity escapes from the electroscope to earth, with the result, of course, that the leaves close. A simple way of connecting up this experiment is to suspend plate *P* from a gasolier.

EXPERIMENT IV

This is another experiment which shows the action of the ultra-violet rays upon the air. A small coil is arranged as shown in Fig. 5, so as to have a spark gap between the secondary terminals, which is so arranged that it is just too great to allow a spark to pass when the coil is worked. If now the ultra-violet rays are allowed to play on the air in the spark gap, a spark will pass, showing again that the air becomes more conductive when under the action of the rays.

There is a great similarity between the ultra-violet rays, the X-rays, and the Gamma rays which emanate from radium. Any of these rays will discharge a charged electroscope, affect a photographic plate or cause willemite, and other substances, to fluoresce; all are invisible to the unaided eye, and they are all of them ether vibrations. Violet is the highest rate of vibration which our eyes are capable of seeing, and above this next comes the ultra-violet. These rays have only about the same penetrative power as ordinary light. Higher than these in the spectrum we come to the X-rays and the Gamma rays, both of these having wonderful penetrative power, the latter in particular. With a small quantity of radium (6 milligrammes) I find that the rays will penetrate through nine pennies, placed one above the other, and will cause distinct fluorescence on a piece of willemite. —*The Model Engineer and Electrician.*

THE DIVINING ROD

The United States Geological Survey states in Water-Supply Paper 255, entitled "Underground Waters for Farm Use," just reissued, that no appliance, either mechanical or electric, has yet been devised that will detect water in places where plain common sense and close observation will not show its presence just as well. Numerous mechanical devices have been proposed for detecting the presence of underground water, ranging in complexity from the simple forked branch of witch hazel, peach, or other tree to more or less elaborate mechanical or electric contrivances. Many of the operators of these devices, especially those who use the home-cut forked branch, are entirely honest in the belief that the working of the rod is influenced by agencies—usually regarded as electric currents following underground streams of water —that are entirely independent of their own bodies, and many people have implicit faith in their own and others' ability to locate underground water in this way. In experiments with a rod made from a forked branch it seemed to turn downward at certain points independent of the operator's will, but more complete tests showed that this downturning resulted from slight and, until watched for, unconscious muscular action, the effects of which were communicated through the arms and wrists to the rod. No movement of the rod from causes outside of the body could be detected, and it soon became obvious that the view held by other men of science is correct—that the operation of the "divining rod" is generally due to unconscious movements of the body or of the muscles of the hand. The experiments made show that these movements occur most frequently at places where the operator's experience has led him to believe that water may be found.

The uselessness of the divining rod is indicated by the facts that it may be worked at will by the operator, that he fails to detect strong water currents in tunnels and other channels that afford no surface indications of water, and that his locations in limestone regions where water flows in well-defined channels are no more successful than those dependent on mere guess. In fact, its operators are successful only in regions in which ground water occurs in a definite sheet of porous material or in more or less clayey deposits, such as pebbly clay or till. In such regions few failures can occur, for wells can get water almost anywhere.

The only advantage of employing a "water witch," as the operator of the divining rod is sometimes called, is that crudely skilled services are thus occasionally obtained, for the men so employed, if endowed with any natural aptitude, become through their experience in locating wells shrewd, if sometimes unconscious observers of the occurrence and movements of ground water.

A copy of the report may be obtained free on application to the Director of the Geological Survey, Washington, D.C.

NOTES ON DRILLS, REAMERS AND BROACHES

GEORGE GENTRY

One of the most important factors in the use of the ordinary twist drill is to remember that it is not a reamer, nor was it ever intended to be used to enlarge a hole smaller than itself, unless there be a reasonable difference in their sizes. All the work done by a drill of any kind should be carried by the bottom cutting edges or lips equally, the clearance and rake of which are in accordance with the conditions in such as a lathe or planer tool. This is shown on Figs. 1 and 2, and it should be noted that the extremes of these edges *aa*, Fig. 2, must not be allowed to become worn away, otherwise the edges of the flutes will take some of the work, and the drill, sooner or later, seize and break. If it does not break, the flute edges, not being adapted for cutting, as in a reamer, will rapidly wear, thus throwing the drill out of caliber, and making it useless so far as the worn portion is concerned. The lips should always be of the same length and to the angle given. It may not be generally known that the peripheral portion of a twist or straight-fluted drill—indicated by *bb*, Fig. 1—is, even in the smallest sizes, backed off, as shown on the point elevation, Fig. 2, leaving very little surface to resist wear, as mentioned above.

FIG. 2.

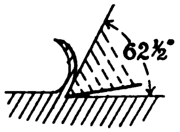


FIG. 3.

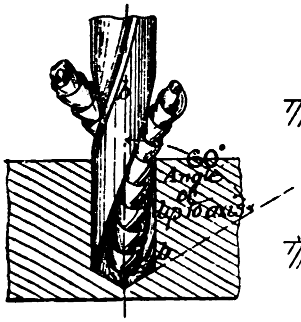


FIG. 1.

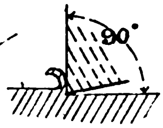


FIG. 4.

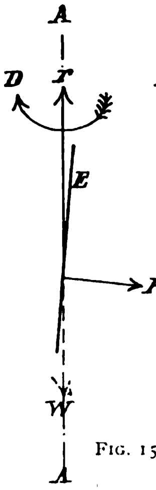


FIG. 15.

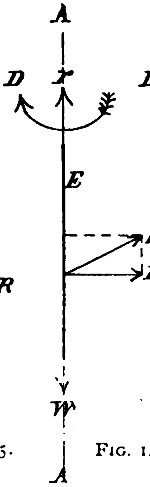


FIG. 14.

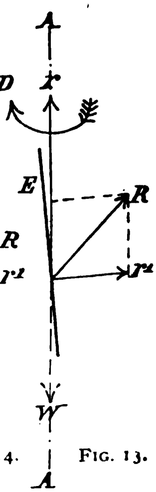


FIG. 13.

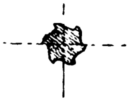


FIG. 8.

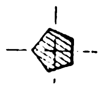


FIG. 11.

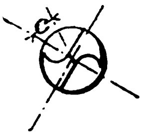


FIG. 5.

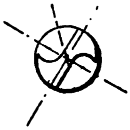


FIG. 7.

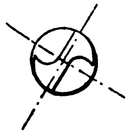


FIG. 6.

FIG. 7.

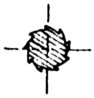


FIG. 9.

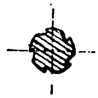


FIG. 10.

FIG. 12.

Suppose it is wanted to enlarge a hole ⅛ in. in diameter to ¼ in. This can be done by means of a ¼-in. drill with safety, without putting any undue strain on the flute edges; but the resultant ¼-in. hole is not so likely to be cylindrically true, on account of the point not coming into play and steadying the drill, neither can the exact position of the hole be maintained, as in the case where reamers are used.

Fig. 3 is an enlarged section of a twist drill cutting edge, showing how the rake is adapted for cutting wrought and cast iron, steel, copper, aluminium, or other tough and stringy metals. Fig. 4 is the corresponding section of a straight-fluted drill, showing the absence of rake. It is this feature which makes the latter drills so useful for brass work, and especially for thin plate work in any metal, as the drill is not able to jump forward, which is usual with a twist drill just before it clears its way through the metal. This trouble arises from the fact that the direction of the twist of the flutes is right-handed (*i.e.*, the same as the direction of a right-handed screw thread, which must be so, or the cutting edges would have a negative rake and would scrape rather than cut), and the tendency of the drill actuated by the feed is to force an 8-shaped hole and to follow the same, screw fashion. It will be shown later on why the flutes of a twist reamer have to be left-handed to avoid much the same tendency. The outline of the flute surface and periphery of the drill, as shown on the point elevation in Fig. 2, will clearly demonstrate the uselessness of a fluted drill for cutting with the flute edges, and compared with Fig. 8, which is a section of a fluted reamer, this will be still more clearly seen.

Reverting to Fig. 3, it will be noted that the angle of rake is 62½ degrees to the plane of the cut. This generally applies to twist drills only, when they have not been worn away much, as it is usual to increase the angle of the twist from that given above at the point to about an angle of 72½ degrees to the same plane at the shank end; the object being to increase the cross-sectional area of the drill near the shank for purposes of rigidity, and to resist torsion, and this without diminishing the cross-sectional area of the flutes. It is obvious that the sharper the angle of the flute in relation to the axis the less metal is removed from the body of the drill to excavate it, and made, and one method of obtaining the advantages of the increase in same is gradually to alter the angle of the milling cutter in relation to the flute so as to cut a wider groove at the top end, and at the same time a shallower one, thus obtaining a thicker web in center without any decrease in the cross-sectional area of the groove or any increase in the total cross-sectional area of the drill itself; the center of the web being regarded as the weak point to be protected against torsion.

In reference to grinding the cutting edges, it must be borne in mind that just sufficient backing off of the point facets is necessary only, and that too much clearance causes the drill to cut rankly and almost as badly, from a practical point of view, as if no clearance was given at all. The best indication for grinding is to observe the angle of the center cutting edge in relation to the lips of the drill. Fig. 5 gives this correctly at *c*, while Fig. 6 shows the angle formed (approximately) by too little or no clearance, and Fig. 7 the reverse, or too much clearance; in short, the drill is here too sharp to maintain an even cut with sufficient feed to make it cut at all. (Note that the thickness between the lips is shown greater than necessary for good cutting to accentuate this angle in these views.)

Readers may have found difficulty in grinding very small twist drills, such as from Nos. 65 to 80. It is not necessary to round off the clearance in such small drills as these, a flat backed-off clearance to the lips being sufficient. The following method with a little practice will answer the purpose. First accustom yourself to holding a wire, with both hands on a rest, to the periphery of a revolving stone, which must run at high speed away from you, so that the resultant flat surface ground is approximately at an angle of 60 degrees to the axis of the wire, with a slight inclination of the end of the wire nearest you to the right to give clearance.

revolve the drill in your fingers, and treat the opposite side the same, giving the same period and compression to the touch. With a little practice, this is so efficient that one cannot detect with a powerful glass the slightest difference in the length of the lips in quite the smallest drills.

When using small drills, do not try the watchmaker's method of using a drill arbor and bow. This requires a great deal of practice and an extra special sense of touch. Mount the drill in the lathe chuck (preferably a three-jaw scroll chuck, which must, of course, run true). If the drill is too fine for the jaws to grip, take a strip of blotting-paper or newspaper about ⅜ in. wide by 1 in. long, moisten slightly, and roll it on the drill shank between the thumb and first finger until the mass of paper is quite tight. This will be found an effective packing, and in the writer's experience, a drill so mounted will run true nineteen times out of twenty. Feed with the poppet head with back center removed; and if the work is small, back it up with a flat piece of hard wood. Do not support the work in your hand, but pack under so that the drill takes no weight. Run the lathe at the highest possible speed, avoid vibration, and use oil as lubricant for all metals. Only practice and familiarity with your lathe will enable you to feel the proper feed necessary for fine drilling. In any case do not try to drill holes below .04 in. with a hand brace. The writer thinks—from bitter experience—that it is well-nigh impossible. Better results can be obtained with an Archimedean drill brace using the usual spade-pointed drills, but great care is necessary with all hand tools. The above hints are given assuming the reader does not possess the luxury of a high-speed sensitive drilling machine, which is doubtless the best tool for actuating fine fluted drills.

REAMERS AND BROACHES

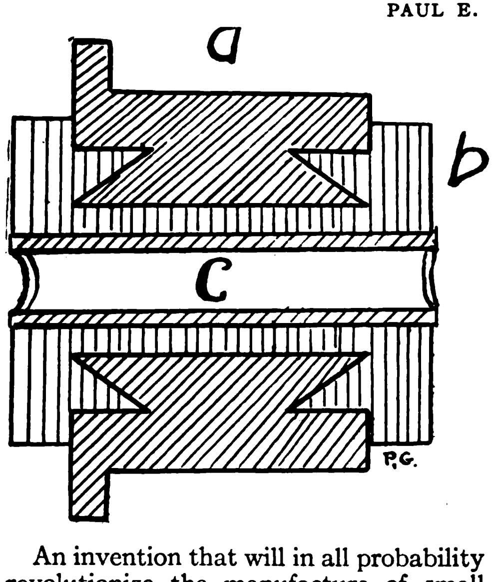
Reamers and broaches are tools for enlarging and truing to a gauge diameter parallel reamers for about one-sixth of their length from the point upward. Fig. 8 is a section of the flutes looking on the point of the latest and best form of six-fluted reamer, showing the shape of flute and backing off of cutting edges. This latter is usually done on a special grinder and constitutes the final process of gauging the tool to size. Fig. 9 is also a good form of multi-fluted reamer, which necessitates the turning of the original blank to gauge and very careful fluting, as it will be seen at once that any extra depth of flute will rob the tool of its diameter, and any shallowness obviates its cutting capacity. Fig. 10 shows the old original form with five flutes, which retains its gauge diameter and wears well; but is not so efficient a cutter as the foregoing, on account of the lack of backing off, although for strength it is far and away superior. Fig. 11 is the usual section for broaches, which are always made with five cutting edges. In addition to these, square section taper reamers (or more properly broaches) are largely used for cutting taper-pin holes in machinery and for enlarging roughly holes in metal plates for taking wood screws. These usually have tapered square shanks and are adapted to fit carpenters' bit braces.

The best design of reamer for general work is that shown in Fig. 12 with left-hand twist flutes, although this is not the general kind sold in tool shops. The straight-fluted variety is more generally found in stock. This is probably due to the fact that straight flutes are easier to produce and do not require the extra feed necessary in milling machines for their production. A glance at Figs. 13 and 14 respectively will demonstrate the superiority of the left-hand twist flute as against the straight. It will be seen that, for any one cutting edge, there are two resistances r and $r1$, acting respectively along the axis AW of the tool and at an angle of about 90 degrees to the edge. The first is that against the weight proximated as equal to $r1$, and their resultant R, in the direction shown, is one-sixth of the total resistance, forcing the reamer out of the hole and preventing its seizing. In Fig. 14 the resistance r is considerably less, as E is much nearer in direction to that of rotation D, and in the same as that of W, hence R, the resultant, is not so effective in freeing the reamer, and as E is in the same direction as W, unless great care is taken the tool will chatter and form an approximate hexagonal hole, especially if used in thin plate work. Fig. 15 shows that with a right-hand flute the inclination E being with the direction of rotation D, r is practically eliminated and $r1$ becomes R. This form would undoubtedly seize and very soon break, as the total resultant tends to draw the tool deeper into the hole.

Broaches are made very slightly taper their whole length, and are gauged at the upper shoulder or maximum diameter to Stubb's steel wire gauge. They are very handy tools, as they will cut in either direction, and will rapidly enlarge holes in plates using a reciprocating rotary motion with a fairly long stroke. If habitually used one way and they become dull on the edge, a reversal of motion will often be an improvement, and will have the advantage of setting the edge for the first direction. They are used largely in clockwork, and their taper is so slight that in plate work it can be disregarded. These tools are generally actuated by a handle provided with a chuck adapted to take several consecutive sizes.—*The Model Engineer and Electrician.*

AN UNIQUE COMMUTATOR

PAUL E. GOLDMANN



An invention that will in all probability revolutionize the manufacture of small commutators and cause the passing of the present taper ring method of con-

placing the bars (with mica between) in a circle and putting a circular clamp around them is followed in this invention, and if necessary this combination is put into a lathe and the tapered recesses "trued up."

The partly finished commutator is then placed in a mould and a bushing of the requisite size is placed in the exact center. The space between the exterior of the bushing and the interior of the commutator, including the tapered recesses, is then filled in with this special compound. Heat and pressure are applied, and these melt and compress the powder into a solid mass.

This mass upon cooling hardens and forms an insulating binder, serving the same purpose as the steel and mica rings used in the old method of construction. This substance when hard can be cut and polished the same as rubber or fiber.

The parallel lines designated by B

SOFT-SOLDERING, TINNING AND SWEATING

OWEN LINLEY

What is generally termed soft-soldering, in order to distinguish it from hard-soldering, or brazing, is one of the most useful processes for the amateur; but he hardly ever performs it well, his joints usually being clumsy and leaky. It is, in reality, one of the simplest processes, and requires hardly any skill, if once clearly understood and a correct start made.

The first thing to be considered is the outfit, and in this the most important thing is the copper-bit, or soldering-iron, as it is sometimes called, and here we come to the first mistake usually made by the amateur, who generally has a bit far too small to be of any practical use. It would puzzle some professionals to do good work with the tiny bits used by some amateurs. What may be termed the ordinary standard bits are shown in Figs. 1 and 2, where it will be seen that the straight bit has two different kinds of ends, and the flat end is best if it is not required to work into corners, as it conveys more heat to the work. The hatchet-bit is more convenient to use on long seams, and an adjustable bit can be obtained which combines the two. Within certain bounds, the larger the bit the better and sounder will be the work produced by it, provided it is properly used. A bit, the body of which is from 1 in. to 1¼ in. in diameter, will give good results without being unduly heavy.

Having settled on a bit, the next thing to consider is the means of heating it, and the best, of course, is one of the stoves made for this purpose. Next to this, an ordinary gas-stove can be used. If no gas is available, a forge or ordinary domestic fire can be used.

We now come to one of the most important matters in soft-soldering, and that is the tinning or coating the end of the bit with solder, for unless this is properly done, it is almost impossible to produce good work. It is always best

prevents its getting burned or roughened, which stops the solder running properly. Another thing is that if a good supply of heat is in the body to start with, the end remains hot so much longer. In order to tin the bit, some flux is necessary to remove the oxide produced by heat, and there are several of these which will be described later; but as far as tinning the bit goes, the old-fashioned "killed spirit," although objectionable in some ways, is perhaps the most efficient in the hands of a beginner. It is prepared thus: Get some spirits of salts, which can be

Fig 1

Fig 2

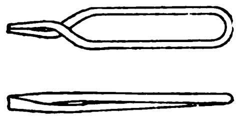


Fig 3

Fig 4

obtained at any chemist's or oil-shop, put it in a jar, and drop a few zinc cuttings in it. This should be done in the open air, as it gives off poisonous fumes. The spirit, or, to speak more correctly, acid, will dissolve the zinc, and then more should be added, until it remains undissolved at the bottom of the spirit, and bubbles of gas are no longer given off. The objection to this preparation is that it rusts iron or steel, and therefore cannot be used under certain circumstances, as will be explained later, and it gives off a vapor that attacks bright work or tools in a workshop; so it is best, when it is killed, to pour it off into a wide-mouthed jar or bottle, which can be closed with a bung when not in use.

There are several varieties of soft-solder; but that mostly used for sheet-metal work is called tinman's solder, and small block of sal ammoniac, about 2 x 2 x 1 in. high, and with the upper surface formed slightly hollow, while others use a piece of ordinary brick, which is useful if Fluxite is used to tin the bit. This preparation is excellent, and very handy to use, and does not cause rust; but is not so powerful as the spirit. It is a good thing to have a piece of canvas or sacking handy, with which to rub the body of the bit clean, and this is more especially the case if it is heated in a fire, and is not very clean, as any soot or particles of coal adhering to it give off smoke, which causes the end to oxidize. Some workmen are very particular about this, and there is no doubt it is worth attending to, and also if a fire is used, it should be kept as free from smoke and flame as possible. The end of the bit should now be filed up smooth to whichever shape is required, and the extreme corners should be rounded off with the file, as this helps to keep it smooth.

The bit is now heated as already described; the whole body, not merely the end, being heated; and if a fire is used, it is best to let the end pass through it into a cooler part. The bit should be hot, so that the solder melts as soon as it is applied to it; but as it will not do this until the bit has been tinned, a certain amount of guesswork will have to be used at first; but it should never be allowed to get red-hot. When the bit is considered to be hot enough, it should be withdrawn from the fire, the end rubbed bright with the file, then dipped in the spirit, and the solder applied to it. These operations should be performed as quickly as possible, and if all is right the solder should unite to the end of the bit, and this can be assisted by rubbing it on the piece of sal ammoniac or brick. The operation may have to be repeated two or three times, but should be kept up until the whole of the end of the bit is covered with solder.

The bit being properly tinned, we will now consider applying it to the work. It must be remembered that the flux should always be put on the work before the bit is applied to it and has made it hot. By this means the oxide is prevented from forming at the beginning of the job. In new work where the surface of the metal is clean, care should be taken to be sparing with the flux, and only apply it where it is wanted, or the melted solder will follow it, and make a wide, unsightly seam. One advantage of Fluxite is that, being a paste, it is not inclined to run about on the surface of the work as spirit does.

The best thing with which to apply the flux is a piece of cane with the end cut to a point, and pounded with a hammer so as to form a kind of small brush. In running joints or seams, the bit should be moved slowly along the work, so that the heat can soak in, and should never be rubbed backwards and forwards, as this makes a rough-looking joint, in fact, the appearance of the joint is a great indication of its soundness, as its surface should be smooth and shining; but if, on the other hand, the solder is rough, and seems inclined to stand up in little spikes, it is a sign that the bit was not hot enough, or it was applied too hastily to the seam.

Of course, there are many ways of using a bit, and much depends on the kind of work, and whether its appearance matters or not. In some cases it is best to use a pyramid-shaped bit, and draw one of the corners (not the point) along the seam; but in working inside a piece of work, this cannot always be done, and a chisel-ended bit has to be used. As the bit is moved along the seam, solder can be fed to it; but this is apt to make a clumsy joint in the hands of a beginner, and in small work, where neatness is wanted, it is sometimes best to pick up some solder with the bit, and apply it to the work. Some have a globule of solder in the hollow in the block of sal ammoniac, and take up what is wanted from this; but it sometimes happens that the whole globule will unite to the bit, and perhaps a better way is as follows: Put a little flux on a piece of clean tin, and apply some solder to the bit, and let it form a blot on the tin, and from the edge of this blot can be picked up exactly the amount of solder required, as you would take up some oil-paint from a palette.

The bit has to be retinned from time to time, so as to keep it in good condition, and the edges slightly rounded, as the frequent dipping in the spirit, instead of rounding these as might be expected, has the opposite effect, and makes them stand up sharp and ragged. If trouble is experienced by the solder's running where it is not wanted, it can be stopped by painting the work in those parts with a mixture of size and lampblack; but this is seldom necessary if care is taken with the flux.

It is difficult to get solder to flow over a gap (even if it is very small), and in joining two sheets of metal with a plain lap-joint (not folded) the heat of the bit causes the edge of the upper sheet to buckle slightly, so that it is difficult to keep it down close on the lower one. This may be prevented thus: Set the edge of the upper sheet slightly, as in Fig. 4, where it is shown somewhat exaggerated, and this should be done with a mallet—not a hammer, as this would stretch the edge of the metal.

In repairing old tin work, all rust and scale should be removed by a scraper, which is best made out of a three-square file that has had the cuts ground off it. For this class of work spirits of salts are best; but the work should be well washed after it is finished, or rusting will set in.

What is known as sweating is joining two pieces of metal by external heat, the surfaces of which have been tinned or coated with solder. A good example of this is the sweating of a union on to a brass or copper pipe. In this class of work, the first thing to do, if a sound joint is wanted, is to make certain that the pipe does not fit too tightly in the union, so as not to leave room for the solder, and this applies to any work of this kind, such as sweating a collar on a spindle, etc. The inside of the union must now be tinned thus: Make a spatula out of a piece of brass wire, flattened at the end and tinned with solder; put some flux inside the hole in the union, and hold it by a wire clip over a Bunsen burner or gas-stove until it is hot, and then put a piece of solder inside, and when it melts, spread it about with the spatula. The end of the pipe can be tinned the same way, and, while hot, wiped round with a piece of rag to spread the solder. Some flux should be put on both, and they should be heated together, and one inserted in the other, and held in the flame until they are united. As you cannot see inside a sweated joint, it is somewhat difficult for a beginner to tell if it is sound or not.

If all is right, the end of the solder should melt at once, and appear to be sucked into the joint.

In some cases pieces of work can be pinned or riveted together after the surfaces have been tinned, or spring-clips can be used to hold the work together, and these are easily made, being about 1/8 in. wire, flattened at the ends and bent as shown in Fig. 3, and they are very useful for holding small pieces of work.

Where clips or rivets cannot be used, it is sometimes convenient to hold pieces of work together with what is known as binding wire, which can be obtained at most ironmongers. It is a very soft annealed iron wire, and being black from the softening, if the flux is kept away from it, solder will not adhere to it.

A blowpipe can be used for tinning and sweating work, but is much inferior to the flame of the Bunsen burner, and the results are not as certain. In the case of work that is too large to be heated by a burner of this size, an ordinary gas-ring is useful. The best flame for this class of work is an upright Bunsen burner, and these can be bought or easily extemporized thus: Take a piece of brass tube about 5 in. long, and 5/8 in. in diameter. About 1/2 in. from one end, file two notches, and then pinch that end together, so that it just fits on an ordinary gas-burner.

Turn the gas on, and light it from the top, and if all is right, the flame should deposit no smoke on a piece of bright metal held over it.

If it does so, it is not getting enough air, and the notches should be enlarged until the flame is smokeless. The gas must not light inside the tube, and if it persists in doing this, it shows it is getting too much air. A piece of thin metal bent so as to clip round the tube can be used to regulate the amount of air that comes in by the notches. These burners are very useful for a variety of purposes, such as tempering, etc., and can also be used for heating the soldering bit if a stand is made to support it.

In some cases, especially in sweating

AN INVESTIGATION OF EXPLOSION-PROOF MOTORS

The term "explosion-proof," as applied by the Bureau of Mines to an electric motor, refers to a motor inclosed by a casing so constructed that an explosion of a mixture of mine gas (methane) and air within the casing will not ignite a mixture of the same gas surrounding the motor. There are two classes of motors so constructed: First, a totally inclosed class built strong enough to withstand high internal pressures and so designed that the efficiency of all inclosing covers can be satisfactorily maintained; second, a class provided with relief openings or valves designed to relieve the pressure of an explosion within the motor casing and to cool any products of combustion discharged through the valves.

A satisfactory motor of the first class is much more expensive to build than an equally safe motor of the second class. For this reason, attempts to make motors explosion-proof have been confined chiefly to motors of the second class.

The function of explosion-proof devices for electric motors is to reduce below the ignition point of gas (methane) the temperature of any flames that may be discharged from the motor casing. The temperature reduction is effected by removing the requisite amount of heat from the flames during their passage through the devices. Various plans have been proposed and developed for thus removing heat from the products of explosion. The principle of the Davy safety lamp has been the basis of most of the protective devices designed for explosion-proof motors. The application of this principle consists in causing the discharged gases to pass over or through metallic plates or screens which by conduction remove the heat from the gases. In some types of devices the cooling effect of expansion is also utilized.

For the sake of simplicity, the means used to cool incandescent gases will be termed, "Protective Devices," whether they consist of valves, layers of gauze, or metal plates.

The investigation described in bulletin No. 46, was undertaken by the Bureau of Mines as one of several investigations having for their purpose the ascertaining of methods for lessening the risks attending the use of electricity in mining.

The Bureau began this investigation by sending a circular letter to manufacturers of electric motors for mine service, stating that the Bureau proposed to make tests of electric motors designed for operation in the presence of gas (methane) in order to determine their suitability for such service. This letter was sent to all manufacturers whom the Bureau believed would be interested in the proposed tests. Five motors were submitted for test, no two being protected in exactly the same manner.

In this report the results of tests are related to the various types of protection employed, which are described in detail.

According to the definition of an explosion-proof motor, such a machine can presumably be safely operated in an atmosphere containing gas (methane) under conditions most conducive to explosion, provided that the protective devices with which the motor is equipped are in good condition and in their proper places. In conducting the investigation, an effort was made to produce conditions that would probably introduce the greatest elements of danger. In the earlier tests especially, and to some extent in subsequent tests, it was not evident just what the most dangerous conditions would be.

Copies of this Bulletin may be obtained by addressing the Director of the Bureau of Mines, Washington, D.C.

Bronzing Brass

Mix 1 oz. of flour of sulphur and ¼ lb. of pearl ash, and put in an iron ladle over a good fire. Keep stirring until it is a well mixed reddish-brown mass, and then turn out on a flat stone. When cold, pour on it 3 pts. of boiling soft water, and, after standing for some time, pour off the clear liquid and keep it for use. The article to be bronzed should be carefully cleaned with dilute nitric acid and then hung in the liquid until dark enough. To make the coating more permanent, the article should, after having been dipped once, be washed and dried, and again placed in the bronzing solution.

A D'ARSONVAL GALVANOMETER

PERCY W. BAKER

The following is a description of a d'Arsonval galvanometer, with scale and lamp, which I have just made, and with which I have obtained some very good results. To construct a similar instrument, first obtain a piece of wood 2 ft. x 6 in. to form the base for the galvanometer and lamp, which are fixed at the two ends. Next get a piece of brass rod bent and fixed to the end of the base, as shown in Fig. 2. At the end of this a nut is soldered to hold the adjusting screw for the coil, Fig. 2, which must come exactly over the center of the magnet to allow the coil to swing within the magnet poles without touching either side. The coil frame is made of beech wood, Fig. 6, and is wound with eight layers of No. 42 s.c.c. wire, well soaked in paraffin wax, and the two ends are fastened to two brass pins, one of which is fixed at each end of the coil. The top pin is then fixed to the adjusting screw at the end of the brass rod by a piece of silver wire (the finest that can be obtained) to allow the coil to swing freely within the magnet poles. The bottom pin is then fixed to a pin in the base in the same manner, except that the silver wire used for connecting should be twisted into a spiral, so as to give the coil easier movement, Fig. 4. Near the top of the coil the small mirror is placed, but care must be taken to leave room for the clamp, Fig. 5, which holds the coil in place when it is not in use. At the other end of the base the lamp is attached in the following manner: First obtain a piece of brass rod and fix it to the base Fig. 1, for the lamp to swing on. This consists of a round tin with a hole

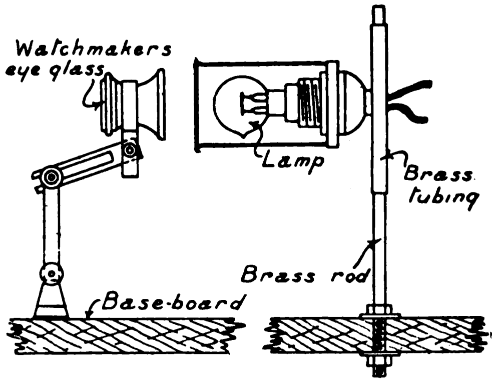
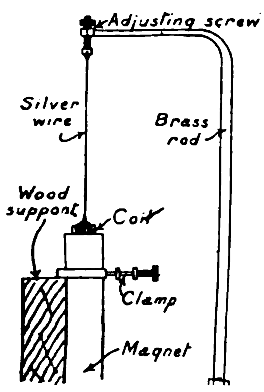


Fig. 1

cut in the end to fix it to the lamp-holder, which is one such as is used for ordinary electric lamps. To the connecting-posts inside the holder, connect two pieces of copper wire, which are then connected to a 4-volt 4 c.p. Osmi lamp, Fig. 1. A small hole about 3/8 in. in diameter is now cut in the lid of the tin to allow the light to shine on the mirror. Between the lamp and the coil a watch-maker's eyeglass is fixed, Fig. 1, which can be



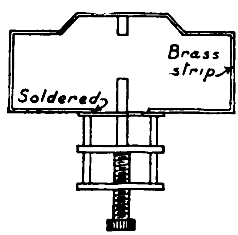
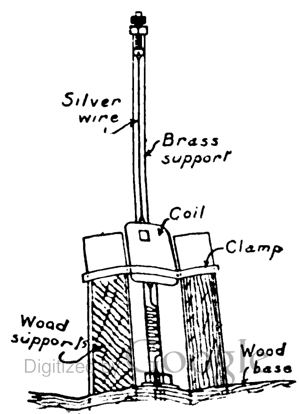


Fig. 5.



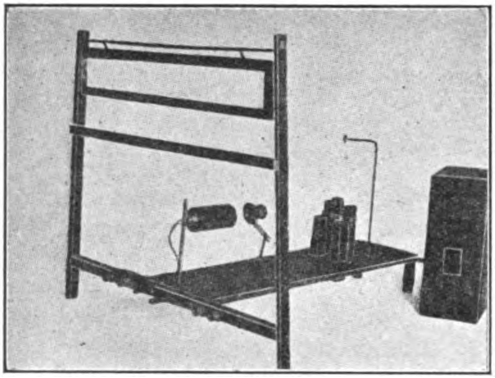
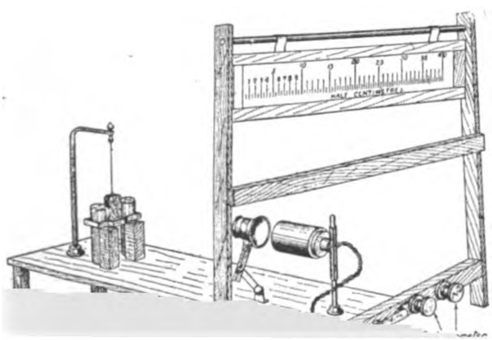


Fig. 3

adjusted so as to focus the lamp on the mirror and so adjust the reflection on the scale.

The scale, Fig. 7, is made of transparent paper marked off in half-centimetres, and is suspended to a brass rod which is fixed to the two uprights which hold the base in position, Fig. 7. Along the bottom bar to which the base is fastened, there are the connecting terminals for the battery and galvanometer, each of which has a switch; the one for the galvanometer being used in the place of a tapping key. The mirror on the galvanometer will have to be attached after the scale and lamp are in position, because it will require tilting at an angle, so as to reflect the image of the lamp on the scale. This can be fixed in position with thick shellac varnish, and then allowed to dry.

This instrument, if made as described, a 1,000,000th part of a volt should give



one millimetre deflection on the scale. To obtain a 1,000,000th part of a volt, get a piece of copper and constantan wire, and solder two ends together. This forms a thermo-couple, the voltage of which is 0.0004 of a volt for a rise in temperature of 1 degree C. Next get some water, the temperature of which is 1 degree C. above the temperature of the room in which the thermo-couple is located. Connect the remaining end of each wire to a terminal, and allow the spot of light to come to rest. Then plunge the soldered ends of the wires into the water, and a deflection of about 36 millimetres should be obtained.

It should be mentioned that the photograph of the instrument was taken when the coil was clamped.—*Model Engineer and Electrician.*

Uranium

There is considerable popular interest in uranium in the United States on account of its connection with radium, the properties of which appear so marvelous when compared with those of more familiar materials. But very little uranium is mined in this country except as it is incidentally taken out in mining carnotite for vanadium, according to the United States Geological Survey. In 1911 the uranium mined amounted to about 21.2 tons. A few hundred pounds of pitchblende was mined from the German mine, at Central City, Col., but this material was not sold, as it was said to have been used in experimental work. The extraction of radium has been attempted in the United States by several persons and firms. Some of these have given up their efforts, but others are still at work, with what success is unknown.

The uses of uranium and its compounds are comparatively few. It is employed principally for making yellow glass, for yellow glazes on pottery, and in a less degree as a chemical reagent. Yellow glass made with uranium oxide is known as "opalescent." Direct light shining through it gives a yellow color and indirect light a greenish yellow. Some of the firms which have attempted to use

TESTING AND ADJUSTING THE BACK CENTERS OF A LATHE

H. R. BECKETT

Having occasion to do some accurate drilling in the lathe, the following method of testing the back centers occurred to me. It is, however, only applicable to lathes having hollow mandrels, and can only be done during the evening, or when it is dark—time generally convenient to the amateur. It need be done only once, and will be time well spent for all who contemplate doing serious work with this kind of tool.

The front centers must first be correctly adjusted, using sharp pointed, truly turned centers—preferably those not hardened, as this process, unless done very carefully, is apt to throw them out of true. Clean out the mandrel bore by poking through small pieces of waste or rag with a stick. Fix up a powerful lamp, incandescent gas burner or, best of all, an acetylene lamp at the back end of the lathe mandrel, so as to project a strong beam of light through the mandrel bore. A mirror at the back of the source of light will be a further improvement. Now take a piece of thin white card about 6 in. square, and describe on it a number of concentric circles about ¼ in. distance apart, using black drawing ink and making the lines fairly thick; pin this card to a rectangular block of wood, so that the center-picked hole in the card is on a level with the lathe center, and with the circular lines facing the beam of light. Let the room be made as dark as possible, shutting out by screens all the stray light from the lamp used. Move the poppet head to the far extremity of the lathe bed and place the card, taking care that it is square on the lathe bed and the centrally pricked hole is exactly on the point of back center. A set-square placed across the lathe will keep the block of wood which carries the card square and in its correct position.

The disc of light projected must be adjusted until it exactly fits the circles upon the card. It is well first to turn the lathe ... the headstock must be adjusted by loosening the large bolts and using the setscrews usually provided for that purpose; if not, it must be tapped with hammer until the correct position is obtained, and then made fast. Do not overlook the fact that any alteration in the back setscrew will also necessitate adjustment of the front setscrew, for upon moving the back setscrew you put the headstock center in a fresh position. A little patience is required, but one will be well repaid by the future accuracy of the work turned out. If the edge of the projected circle of light is not sufficiently defined, the back headstocks can be brought up closer to the light. Of course, the greater the distance that the observation can be made the greater will be the divergence

Card for Use in Testing the Back Center of Lathe

shown if the centers are out, and in consequence the more sensitive the test.

Another way that I have tried—precise enough for most work, but not so fine a test as the above, though applicable to any lathe—is this: True up the front centers as before. Take a piece of hardwood having one side planed smooth, and about 2 or 3 in. thick; attach to the bottom of this another longer piece of wood which has been made a sliding fit in the lathe bed. Put a sharp twist drill—the bigger the better—and carefully drill a clean hole through the wood, placing the prepared smooth side of wood for the exit of the drill and feeding up the wood by means of a plate on the poppet head, another small piece of wood being placed between the wood being

TREATMENT AND FINISHING OF FLOORS

A practical painter who has been in the habit of finishing floors in various ways, such as painting or graining when too much worn to finish in the natural, raises the question as to the best way to finish floors and how to wax and polish them. He also asks how painters in the larger cities treat hardwood floors. In replying to these questions of its correspondent, *The Painters' Magazine* presents in a recent issue the following interesting comments:

For ordinary floors, such as in kitchens or laundries, warehouses, etc., the floor oil treatment is most practised. This consists in applying to the new floor a non-drying mineral oil, which is prepared for the purpose by heating in a hot-water bath 1 gal. of light paraffin oil to near the boiling point, and in the meantime melt in a ladle ½ lb. of paraffin wax, adding same to the hot oil, while continually stirring. Stir occasionally, while the mixture is cooling, to keep the wax from going back into lumps. The oil is applied to the floors with a brush, allowed to soak into the wood, and when well set the floor is wiped with a woolen rag wrapped around a floor brush to remove the excess of oil, so as not to soil dresses. The operation should be repeated until the wood is so saturated all over that no flat spots are visible, but a finished surface apparent all over the floor. This finish applies only to soft and hard pine as well as spruce. It is what has been called "dustless" floor finishing, and when the wood is once well saturated it does not need oiling again for from four to six months, and is far cheaper than waxing.

Oak and hard maple floors also are often simply oiled, but for these woods the floor oil described above is not the proper material. Take ½ gal. of kettle-

Yellow or hard pine floors may, without any previous treatment, be waxed, and the best method is to use one of the reputable floor waxes now on the market, applying same to the wood as directed, and then polishing by the use of the weighted floor brush. When the first coat, which acts as the filler, is hard, a second coat should be applied, and also polished in a similar manner. Oak and all other open grained woods require hardwood filler before waxing. When the wood has been filled, the surplus filler removed with excelsior or tow, and the filler has dried hard, the floor should be sandpapered and the waxing done as above.

The occupants of the house can wax polish such floors from time to time. If it is desired to stain a hardwood floor, the staining is done before filling and the paste filler colored to match the stain. In very fine residences the hardwood floors are filled with paste filler to match the color of the wood as closely as possible, then smooth sandpapered and varnished with one coat of high-grade shellac varnish, again sandpapered and finished with at least two coats of very best floor varnish. For extra fine rooms the last coat of varnish is rubbed or mossed, then polished with rottenstone and sweet oil. In touching up old varnished floors it is best to touch up the bare spots with quick drying flat color to match the remainder of floor in color, then give a coat of floor varnish to which color has been added to match the old color of the floor. The color in this case should be ground in Japan or varnish, and only enough added to stain the floor varnish.

For parquetry floors the best treatment is to apply, in succession, three coats of white shellac varnish, allowing each coat

A PORTABLE ELECTRIC DARKROOM LAMP

W. H. ASPINALL

Herewith is given a drawing of a portable electric darkroom lamp, which I have recently made from scrap materials, some of which had done duty as portions of a gas fitting. The design, it will be noticed, is of a very simple character, and no doubt will be appreciated by those readers who do a little in the photographic line, as it can be made by the average amateur. The flange pedestal and tee-blocks are part of an old gas fitting, and of brass, the tubes forming the rectangle being ½ in. copper. The tee-block at the top was bored out to take ordinary ½ in. nipple lamp-holders; the one at the bottom has a shade carrier and shade, inside of which is a red lamp, the shade itself being of a ruby color, the one on top being an ordinary 16-c.p. plain lamp. Both lamps are controlled by a two-way switch, the current being taken from a fitting by substituting for the lamp an adapter, connected with a length of flexible wire, the whole mounted on a walnut wood baseboard of about 9 in. square (see Fig. 1).—*The Model Engineer and Electrician.*

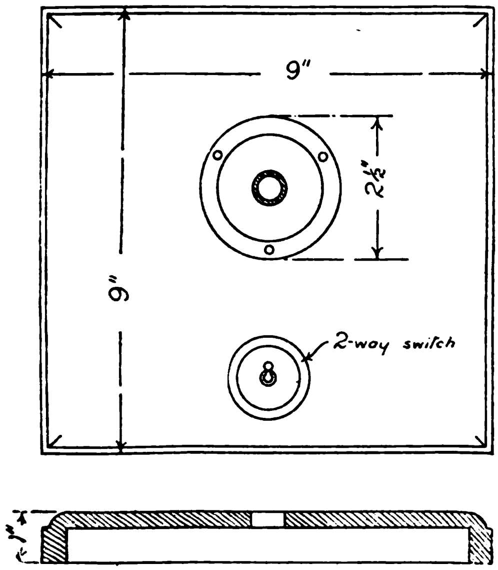


Fig. 1—Section and Plan of Baseboard

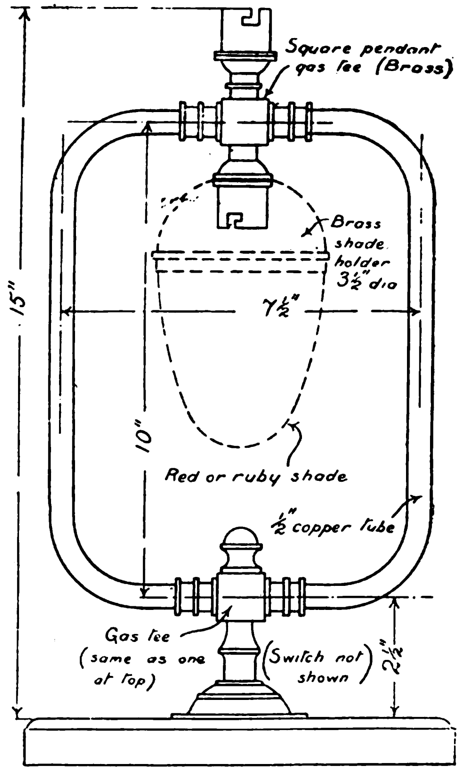


Fig. 2—Front Elevation

Habit is nature multiplied by either a *plus* or a *minus* quantity and either adds to or decreases its beauties and benefits.

Another Aluminum Solder

Another aluminum solder has been added to the already long list now in existence. This time it has been patented by Charles R. Erkens of the Simplex Aluminum Solder Company, Inc., of New York City. The solder is composed of the following:

Tin	60 lbs.
Zinc	15 lbs.
Lead	10 lbs.
Antimony	5 lbs.
Bismuth	5 lbs.
Chromium	5 lbs.

The metals are melted, according to the inventor and then treated with "35 grams of salicylic acid and 10 grams of calcium to each 5 lbs. of the alloy; and for a like amount of material 2 grams of sulphur." The inventor states that the sulphur acts as a "binding agent." The solder is used with the ordinary solder fluxes for soft solder and in the same manner.

A HOME-MADE ATTACHMENT FOR CONVERTING OIL AUTOMOBILE LAMPS TO ELECTRIC

JAMES P. LEWIS

If the auto owner desires an up-to-date car a distinct help is to eliminate the perpetually smoked-up and dingy oil lamps.

While there are several attachments on the market for changing oil lamps to electric, neat and serviceable holders can be made by the owner himself.

The little holder shown in the figure, is the type in which the lamp bulb can instantly be folded back out of the way, and the oil light used when desired. The parts are made of brass, but will have a somewhat better appearance if nickel-plated.

A band *A*, about 1/16 in. thick, and 3/8 in. wide, serves to secure the holder to the oil lamp burner, it being clamped there by a machine screw and nut *B*. One end of the strip is left sufficiently long to project about 1 in. Another short arm, or lever *C*, is riveted or soldered prependicularly to this arm. Another arm *D*, which carries the socket proper, is secured to *C* with a machine screw, as shown in the figure; a short piece of stiff spiral spring being placed between the arm and the nuts, the purpose of this will be seen later. A dent is now made on *D* at *L* heavy enough to show through on *C*, but it must not pierce either. Arm *D* is now turned up in line with *C* and another blow given to dent *L*, so as to mark a second point on *C*, after which the two arms are taken apart and the dents *N* and *K* deepened. Then, as will be seen, the arm carrying the bulb will be held firmly in the two positions, but is instantly changed from one position to another, the principle being the same as that used on some wind-shields. If any other positions of the arm are desired they can be secured by making additional dents on *C*.

Now secure a 3/8 in. piece of 3/8 in. brass tube *F*, also the sheet metal screw from a miniature lamp receptacle, and solder the latter in the former; also solder *F* to the arm *D*. At *H* is screwed a small square of hard fiber; this has a small brass piece screwed to it at *G*. These screws must not make contact with the others.

Two binding-posts can be mounted on the under side of oil lamp, one being insulated and a piece of small flexible-cord run from it to *G*. The other post will make contact through the metal lamp and holder parts to bulb.

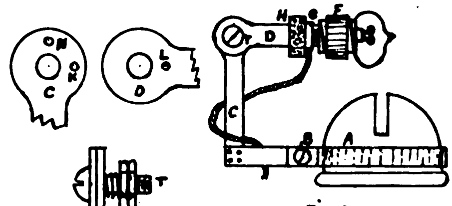


FIG. 1.

The binding-posts are connected through a suitable switch to whatever source of current is available.

Where a machine is not equipped with a storage battery or lighting dynamo, the tail lamp fitted with the above adapter, using a small 4-volt tungsten bulb and a small battery, is both satisfactory and economical.

Lightning Freaks

During a succession of electrical storms at Portsmouth on Friday, August 23, 1912, there was just one lightning discharge at 1.40 p.m., which appeared to be of any consequence. This particular discharge entered the chimney of a house on Congress Street, and after doing more or less damage to the premises, appeared to find the ground through the telephone company's sixty pair aerial cable in the street nearby. The cable was burned completely off and about 7 in. of it entirely disappeared.

Approximately 300 subscribers' telephones were put out of commission. The cable men were soon on the ground, had the cable repaired and about one-half of the subscribers affected were in order at 9.30 p.m. the same day. It seemed strange that this should be about the only damage which this vicinity experienced from these several electrical storms, which covered a period of several hours' duration.

The science of the Microscope is inverted Astronomy and teaches us the immensity of minute things.

A SIX-POINT CIRCUIT-BLOCK

THERON P. FOOTE

The accompanying illustration may at first sight look somewhat complicated, but a little careful study will reveal how simple and extremely useful such a connection of wires and instruments is to the electrical experimenter. All connections terminate at one of the six small binding-posts located on the laboratory work-bench.

Circuits are so connected that the direct-current ammeter always reads in the right direction. The alternating-current ammeter can be connected either way.

Nos. 1, 2, 3, 6, 7, 8 are S.P.D.T. switches; Nos. 12 and 13 are S.P.S.T. switches; No. 4 a home-made rheostat for a bank of lamps in multiple; No. 5, a 12-point switch used as a rheostat for inserting a resistance of one 4- or 6-in. porcelain tube wound with composition wire at the advancement of each point; No. 9, a D.P.S.T. switch; No. 10, a double-arm, three-way, four-pole switch; No. 11, a battery rheostat.

USE OF THE CIRCUIT-BLOCK

110 *A.C.*, use *A* and *B*; No. 2 to right; *Voltmeter reading*, No. 1 to left.

110 *D.C.*, use *A* and *B*; No. 2 to left; *Voltmeter reading*, No. 1 to left.

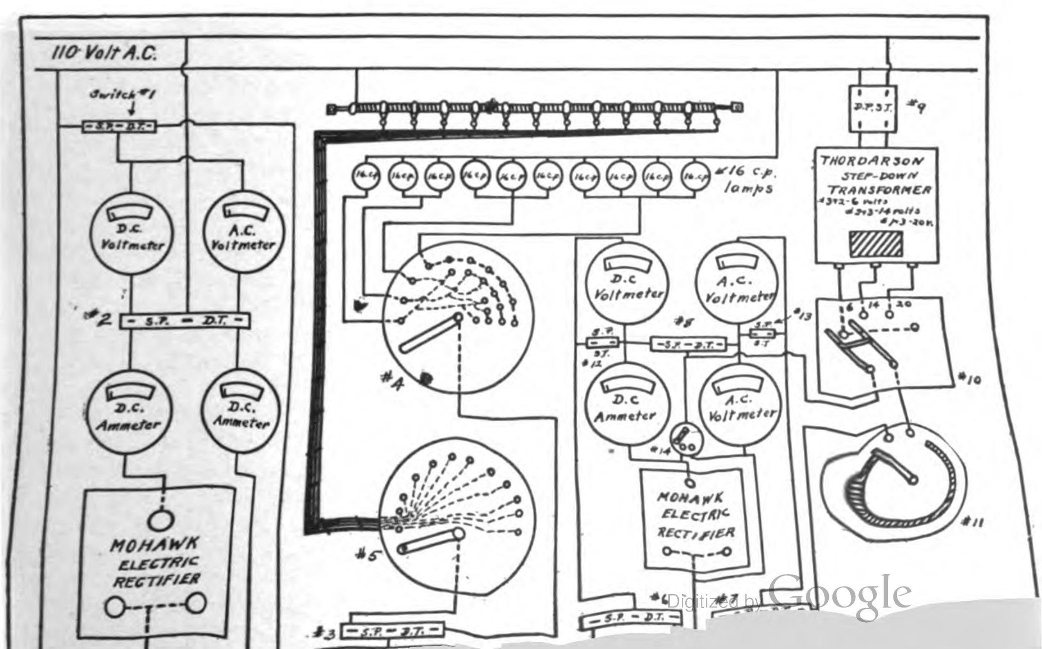
110 *A.C. through resistance coil*, use *B* and *C*; No. 2 to right; No. 3 to left; use No. 5 as rheostat; *Voltmeter reading*, No. 1 to right.

110 *D.C. through resistance coil*, use *B* and *C*; No. 2 to left; No. 3 to left; use No. 5 as rheostat; *Voltmeter reading*, No. 1 to right.

110 *A.C. through resistance of lamps*, use *B* and *C*; No. 2 to right; No. 3 to right; use No. 4 as rheostat; *Voltmeter reading*, No. 1 to right.

110 *D.C. through resistance of lamps*, use *B* and *C*; No. 2 to left; No. 3 to right; use No. 4 as rheostat; *Voltmeter reading*, No. 1 to right.

1-5 *to* 20 *volts A.C. or D.C.*, use *E* and *F*; throw No. 9 on; No. 10 to first position for 1-5 to 6 volts; second posi-



tion for 6 to 14 volts; third position for 14 to 20 volts; No. 8 to right for A.C.; left for D.C.; No. 11 as rheostat; *A.C. Voltmeter reading*, No. 7 to right; *D.C. Voltmeter reading*, No. 6 to right.

For Ampere reading of a battery, dynamo, etc., connect circuit in series with given resistance to *D* and *E*. If D.C. throw No. 12 on and No. 6 to left; if A.C., throw No. 13 on and No. 7 to left.

For Voltage reading of a battery, dynamo, etc., connect circuit directly with *D* and *E*. If D.C. throw No. 6 to left; No. 8 to left; No. 14 to left. If A.C. throw No. 7 to left; No. 8 to right; No. 14 to right.

HOW TO PATCH A CONCRETE FLOOR

When a cement floor surface begins to wear it is often desirable to patch it and the way in which this can be done to the best advantage is described in a recent paper prepared by President L. C. Wason of the Aberthaw Construction Company, Boston, Mass. In this paper he gives the wrong way to do the work as well as the right way, and, says *Building Age*, we present both herewith for the benefit of our readers:

THE WRONG WAY

Commonly a sand and cement mortar is made, some cutting is done and the mortar is put in and scrubbed with a steel trowel until smooth. It is then covered up for a while. If the concrete under the patch is left dry it soaks up the water of the mortar. As a result, the mortar does not set. If the room is dry or hot the surface of the patch dries out and for the same reason it does not set. If the concrete under the patch is dusty, the patch does not adhere to the concrete. If the materials in the mortar are not suitable, naturally the patch wears badly, particularly as it is obviously located at a point of severe wear.

THE RIGHT WAY

Cut down the worn place at least 1½ in. This cutting should be carried into the strong unbroken concrete and the edges should be cleanly undercut. The bottom of the cut should then be swept out, clean-blown out with compressed air or a pair of bellows, if available, then pressed and worked into the surface, which has already been spread with grout. Finally, before the grout is set, a mortar made of one part cement to one part crushed stone or gravel, consisting of graded sizes from ½ in. down to the smallest excluding dust, should be thoroughly mixed and put in place, then floated to a proper surface. Cover with wet bagging, wet sand, sawdust, or other available material. All trucking should be kept off and the surface kept thoroughly wet for at least one week or ten days.

If a particularly hard surface is required, 6-penny nails are sometimes mixed with the mortar and other nails stuck into the surface when the patch is finished. This will produce a surface which is extremely hard and durable.

Copper Production in 1911 Passed High-Water Mark by 17 Million Pounds

The year 1911 was one of prosperity for the copper industry, both smelter and refinery outputs being the largest in its history, according to a report by B. S. Butler, just issued by the United States Geological Survey as an advance chapter from Mineral Resources of the United States for that year.

The average price of copper for 1911 was 12.5 cents a pound, slightly below the price of 1910, but near the close of the year the price advanced, the average for December being 13.71 cents a pound. Metal-market conditions continued to

THE HISTORY OF THE CHRONOMETER

Magnificent Prize Offered by British Government Two Hundred Years Ago Won by John Harrison

An interesting address was given recently before the Manchester branch of the National Association of Goldsmiths, by Mr. J. H. Hobbins, on "The Chronometer: Its History and Use in Navigation."

Mr. Hobbins said that the history of the chronometer in some respects was, perhaps, one of the most romantic stories in the whole realm of invention and science. But before entering into that he asked them to first consider what the chronometer had to do. That might seem a simple kind of question to ask in a company composed of men who were familiar with its details. Still, he thought it desirable for the purposes of his lecture.

Having explained shortly but clearly by means of slides shown on the screen how the mariner is able when on the open seas to determine by the use of the chronometer his longitude and by calculation his latitude, Mr. Hobbins proceeded to say that it was only during the last century that considerable progress was made in the application of the time-piece for the purpose of discovering one's longitude. Of course, there were various other methods of determining longitude without the chronometer, and which need not be mentioned in detail, but not every man who went to sea was versed in astronomy, and therefore the chronometer was used, because by it the mariner could determine right away—without any calculation whatever beyond the simplest arithmetic—his exact longitude, and, of course, from that find out his position at sea.

TAKING THE LONGITUDE

It was about 200 years ago that the government of Great Britain, after many representations had been made, appointed a commission to consider what could be done so that the mariner could more easily and accurately discover his longitude, and the Board of Longitude, as it was designated, offered a considerable reward for a timepiece that would enable the navigator and the mariner to discover their longitude at sea. A sum of £20,000 was offered to the person who devised the most simple method which would enable the mariner to ascertain his longitude to half a degree, or two minutes of time; a sum of £15,000 to be paid for a system which would enable the mariner to determine his longitude to two-thirds of a degree; and £10,000 for one degree. There were a number of conditions attached to the offer made by the Board of Longitude, one being that the test would have to be made on a vessel making a voyage to the West Indies.

The incentive of the large reward, of course, brought many schemes forward to be considered by the committee over which Sir Isaac Newton presided. Some of these were practical schemes and some were so complicated as to be quite useless for the average mariner. Just to show how the matter was then regarded, Mr. Hobbins had thrown on the screen extracts from pamphlets of the period, and also specimen pages from a book published by Richard Locke in 1730, entitled, "The Circle Squared," and "How to Discover Longitude both at Land and Sea by Means of a New Instrument."

EVOLUTION OF THE CHRONOMETER

Now, when one came seriously to consider the evolution of the chronometer, proceeded Mr. Hobbins, it could not be done without mentioning the name of John Harrison, who after forty years' ardent and assiduous labor succeeded in producing a machine which enabled the mariner to determine his longitude with such accuracy as to be really remarkable considering the period. Harrison was the son of a Yorkshire carpenter, and as a young man, when not engaged in assisting his father, filled in his time by making and repairing clocks. As a young man he constructed a clock which was said not to have varied in time more than one minute during a period of ten years. There was no reason to doubt the truth of the story and it was certainly a remarkable achievement in those days. In addition, young Harrison devised a number of other appliances, and one of his inventions was the compensation pendulum, known as the gridiron.

It was some little time after the Board of Navigation had been appointed that

Harrison, probably attracted by the large reward, turned his attention to the matter, and fourteen or fifteen years later he consulted George Graham, an eminent horologist of the time, with regard to a machine he had devised, and there was no doubt that Graham was of considerable assistance to John Harrison and in bringing him to the notice of the Board of Longitude. It was in 1736, something like fifteen years after the passing of the Act, that Harrison submitted his first machine—a very bulky machine undoubtedly—first to the Royal Society, and then to the Board of Longitude. It was tried on a voyage to Lisbon and with considerable success, and Harrison was paid £500 on account, although under the Act the machine had to be tested on a voyage to the West Indies. Some years later Harrison produced another machine, which was much less in bulk, and then commenced the construction of a third machine.

HIGH HONORS FOR HARRISON

The whole matter had been exciting considerable attention in scientific circles year by year, and in 1749 Harrison was considered worthy to be made the recipient of the complimentary medal of the Royal Society. About that time he began to construct a fourth machine, which was now described as a watch. In 1761, after considerable delay on the part of the Admiralty Board and the Board of Longitude, a vessel was commissioned—the *Deptford*—to make a voyage to the West Indies to test the invention of Harrison, who was now getting old and infirm. As he could not make the voyage, his son William was appointed to take his place and have charge of the instrument. In addition to the man-of-war *Deptford*, another vessel, the *Beaver*, was sent out with instruments for the purpose of testing the accuracy of the new machine of Harrison. From the documents published at that time it was shown that Harrison's instrument was in error on the voyage only five seconds of time, which was about a geographical mile. When it was remembered that the *Deptford* was not a modern ship, that was a great success for Harrison, and he became entitled to the large reward of £20,000 offered by the Government.—*The Keystone.*

New York's Waterfront Neglected

ONLY SMALL PART OF 790 MILES OF BEACH AVAILABLE FOR TRADE

Greater New York has a waterfront line of 790 miles. Of this great stretch only a small part has been developed in any way by the city authorities. All attention has been given by the city's engineers to the development of the beach at the lower tip of Manhattan, which has long since been deserted by transatlantic liners for sites farther up the river. They are now in the Chelsea section, where the city has erected a new system of docks. But it took so long to finish the improvement that the steamships had outgrown the piers that had been prepared for their use. These piers are 900 ft. long. The steamships want 1,000 ft. piers and there are but two of this size in the city, and they are in the South Brooklyn section, far from the center of the city, with varying depths of water, inadequate for the leviathans which now ply the ocean.

Although New York is one of the greatest seaports of the world, it is not because it has been made so by improvement, but because it is a natural harbor. For the latter reason business has been crowding in year after year. Commerce has now grown beyond the facilities of the harbor or waterfront, and unless additional dockage is provided it is said that the growth of New York as a seaport will stop and the business that would go there will be diverted to other ports.

What is an accident? It appears to be a simple question, but when applied to industrial conditions in which the responsibility of both employer and employee must be determined, the question presents many difficulties. For example, as applied to railway disasters, collisions, derailments and bridge wrecks have always been termed accidents, but if we apply the usual definition of an accident as an unforseen or injurious occurrence which is not the result of negligence, mistake or intent, then many of these disasters in which reasonable foresight and caution are employed are not accidents at all. The question of what is an accident, therefore, presents certain interesting legal considerations.

GLUED OR FLUSH JOINTS FOR BELTS

C. E. OLIVER

As far as a laced joint is concerned, the hinge butt joint is the only one that will stand the strain of high speed while passing over small pulleys, and also where idlers are in use. I had to go to Chili, S.A., to gain that knowledge from a good Canadian in charge of an American sawmill at the foot of the Cordilleras or Andes mountains. I called to pay this gentleman a visit. He had a planer and tongue- and grooving-machine at work. The driven pulley on the planer was running about 3,000 revolutions, and belt was breaking at the lacing about every other day, causing him much annoyance and loss by shut-downs. I asked him to allow me to apply my English joint, to which he consented, first using the butt joint, four holes in each end, with the straight lace on the underside, and crossed over; but this joint only lasted about an hour. I next tried the double row of holes, taking the lace through front hole in one end and the hook in the other. This only stood the strain about an hour, and if anyone was surprised, I certainly was, for I had not yet learned the lesson of the terrific strain placed upon a belt under the conditions existing in connection with wood-working machines. My friend now applied his old-time friend, the hinge joint, the first time I had ever seen it in my life, and it is good in its place, that is, where small pulleys are in use, and where belts have to run over and under idlers, as it will give and take just like the hinge of a door working in and out.

To make the hinge joint is just as easy a task as to make any other laced joint. Have each end of the belt perfectly square, coming together as a butt joint. For a 5-in. belt punch six holes in a row in each end of the belt, and five ¾-in. holes behind these. Commence lacing in the cent[illegible]

other words, always bring the lace *up* through each hole, much in the same way that a boot is generally laced. When pains are taken with this joint it can be done very neatly, and is very durable. I have known it to last six months in an 8-in. belt on a roller mill, with an idler in use on the same, placing it under terrific strain.

According to the article by my old friend, W. T. Bates, it does not appear that the British millers are using one of the very best joints—that is, the flush or glued joint, which makes the belt endless. There is, I believe, not a joint made that will compare with it for strength, neatness and easy running, and it runs noiselessly at all times; one may place one's fingers on it while in motion; it may rub against clothing and be harmless. It can be made in a few minutes, and does not require riveting of any kind. I had to come to the United States to find out the way of making the flush or glued joint, and even in America it is not used in many mills—chiefly in those of large capacity. How well I remember the old lap joints that were fastened together with elevator bucket bolts, and what a source of danger they were when running. Woe to the one whose head or any part of his anatomy came into contact with that joint while it was in motion. It was an unsightly, noisy, uneven, and altogether undesirable lap, which ought never to be used on any kind of a belt when there are so many other joints that may be used. Then there was the laced lap, which was another undesirable joint, just as unsightly as the bolted one, and, beside being unsightly, it was inefficient when passing over each pulley by its loss of contact.

To my mind the only fastener which at all compares with the glued joint is ready for gluing; a small plane, a buffer to scrape and buff the gluing side of each lap; a brush to apply the hot or boiling glue, and a board 3 in. wide, 1 in. thick and 24 in. in length, that is used to rub the joint down after the glue is applied. A list should be taken during the week of each belt needing attention, so that these may be repaired when the mill is closed down, and thus each belt can be kept in perfect condition, and when in motion appears to be endless. The trouble I always encountered with metallic fasteners was their uselessness after they had once been used, and they will sometimes come apart, break, etc., at times when one is least anxious to shut down the mill. It will pay to try glued joints; they are cheap, neat, noiseless, clean and powerful, the joint being as strong as any part of the belt, very easily made, and once used they are always desired. With this belt joint there is no loss of power, as there is a continual contact between belt and pulley, and all that is required to give perfect adhesion is a clean surface obtained by holding a brush against the belt while it is in motion, and then applying half a dozen drops of castor-oil.—*The Miller.*

A HOME-MADE WIRE GAUGE

J. R. BROWN

Having some odd lots of wire and not possessing an up-to-date standard wire-gauge, I have made the following one from odds and ends: *A* is a piece of stout tinplate, 8 x 2 in. *B* is a broken hacksaw blade, or piece of a clock spring, pivoted at *G*. *C* is a piece of brass cut to shape, drilled, and one jaw tapped for setscrew *F* and then sweated to *A*. *D* is also a piece of brass drilled and tapped for ⅛-in. brass wire to be screwed into it and sliding through the left jaw *C*, and abutting *H*, thereby moving the pointer *B*. *E* is a small steel spring. *F* is a steel setscrew to open jaws *D* and *C*. *G* is a steel setscrew for pivot *B*. *H* is a piece of brass sweated to *B*. *K* is a brass nut sweated to *A*. *V* is the vernier.

To calibrate the tinplate, take your divider with *G* as center, and from *G* to the tip of the pointer as radius, describe four arcs; unscrew the setscrew *F*, allowing the sliding jaw *D* to meet the right jaw *C*; press *H* to the end of sliding wire fixed to *D*; where the pointer cuts the arcs call it 0; then screw up *F* till jaw *D* is exactly 1-10 in. from the right jaw *C*; press *H* against end of wire, and where the pointer cuts the arcs call it 10; then divide the arc from 0 to 10 into ten equal parts. Each division will register 1-100 part of an inch. Now subdivide each part into four.

The pointer now will register .0, .0025, .0050, .0075, .01, and so on to .1 or 1-10 in.

To test a piece of wire, insert it between *D* and *C*, turning screw *F* till a sliding fit is made, and then compare the number registered with table of B.W.G. sizes in decimal parts of an inch.—*The Model Engineer and Electrician.*

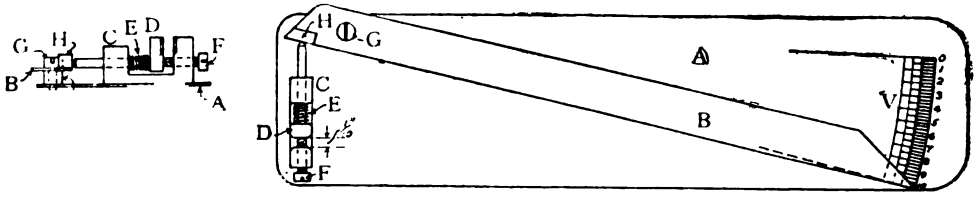


Fig. 1.—Plan.

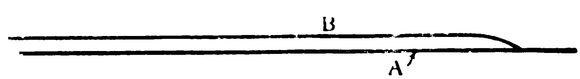


Fig. 2.—Side View.

MODERN USES OF THE METAL ALUMINIUM

Its Mechanical and Chemical Properties Readily Adapt It to a Number of Important Applications

RICHARD SELIGMAN, PH.D., in *Science Progress*

Aluminium, which is the chief component of all clays and an important constituent of many rocks, is one of the most widely distributed chemical elements. Despite this fact, it was not isolated until the year 1827, when Wohler obtained the metal in the form of minute gray scales by the interaction of aluminium chloride and metallic potassium. Although this method was improved upon by St. Clair Deville, aluminium did not become a common metal until the simultaneous discoveries of Heroult and Hall in 1887–1888 permitted of its manufacture by electrolysis. The process perfected by these two inventors, which is the only one in use today, consists in electrolyzing a solution of alumina in the molten double fluoride of aluminium and sodium, known as cryolite. The electrodes used are made of carbon and the products of electrolysis are aluminium on the one hand and oxygen and the oxides of carbon on the other. The electrolysis is carried on at a temperature of 950 to 1,000 deg. cent., so that the metal, which melts at 657 deg. cent., is obtained in the molten form.

For close to ten years after these discoveries, aluminium was still regarded as little more than a scientific curiosity, but more recently it has found its way into a rapidly increasing number of industries, for many of which it has become an essential.

RAPID DEVELOPMENT OF INDUSTRY

The rapid development of the aluminium industry is an exemplification of the rule which, though universal, is frequently unrecognized—that supply creates demand. To show that the advance is in this case governed by this rule, it will be necessary to consider the uses to which the metal has been put during the last ton; the amount produced was undoubtedly in excess of the consumption by no small amount, and the makers held considerable stocks of the metal. At that time, the chief difficulty confronting the manufacturer was that of marketing his wares and in view of the hopes which had attended the inception of the industry the outlook was sufficiently discouraging.

However, the time at which the aluminium industry was at its lowest ebb coincided very closely with the first strong impulse given to the automobile trade, which was destined to carry it into the forefront of industrial undertakings. In the early days of self-propelled road vehicles, as at a more recent date in the case of aerial vehicles, every effort was made to lighten the burden placed upon the weak engines which did duty as tractors, and in accomplishing this, advantage was taken freely of the most salient feature of aluminium, its extraordinary lightness. Wherever possible, aluminium was used, whether for engine parts or for the coach work. In a very short time the aluminium makers, who a few months before had been piling stock on stock, not only found their accumulations absorbed, but their factories incapable of keeping pace with the rapidly growing demand. The writer can recall days as recent as 1906 when anxious hours were spent waiting for small consignments of a ton or two of metal from the reduction works to keep the rolling mills going, and when every corner and cranny was searched for bits of old scrap which could be remelted to feed the apparently insatiable motor trade.

IMPROVEMENTS IN PLANTS

Steps were at once taken to increase the capacity of the reduction works and the extension of old and and the installa not wait. Faced by the imperative necessity of finding a substitute for aluminium wherever the latter could be dispensed with, he turned to thin steel sheets, which he found not only far cheaper, but also to his surprise not markedly heavier. He had overlooked the fact that weight for weight steel is stronger than aluminium, so that for many purposes, he was able to reduce the thickness of the metal used to such an extent that no material increase in weight resulted. Moreover, as engine power and efficiency were increased, gradually dead weight began to be of less importance, a process which we can see going on today in the development of aeroplanes. By the time, then, that the cumbrous water wheels, which had been installed all over Europe and America, had been made to revolve, the motor car had swept on its course and the aluminium maker was left with his enormously increased output, but robbed of the outlet for which the output had been called into being.

Thus the supply was created. By 1910–1911 the world's output had been raised to 34,000 tons, and as the power available is now very great and many hydraulic installations which serve other processes would be available, in case of need, for the production of aluminium, the price is half what it was at the opening of the period under review.

WIDENING THE DEMAND

Now as to the demand. Faced by a surplus of metal for which there was no outlet, the manufacturers set themselves to ascertain the fields in which aluminium might best find an application. As a consequence of systematic efforts to educate potential consumers, results have been attained which a few years ago seemed beyond the dreams of avarice. In different countries different lines of action have been pursued. Thus in America the chief new application found have been in culinary ware and the electrical industry; in Germany also the cooking utensil trade has reached enormous proportions, while a most promising outlet has been opened up in chemical apparatus; in France the motor trade still takes a very large amount of aluminium, but a great deal of the metal produced in France finds its way into Germany to feed the industry there, no aluminium being made in Germany, which has to import all its raw metal from other countries. England, characteristically, was long content to send the metal made there abroad rather than go to the trouble either of creating new industries at home or of devoting energy to the studies necessary to enable her to do so. During the last two years, however, a great deal of spade work has been done and foundations have been laid upon which promising business in electrical and chemical apparatus are being built. Moreover, the motor trade, encouraged by low prices, is once more using the metal in large quantities.

In this article it is proposed to discuss the advantages and disadvantages which aluminium has for these purposes and to explain, as far as possible, the causes which have favored its introduction into each branch of industry.

ELECTRICAL INDUSTRY

Owing to its relatively high electrical conductivity, the metal aluminium is now playing an important and steadily growing part in the distribution of electrical power. Taking the conductance of a copper cable of unit cross-section as 100, aluminium of the requisite purity has a conductance of 60, the exact figure depending, as in the case of copper, upon the purity of the metal and its physical state. To carry a given amount of current it is therefore necessary to take a bigger cable if aluminium be used, the cross-section required being 1.66 that of copper. At first sight this does not seem promising, but when it is remembered that the densities of aluminium and copper are 2.71 and 8.95, respectively, it will be seen that the *weights* of cable required to carry the same amount of current will be $1.66 \times 2.71 = 4.50$ in the case of aluminium, and $1 \times 8.95 = 8.95$ in that of copper. In other words, half the weight of aluminium will be required, and as the cost depends upon the weight, and aluminium wire is little more expensive than copper wire per ton, a very large saving in capital outlay is effected by the use of aluminium instead of copper. In the case of bare, overhead conductors, such as are largely used in young countries to convey electrical energy, the full benefit of this economy is felt; and there are, in addition, one or two subsidiary advantages, such as the decreased cost of carriage to the point where the power line is to be erected, usually in remote parts to which the cost of carriage is heavy. On the other hand the strength of aluminium is only half that of copper, but as the area of the aluminium is 1.66 times that of the copper line, the strength of the former is $0.5 \times 1.66 = 0.83$ of that of the former. In consequence the sag between two poles or towers is greater where aluminium is used, and the poles have therefore to be somewhat higher. The general conclusion to be drawn from these various considerations is very favorable to aluminium at the prices ruling today for the transmission of power by means of bare conductors.

ALUMINIUM AND OXIDATION

Aluminium has so far not been found advantageous in cases in which small bare single wires are used, such as telephone and telegraph circuits. The explanation is to be found in chemical and mechanical rather than in electrical considerations. Aluminium when exposed to the atmosphere undergoes superficial oxidation, but this ceases at a certain distance from the surface, the coating formed acting protectively. In the case of large conductors, corrosion does not proceed far enough to cause any trouble, whereas the strength of a small wire may be seriously impaired or the wire may even be corroded throughout its thickness. On the other hand, by using aluminium for large switchboard connections and for "bus bars" for internal transmission of heavy currents in power stations, etc., very considerable economy may be effected. The same advantage does not accrue from the use of aluminium for insulated and armored cables. Owing to the increased diameter of the conductor, the amount of the dielectric or of the armoring has to be increased largely and the additional cost of the latter frequently more than neutralizes the saving made on the cost of the metal. At existing prices, there seems to be a marked saving in the case of single-core cables of l[illegible]

advantage attending the use of aluminium for all the purposes cited above is the difficulty of making joints, a difficulty which we shall see later has played so large a part in retarding the introduction of aluminium for chemical plants and one which is not to be not in the way found effective in the latter case. For electrical purposes, joints in aluminium conductors are usually made by purely mechanical means.

Aluminium is said to have been used successfully for battery connections in storage battery installations, but the fact that in such a case it is in contact with the relatively highly electro-negative metal lead in an atmosphere which is always charged with sulphuric acid spray seems to make its use for this purpose particularly inadvisable.

A most interesting and probably very important recent application of aluminium in the electrical industry, based upon its electrical, physical and chemical properties, now claims more than passing attention.

MANUFACTURE OF COILS

The manufacture of coils, whether for motors, dynamos or other electrical apparatus, involves the insulation of each turn of wire from its neighbor so as to insure that the current will pass only along the path ordained for it. One of the greatest problems which the designer of electrical machinery has to face is to get a sufficient number of turns into the space at disposal, which is usually very restricted. As has already been shown, an aluminium wire has to be materially larger than a copper wire, so that if it were necessary to insulate it in the way practised in the case of copper wire (wrapping with rubber, silk, etc.), the use of aluminium would be very disadvantageous. Aluminium, however, has a chemical property which has been pressed into the service of the electrician in a most ingenious manner. The surface of the metal is normally covered by a thin, invisible coating of oxide. By immersing the metal in suitable solutions.

machinery which, according to Mariage, show a saving in weight of about 50 per cent., which, owing to the position of the coils in electrically propelled vehicles is a saving of very great moment, and a reduction in cost of 60 per cent. Moreover, unlike the usual insulating material, being entirely inorganic, the coating made on aluminium is improved rather than damaged by heat, so that the danger of burning the insulation and so short-circuiting the coils is diminished. On the other hand, the size of the coil must still be somewhat larger and the difficulty of making effective joints is greater than in the case of copper. Such coils have not been in use very long, but their application seems to be increasing very rapidly and the writer is of the opinion that their ultimate adoption on a very large scale is assured.

Space does not allow of a detailed discussion of the use of aluminium in other directions in the electrical industry, and mention can therefore only be made of such articles as current collectors on electric railways, fuses, lamp fittings, meter cases, lighting interrupters, etc., for all of which purposes aluminium is now in use to some extent.

In conclusion, it may be said that the very large development which is taking place in the introduction of aluminium for electrical work represents no mean achievement. Unlike some of the industries which will be considered later, the electrical industry was quite satisfied with copper and did not realize that the advantages which have been enumerated were attainable. It has been led to appreciate them by an enlightening propaganda which benefited both the industries concerned.

TRANSPORT VEHICLES

The rapidly growing use of aluminium in the construction of vehicles is based on several distinctive properties of the metal and its alloys. Before dwelling on these, it will be well to enumerate the actual uses to which the metal is being put. The principal users are the motor-car builders, who have applied the metal to making panels and moldings of carriage work, in the construction of the jackets and crank-cases of the engine, ium in railway coach building, in which it is used only for panelling and in still rarer cases for door handles and similar minor fittings. In the case of aerial vehicles, aluminium is used in constructing seats, shields, instruments, cases, and, in fact, wherever lightness without strength is required. Formerly aluminium was used in making the joints between members of the frame, but this use of aluminium seems to be dying out; the classic cases of the Zeppelin airships and the Barrow airship represent isolated instances of abortive attempts to use aluminium and its alloys for constructional purposes in aerial work.

From the above it will be seen that aluminium is used either as sheet metal or in the form of castings.

Aluminium sheet was originally used for panels on account of its lightness. Today a more important property of the metal is its extraordinary malleability, by reason of which panels of complicated shapes may be beaten out from it more cheaply than from thin sheet steel, unless a large number of similar panels are to be made, in which case costly machinery can be installed for the purpose. The surface of a well-made aluminium panel is also better than that of one made of steel, while wood, owing to the shrinkage which it undergoes, the amount of paint it absorbs and the difficulty of working it, is no longer used for motor-car work.

The advantages accruing from the use of aluminium for the purposes mentioned are not sufficiently marked, however, to induce makers to employ it unless the price of the metal be very low. It has been seen already that when the price rises appreciably, aluminium is discarded in favor of steel, but at prices obtaining at the time of writing, aluminium panels are being used to a large extent.

ALUMINIUM CASTINGS

The case of aluminium castings for engine parts is very different, as the advantages the metal has are very conspicuous, and be the price high or low, very little else than aluminium is used. In the first instance, the saving of weight is very considerable, as such castings are of necessity bulky, and if made in

Pure aluminium is not used for this class of casting. When unalloyed, aluminium does not run at all well, and in consequence small passages in the mold may not be well filled. Moreover, it often happens that portions of the molten metal which meet in the interior of the mold do not unite, owing to the skin of oxide which covers their surfaces. Aluminium itself also lacks the necessary rigidity and the shrinkage of the metal on solidification (1.8 per cent.) makes the production of sound castings difficult. Recourse is usually had to alloys containing about 10 to 12 per cent. of zinc and 2 to 3 per cent. of copper. These alloys have the properties which aluminium itself lacks, and are more suitable even than other metal for the production of castings of intricate pattern. If the percentage of zinc be increased to excess, the castings are apt to break when exposed to continual vibration. In earlier days great trouble was experienced on this account, but when the enormous number of castings in daily use is borne in mind, the number of breakages now occurring must be considered trifling.

HOUSEHOLD AND TRAVELING UTENSILS

In discussing the application of aluminium to household purposes, traveling and military equipments, properties of the metal have to be considered which are of no account in the cases previously considered. The use of the metal for such purposes depends in the first instance upon the fact that compared with the materials heretofore used in kitchen and camp, aluminium is either infinitely safer from a hygienic point of view or far more durable. In this case comparison lies between aluminium on the one hand and iron, copper, enameled iron, and tinned iron on the other. For heavy cooking utensils, such as large kettles and heavy pans, iron still holds the field. Iron vessels, however, can be used only for a very limited number of purposes, and are unsuitable for general use, owing fact that copper salts are most active poisons. Copper vessels, therefore, are coated with a thin layer of tin. This precaution is by no means sufficient to eliminate the danger, because the tin sooner or later wears off. Moreover, the cost of copper vessels is more than the purse of most housewives can bear and the cost of retinning is a permanently recurring charge. In point of price, aluminium cannot bear comparison either with tinned or enameled iron, but the life of the former is so very short that it does not form a serious competitor. Enameled iron may and frequently does give satisfaction on this score; on the other hand, it is entirely untrustworthy, and in case of damage to the enamel it is the most dangerous material which can be used. There is in this case no question of poisoning, as with copper, but chips of enamel become intermixed with the food, and probably are the cause of disorders such as appendicitis, etc., more frequently than is supposed. From all these disadvantages aluminium is absolutely free. Drawbacks of its own it has, but these are distinct from those cited above. Aluminium is second only to copper among the common metals in thermal conductivity, and gives no color to the finest materials. Dirt is seen so easily upon its white surface that it is possible to tell at a glance whether it be clean or not. In addition to the fact that it dissolves but slowly in weak organic acids is the immensely important fact that even in solution it is entirely innocuous. Unlike tinned copper, tinned iron, and enameled iron, it is uniform throughout its thickness, and consequently there is no coating to wear off, crack, or chip. Having these advantages, the question may well be asked, "How is it that its use is not universal?" The reasons are three in number. The cost of aluminium still places it above the reach of the poorest; the aluminium formerly used for the purpose was inferior; lastly, the metal cannot be cleaned ganic acids is small, and if it took place generally over the surface of the metal, it would be negligible. Unfortunately, however, this is not the case. The presence of small impurities in the metal or even of physical differences between adjacent particles may lead to local dissolution and pitting or perforation of the metal. Owing to improvements in the methods of manufacture, the former trouble has been largely obviated, and since the recognition of the importance of the physical state of the metal, still further improvement may be looked for. As a matter of fact, the degree of progress which has already been attained is very remarkable. In America and in Germany, millions of cooking utensils are made annually, and the percentage of returns is nowadays very small indeed.

Now as to the third difficulty.

Aluminium unfortunately is readily attacked by alkalis and, therefore, the cleansing agent of the kitchen, soda, is one of its worst enemies. As a consequence, the cleansing of aluminium must be effected mechanically and entails appreciably more labor than if effected in the customary manner by means of an alkali. This is the chief difficulty which remains to be overcome. In Germany, where the "hausfrau" herself takes pride in the appearance of her kitchen and herself does much of the cooking, it has not been sufficient to counteract the obvious advantages the metal has. One German factory known to the writer used in 1910 about 3,000 tons of aluminium, almost all of which was made into kitchen utensils. In the United States a huge business has been built up, mainly by the exertions of university students, who in their long vacations were engaged to educate the public to appreciate the advantages of aluminium; while even the Indian "ryot," who has always cleaned his pots and pans by polishing them with sand, is rapidly learning to substitute aluminium for the brass bowl prescribed by immemorial custom. Only in England is progress slow, mainly, in the writer's opinion, because in England the housewife does not cook, and is not mistress in her own kitchen—where she walks in fear and trembling—and because no one has arisen who has had the courage to undertake the education of our national institution, Mary Ann.

In addition to the advantages cited above, the lightness of aluminium is the cause of its wide use for the field equipment of soldiers and travelers, to whom every ounce saved in the weight of water-bottle and cooking-pot is of importance. Moreover, the malleability of the metal renders it practically unbreakable, a factor of no small consequence when the treatment to which field equipment is subjected is borne in mind.

The properties which have rendered the success of aluminium in the kitchen possible are also those upon which its claims as a material for the construction of chemical plant are based. This is true more especially of apparatus suitable for use in foodstuff factories, which have been erected in such large numbers during the past two decades. A modern jam factory, an extract of meat factory, a cordial factory, is each but a domestic kitchen magnified a thousandfold, a well-equipped condensed milk or margarine works being but the apotheosis of a dairy, where purity of taste and color and freedom from infection must and do reign supreme.

Dr. Strauch, a mental specialist, has discovered a new disease which he calls telephone nervousness. A prominent Berlin attorney had been in continual conflict with the Post Office for more than a year regarding his telephone. Several times he was prosecuted on the charge of insulting the telephone girl and finally his telephone connection was cut off. The attorney immediately began proceedings for its restoration. The Post Office Department offered as a defence that the attorney was continually insulting officials.

Dr. Strauch was called as an expert and testified that telephone nervousness was a serious ailment. The telephone, he said, acts on certain persons like poison. He continued: "I know a case in my personal practice of a physician who was so worked up by delays and other unpleasant occurrences that he became permanently insane. Excitable persons should never use the telephone."

The court was so impressed that it adjourned the case in order to enable Dr. Strauch to submit further instances of the disease and observations as to its effect.

ELECTRIC LIGHT AND ALARM SWITCHBOARD

W. T. JOHNSTON

I am sure that most of the amateurs who take up the hobby of electricity would like to make something that would be of good service to them, and something that would show what they could do.

The idea of this board is that by setting the electric clock alarm at the hour you wish to be awakened, the clock bell rings for a few seconds, stops, and then the large bell rings and continues ringing until switched off from the board; then again, you have the electric light, which you can switch on from a flexible wire push whenever you wish to see the time.

As regards upkeep expense, this should not be any hindrance to anyone who is desirous of making such a useful article, for, with usual care, the cost per year does not exceed ten cents—the price of 1 lb. of sal ammoniac.

First, obtain a piece of wood, 2 ft. ½ in. x 12¼ in. x 1¼ in. This can be either African mahogany or ordinary white wood, which could be stained and varnished by any worker himself; as for the fancy beading around the edge of the board, this is a matter of taste, as it would look quite as well by half-rounding the edges with an ordinary wood file or plane. Then obtain another piece of wood 7⅜ x 3½ x ½ in. for the clock-base; the corners of the shelf should be cut away or rounded. This completes all of the woodwork.

Now for the remainder of material, which can be purchased from any of the well-known electric firms, such as those whose names appear elsewhere in this magazine.

One swan-neck bracket, with shade; also a joint to take the bayonet cap of the lamp.

Two brass terminals (telegraph pattern).

One electric lamp, 2 volts.

One electric alarm clock.

One electric bell (door-bell pattern).

One rosette with flexible wire push.

One small switch 2¼ x 1⅜ in.

Two complete Leclanché batteries.

Two small iron brackets for clock shelf.

Red and blue bell wire, equal lengths; length according to distance from battery to board.

The items of lamp and batteries can be increased if a stronger light and louder bell be required—say 4 volts; this gives a sufficient light and ring.

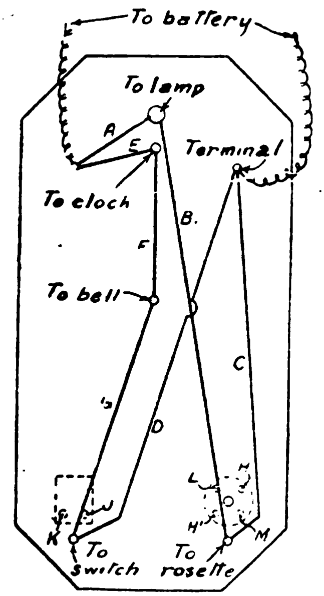


Fig. 1

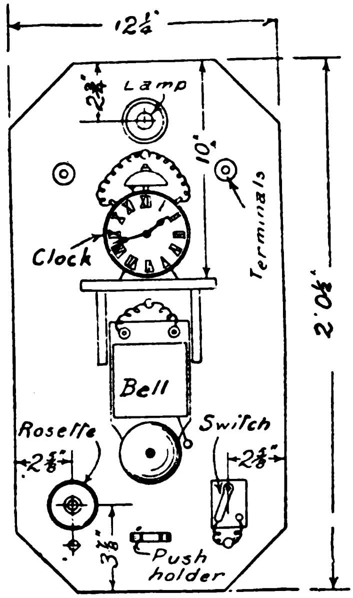


Fig. 2

Front and Back Views, Showing Connections

Now for the fixing up and wiring: Measure down the board 10 in. (see diagram, Fig. 1) and screw on your bracket and shelf to hold the clock. (The brackets should be wide enough to place the bell between.) In the exact center of the board measure down 2¾ in. and bore a hole to admit wires to the lamp; then, from the lamp hole, measure down 2½ in. and draw a faint pencil line across, so as to allow you to bore the two holes, one on either side. On the exact center of horizontal line bore a hole for the wires to the clock, then below that again in the center of the board measure down 6¾ in. from the clock hole — this brings you below the clock bracket—and there bore a hole for the wires to the bell. From the bottom of the board measure up 3⅞ in. and draw another faint horizontal line, so that you will have the push rosette and switch in line; measure from the left-hand side 2⅝ in. and bore a hole to admit the wires to the rosette, and on the right-hand side measure 2½ in. up and bore another hole for the switch. All the holes are to be ¼ in. in diameter.

Now you have everything ready to fix up the wires temporarily, and if you are careful in following out the instructions for wiring, you can see if it is working to your satisfaction before proceeding to stain and varnish the board and fix up for good.

The wiring (see diagram, Fig. 2) is the most particular part about the whole thing, and it will be necessary to follow out the directions very carefully. First you take the two different colors of wire and from the blue wire cut one piece 15 in. or 16 in. long (wire *A*) and fix from left-hand terminal at back of board through hole for lamp, and with another piece of blue wire, 21 or 22 in. long, *B*, put through the hole at right-hand bottom of board through hole for lamp;

Now for the red wire. Cut a piece 10 in. long, *E*, fix on left-hand terminal across through hole for clock and coil the two ends as shown in diagram; you can coil the wire by rounding through a pencil. Cut another piece of red wire *F*, from clock hole again, leading down through hole for bell, cut one other piece of red wire, *G*, from hole for bell (coil the two wires in front of board, as already done for clock), down through hole for switch, and fix in binding screw *K*. This completes all the back wiring.

Now let us turn to the front of board to complete the wiring. You will see we have just the two red wires for clock, then below that again (below bracket) other two coiled red wires. Fix these to the bell terminals, then go down to the rosette. We have still two binding screws vacant, *L* and *M*, on which we fix the two wires from push. Now this completes all wiring for board; now the only remaining two wires are from battery, and on charging the battery in the usual way with sal ammoniac, join up battery as shown in diagram; carry your two leading wires—red one from carbon of battery right up and across front of board to left-hand terminal; and the other (blue) wire from zinc of battery up and across to right-hand terminal.

Now, if you have followed out the instructions carefully, you will find you have a most useful and interesting instrument over and above having learned some wiring. I may say, however, the above instructions are all that are necessary; only you may improve the look of the board greatly by adding a few extra things, such as a small brass wire holder screwed into center of board at bottom, to hold the push. Then again, should you fix the board close to the bedside, the ticking of the clock sometimes annoys one, but this can be easily ... felt,

A WIRELESS TELEGRAPH EQUIPMENT FOR A SMALL CRUISER

B. F. DASHIELL

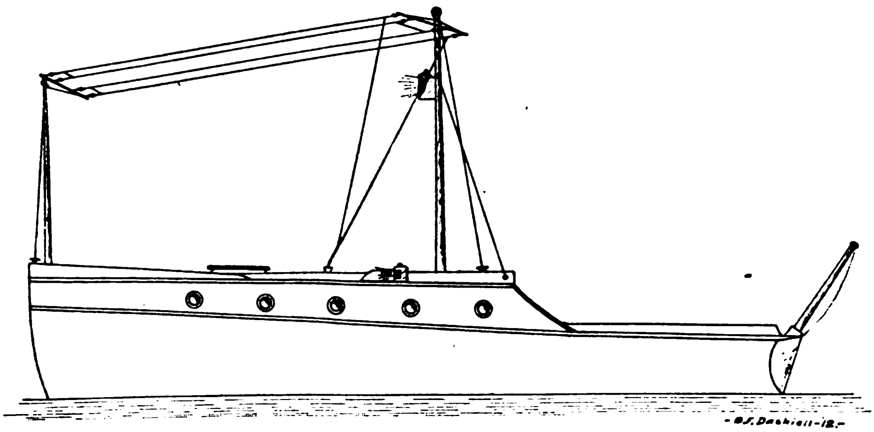


Fig. 1—Aerial Masts

It is the purpose of this article to give in as simple and concise a manner as possible the necessary information on the construction of a wireless telegraph station to be installed upon any type of cabin cruiser, either sail or motor. A wireless telegraph station installed on board a small boat will be of great use not only in case of dire necessity, but also to get the weather reports and news from local land or ship stations. This station has a positive receiving range of 50 miles in the day and over 100 at night. The writer has taken it for granted that the average reader has some knowledge of electricity and the principles of wireless transmission, so that he need not go into detailed explanation.

First, we will take up the construction of the aerial. This is composed of four No. 14 B. & S. gauge bare copper wires, and are so arranged as to be strung up above the deck of the boat as shown in Fig. 1. As all cruisers have a mast or two, they can be well utilized to support the aerial wires. If the mast can be lengthened it will be much better, as a higher aerial means increased range. Try to have both ends of the aerial of the same height so as to keep the aerial horizontal. The length of the wires depends upon the distance between the masts. If only one mast is used, have one end of the aerial come down to the bow or stern of the boat, that end which is the greatest distance from the top of the mast, so as to get the aerial as long as possible.

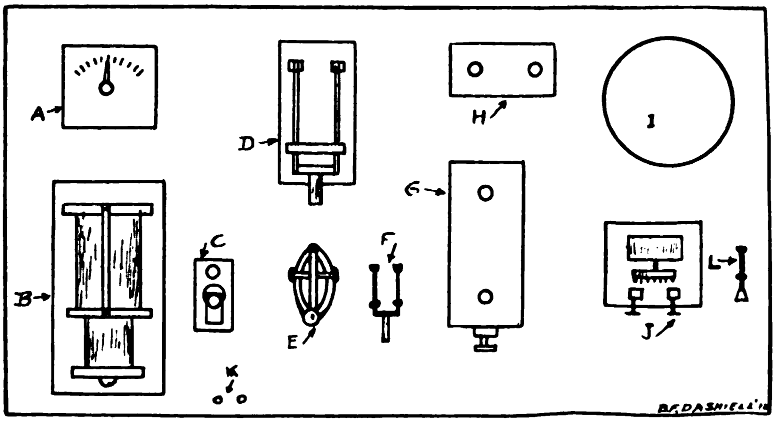


Fig. 2—Layout of Table

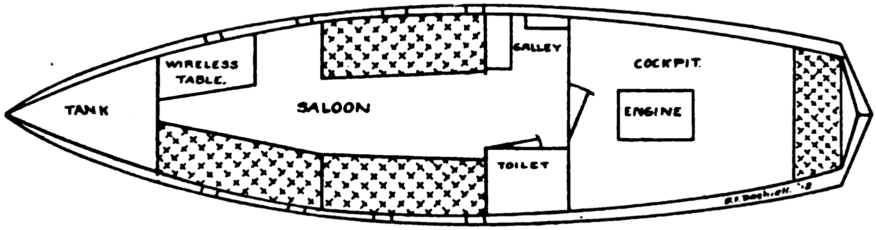


Fig. 3—Showing Wireless Table

Two light wooden spreaders will be needed, each 6 ft. long. Holes are bored in them so as to separate the wires by 2 ft. To assemble the aerial, cut the four wires of the correct length; fasten them to hard rubber high-tension insulators which are then fastened in the holes of the spreaders. Connect all the wires together so as to form a continuous circuit, as shown in Fig. 1. The two free ends of the wires are connected together at a distance of about 1 ft. from the top of the cabin roof. These two wires are soldered to a No. 10 rubber-covered, high-tension cable, which passes down through a hard rubber bushing in the cabin roof. This lead-in must go direct to the aerial switch. Solder all joints well, using resin as a flux.

If the boat is equipped with a 110-volt dynamo for lighting service, a high power station can be installed. If not, storage batteries furnish the necessary current. The battery should have a capacity of 60 ampere-hours at a pressure of 12 volts. If the 110-volt current is used, the transmitting set will use either a ½ or ¼ k.w. transformer, this depending upon the capacity of the dynamo in amperes. If the storage battery is used, either a 3 or 2 in. induction coil is used. The coil should be one designed for wireless use. The transmitting distances of the various coils are: ½ k.w. 20 miles at day, ¼ k.w. 12 miles; 3-in. 8 to 10 miles, 2-in. 5 to 8 miles. At night the distances will be almost twice as great. The sizes of aerials, weather conditions, types of instruments used, all will have some influence on the sending and receiving distances.

The entire transmitting set is composed of the following: ½ or ¼ k.w. transformer; 3 or 2 in. induction coil, oil condenser of the correct capacity to go with the coil used, ribbon-wound helix, rotary spark gap, key and aerial switch. The rotary spark gap is preferable, inasmuch

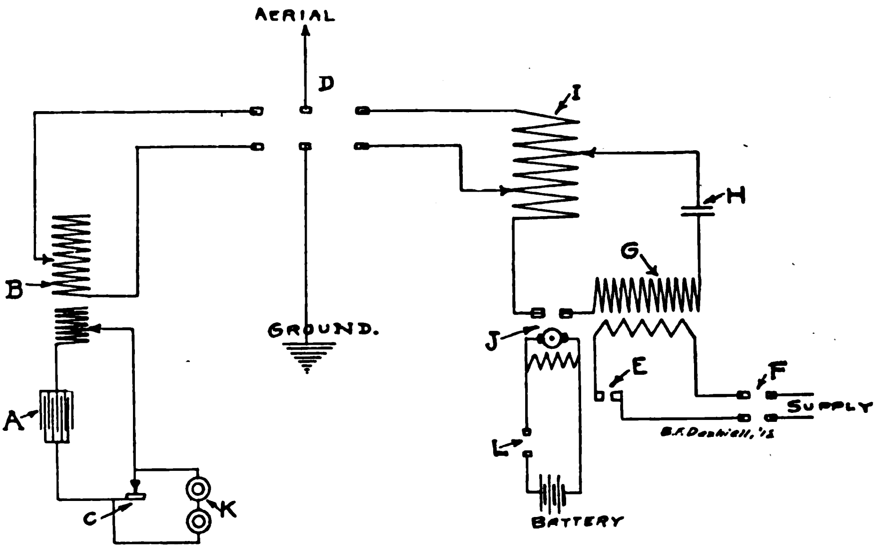


Fig. 4—Wiring Diagram Showing Connections

that it will increase the range materially and heighten the pitch of the spark, thus making it more easily read through static and interference. This gap will operate on about 4 volts and ½ ampere. Use high-tension cable for all secondary wiring and plain insulated wire for other wiring.

The receiving set is composed of the following, and has been found by the writer to be very efficient with small aerials. One loose-coupled tuning coil, silicon or ferron detector, variable condenser and a pair of reliable telephone receivers.

Fig. 2 is a plan of the wireless table with the instruments arranged upon it. *A* is the variable condenser, *B* the tuning coil, *C* the detector, *D* the aerial switch, *E* the key, *F* the battery switch, *G* the transformer or coil, *H* the condenser, *I* the helix, *J* the rotary spark gap, *K* the telephone connections, and *L* the switch to control the rotary spark gap.

The transmitting set is put on the right-hand side of the table and the receiving set at the left. The key and aerial are so placed as to be easily operated. Fig. 3 shows the situation of the wireless table, but it can be arranged to suit the shape and size of the cabin or boat. It is best to have it in a convenient and yet out-of-the-way place. The ground wire, a No. 8 B. & S. Gauge, is soldered to the engine frame or metal hull of the boat. In case of a sail boat and having no metal hull, solder the wire to the rudder support. Fig. 4 gives a wiring diagram which shows the connections of the sending and receiving instruments.

The writer suggests to those who contemplate the installation of a wireless set on their boat, and are not familiar with the operation of the instruments, that they get a copy of some good wireless text-book that will not only give the explanation, but the actual construction of the instruments, as this latter item will prove a great help in the study of wireless telegraphy.

A "Master" Wireless Clock Promised for the Future

Cosmos of Paris says that dial clocks operated by wireless waves soon will take the place of the ordinary electric clock-dial, connected by wire with a central "master clock." This requires separate wiring and on this account is expensive. "There are watch factories in Switzerland that receive the exact hour from the Eiffel Tower daily," says *Cosmos*, "but the communication of the time, minute by minute, to numerous clocks by electric waves is an entirely new and unexpected fact. A sufficient power must be given to the electric wave to permit of precise action, and receiving clocks must be so built that the hand will make only one advance movement in a given time, to avoid all disturbing influences from outside sources of electricity. Finally, all hertzian waves not coming from the sending apparatus must be neutralized. All these difficulties are solved in the system of Mgr. Cerebotani of Munich, well-known for his work in electro-technics.

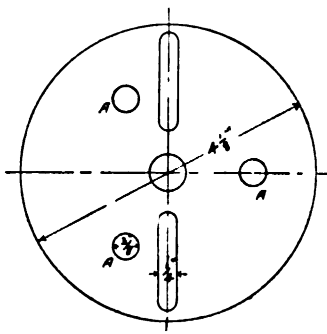
The experiment would appear to be very simple. On a table is placed an ordinary clock, marking seconds, in communication with a relay and a dry battery operating a wireless sending apparatus. On another table is a receiving antenna connected to a clock which, instead of the ordinary clockwork, contains an electromagnet and a relay of special construction. As soon as the second-hand of the first clock has made its round of the dial the antenna sends out a wave that operates the minute-hand of the receiving clock, or of several such, causing it to advance by one division. The only difference between this device and an ordinary electric clock consists in the absence of a connecting wire. A sending clock placed in any central position—on top of a tower, for example—and provided with an antenna similar to those used in wireless telegraphy, can thus send out the exact time to a great number of public clocks, located in squares, restaurants, offices, etc. A fact worthy of remark is that the new receiving clocks cost not more than $3.00, according to Mgr. Cerebotani. He proposes to deliver lectures in various European cities to enable specialists to form an opinion of his invention."—*Keystone.*

Three barleycorns make an inch, so the table says, and three drinks of barley juice sometimes make a riot.

A CHUCK FOR OVAL TURNING IN THE LATHE

THOS. W. PLANT

Following is a description of my oval turning chuck for the lathe, which is fitted to an ordinary cast-iron slotted faceplate, and can be made by an amateur at a very trifling cost. The accompanying illustrations are for a 2½-in. center lathe; but the chuck can be fitted to one any height by making the support of the guide ring sufficiently high to bring the center of guide ring in line with center of mandrel when pushed back. The faceplate (preferably one with a small boss at the back) must be screwed on mandrel and faced up true and straight across the face, being constantly tried with a straight edge, as the chuck will work much steadier if true, and prevent the outside plate from rocking when at work. Now get the exact center, and draw a line through center and across



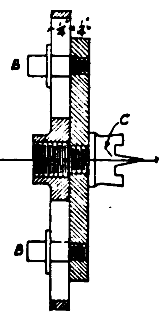


Fig. 1—Faceplate. Fig. 2—Section X. Y.

the exact middle of the two slots in faceplate; then space out equal distances on each side of the line—say, ⅛ in.—and clean out the two slots with a file to the line, to make grooves for the studs to slide in; take off faceplate, and either reverse on the mandrel and turn up equal

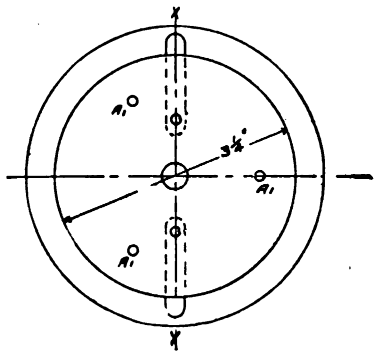


Fig. 3—Chuck

center of the hole exactly in a line with the center of the plate.

Now with two short screw pins, screw the brass plate to faceplate from the back of same, through the slots, setting it roughly near the center, and turn up the face of brass plate flat across to straight edge. Now take off the faceplate, and refix with the same screws the trued-up side to the faceplate, and turn up what is now outside, making a truly parallel plate 3½ in. in diameter. Now turn the outer edge circular, and at right angles to face to 3¼ in. diameter; while still on the faceplate turn out a hole in center to be tapped for insertion of forked chuck *C*, Fig. 2, for holding such things as bradawl handles, etc.; drill three ⅛-in. holes *A*1, Fig. 3, so that they come over the ⅜-in. holes in cast plate. These are for screwing on the work.

Take off the faceplate and fix a piece of ⅝ in. diameter iron rod in lathe not less than 4 in. long, and turn out two screw blanks, as *B*, Fig. 2, the long ends to be turned a good fit to slots of faceplate, and sufficiently long to reach through both the faceplate and the brass plate, the other ends to be turned long enough to reach well over guide ring; slot the ends for screw-driver, thread the long ends just enough to reach through brass plate. These screws should fit well in brass plate so as not to get shaky when in use.

The guide ring, Fig. 4, is made of a piece of iron or brass 5/16 in. thick, turned nicely to make a smooth fit within the two studs *B*, Fig. 2; when screwed into the sliding plate you now require a circular piece of iron 1/8 in. thick, slightly smaller than guide ring, as shown by dotted line, Fig. 4, for packing guide ring from support. The support can be made of iron 1/8 in. thick by 2½ in. wide, bent up at right angles about 1 in. from the end. Cut a slot in the bent part, as shown at *D*, Fig. 4, from the center towards the back

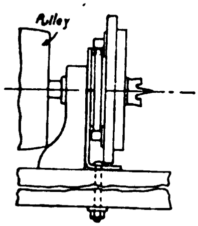


Fig. 5—Complete Chuck on Lathe Mandrel

when on the lathe, the slot to be made about 1 in. long and to fit a ¼ in. pin going through between the lathe bed to screw up underneath with washer and nut; push up support to nose of mandrel, and drill a hole for mandrel to come through; get a piece of wood or metal and fasten to mandrel, and with a striking point fixed in the wood the same diameter as guide ring, mark the exact place for riveting the ring, packing-piece, and support together, taking great care to get the center of guide ring and the center of mandrel the same height; take support off lathe bed, rivet all together, and finish by cutting out oval hole *E*, Fig. 4, extending nearly to the back of ring.

To use the chuck, join all parts together. the material more or less oval, according to position of guide ring. With a piece of wood fixed in forked chuck at one end, and held up with the back center, some nice turning may be done, as bradawl handles, hammer shafts, etc. If you want to turn short objects oval throughout, you fix your wood, etc., on brass plate with screws through holes A1, Fig. 3, without taking off cast plate. When turning you require to keep the tool at one fixed height to get the best results. This is an easy matter with a slide-rest.

Electric Timing at the Olympic Games

At the Olympic games at Stockholm there was used a novel electric method for timing the runners in some of the races, so as to get the exact time made by the winner, and also to decide who crossed the line first, even when the difference was very small. The starter gave the signal by firing a pistol, and this was connected by electric wires with two stop watches and these commenced to run for taking the time. The start and finish were at the same point, and across the track a light string was stretched between poles and the string was also connected with the stop watches for stopping them. The first comer broke the string when crossing the line so that the watches were stopped and the exact time between start and finish could be seen. Breaking the string also served to work an electric device for the shutter of a camera which was mounted just on the finish line and above the judges' stand, so that the photographer had an image of the winner when crossing the finish line. This method is very useful in settling all disputes.—*Le Nature, Paris.*

Soldering Irregular Pieces

To solder together, accurately, irregular pieces of metal or the two parts of a broken piece, impress the parts into a lump of putty placed on a piece of tin-plate. Having thus formed a mould.

AN ARMCHAIR

An armchair is not the easiest piece of furniture to make, and on account of its difficult mortise and tenon joints, is rarely attempted by the amateur. The design given in Fig. 1 is about as simple as it is possible to make one; the chair is comfortable, an important point, contains a very little upholstering and there are only eight very simple mortise and tenon joints, two lapped halving in the framing and two joints in the arms. First of all, prepare two 25 in. lengths of 1½ in. x 1½ in. wood, one 26 in. and one 14 in. length, see that they are quite square and true, and then prepare two 23 in. and two 18 in. lengths, 2 x 1 in.

ERECTING THE FRAMING

These pieces are fitted together, as shown in Fig. 4, and in detail in Figs. 5 and 6. First of all mark off in the middle of the 2 x 1 in. length, a groove exactly 1 in. wide and deep, and then saw down inside the marked lines and space out the waste, as shown in Fig. 5. Now fit one 23 in. and one 18 in. length together, and test if they are square, for this is important. Next mark off on the long arms exactly 9 in. each side of the slot and on the short arms, 6½ in. on one side and 6 in. on the other; these lines will form the shoulders of the tenon, as shown in the section, Fig. 6. Next gauge a line ¼ in. each side, and then saw down with a tenon saw to the shoulders and cut off the waste. We must now mark off the joints in the uprights and from the end of each 1½ in. length, mark off exactly 4 in. and then 2 in. and carry the lines in pencil right around the wood with a try square.

Now at 12 in. up from the same end mark another set of lines, and another 2 in. higher up (in one length this will be at the top). In the two 25 in. lengths saw down as shown in Fig. 7, and pare out the piece, making the width of the cut exactly 1 in.; three or four 7/16 in. centerbit holes should now be bored right through and the sides pared down to make a mortise of ½ in. wide. This should be done in four cases. In the short length and the 26 in. length, the mortises are on one side, a line being marked off ¼

prepared. This should, if possible, be in one piece, 16 in. square and 1 in. thick, plane it up carefully and draw lines across from corner to corner. The curves should be marked out with a radius of 7 in., the center of each being 1½ in. from the middle of the wood. Cut off the waste and spokeshave to the line and then cut out the slots, as shown in Fig. 8, and fit the seat in, just rounding off the front edge. The arms should now be made, a 2 ft. 4 in. length of 4 x 1 in. wood being required. The method of marking out is shown in Fig. 9, and the arm piece cut to shape and spokeshaved in Fig. 10. The corners should be carefully rounded off to suit, a curve of ¾ in. radius being most suitable. The arms are fitted in a slot, or groove, cut in the back upright 1 in. from the top and fitted on the outside uprights with the mortise and tenon joint shown, going right through or within ¼ in. as preferred, the former method being more simple.

The rails of 5 x ¾ in. wood should be 9½ in. long and fit in slots cut out to a depth of ¼ in., as shown in Fig. 8.

The framework should now be glued up and bound together with strong string pulled up taut, taking care to protect the corners with thick cardboard, and then screw the seat to the top cross pieces.

THE FINISHING TOUCHES

The work should now be stained, polished, or enameled, and when quite hard the seat may be upholstered. We shall now require a little well curled horsehair. Probably ¼ lb. would be sufficient, but this depends on the give of the material used for covering; a 15 in. square piece of canvas or calico and a similar quantity of leather, pegamoid, or tapestry, about 1¾ yds. of gimp or leather banding and 3 doz. studs. Commence by tacking on the canvas 1 in. away from the two back edges and stuff that part with hair. Gradually tack up the front portion, stuffing the hair up tightly as the seat is covered. Now cut the leather or tapestry to shape and tack in position, and then put on banding or gimp and knock in the studs at intervals of 1 in. or so. This method of upholstering is not

FIG. 1.

IDEAL HOUSE FURNITURE.——An Arm Chair.

1. The completed chair. 2. Front elevation. 3. Plan. 4. Framing from front. 5. Lapped halving joint in crossbars of frame. 6. Mortise and tenon joint (section through leg). 7. Method of cutting mortise in leg. 8. Seat. 9. Method of marking out the arm pieces. 10. One piece for arm shaped.

MATERIALS REQUIRED.

8ft. run of 1¼in. by 1¼in. finished size. One piece 10in. by 16in. by 1in. finished size. 7ft. run of 2in. by 1in. finished size. 2ft. run. of 5in. by ⅝in. finished size. 2ft. 4in. of 4in. by 1in. finished size. ¼lb. horsehair, 15in. square of canvas and tapestry or leather, 1½ yds. gimp or banding, 3 doz. studs and screws, tacks, stain, &c.

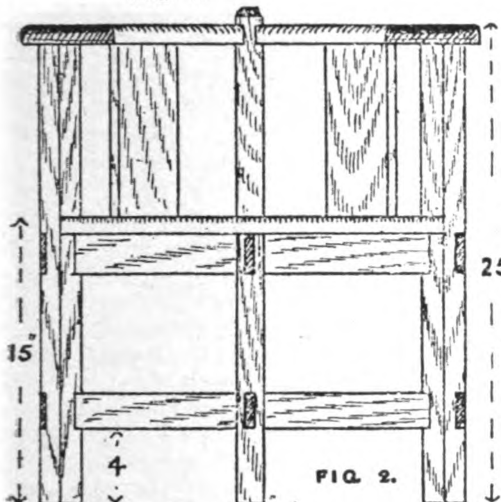


FIG. 2.

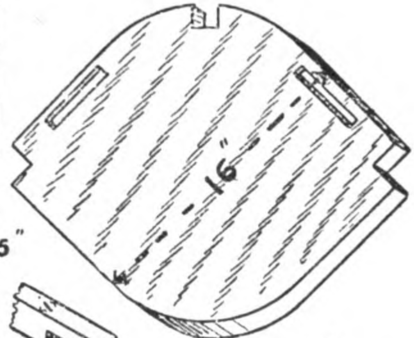


FIG. 8.

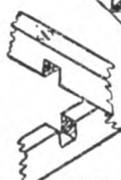


FIG. 5.

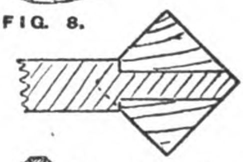


FIG 6.

FIG. 7.

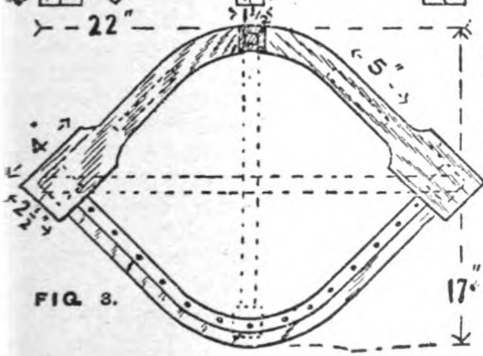
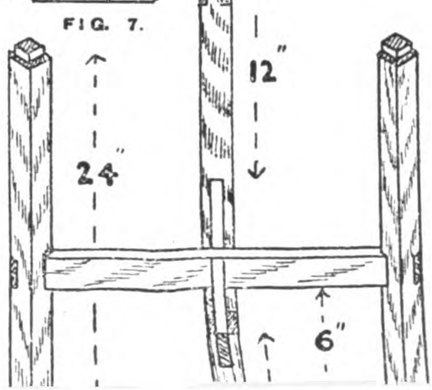


FIG. 3.



A DOOR LETTER BOX

This useful letter box, which is shown complete in Fig. 1, is suitable for fitting to a street door. The box may be fixed at any convenient height, and a slit, through which the letters may be passed, must, of course, be provided in the door, while a small door is fitted at the bottom of the box by means of which the letters may be removed. Fig. 2 shows a sectional perspective view of the box; Fig. 3 shows an end view, and gives the principal dimensions; and details of the construction are illustrated in Figs. 4 to 8.

Yellow pine ½ in. thick will be a very suitable wood to use in making the box.

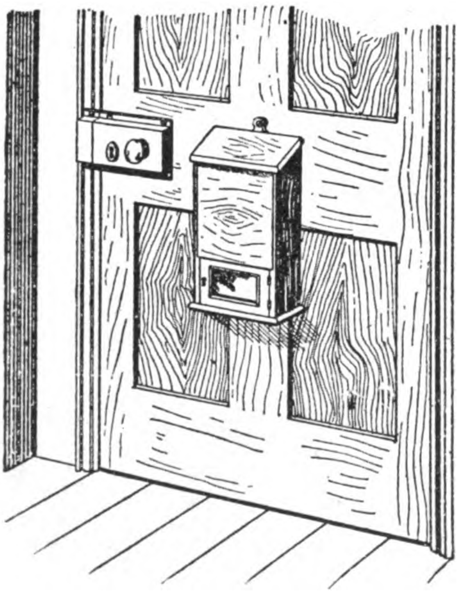


Fig. 1

The first consideration will be the sides *A*, and the top and bottom *B* and *C*. The sides are cut 1 ft. 4½ in. long at the back, and 1 ft. 2½ in. long at the front, by 5 in. wide: and the top and bottom are 8½

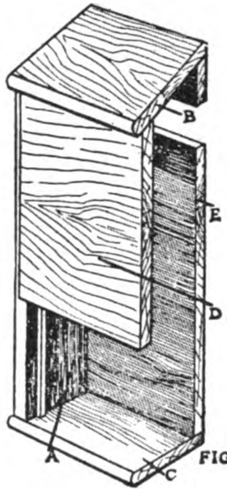


FIG. 2.

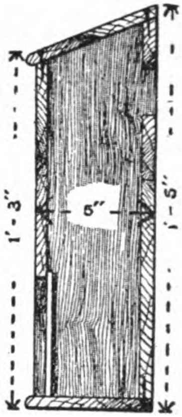


FIG. 3.

and back of the box, after which the sides, top and bottom may be finally fixed together. The overhanging front and end edges of the top and bottom should be rounded, as shown in the illustrations, and the joints when finally fixed together should be secured with glue.

The front of the box *D* is then prepared and fixed in position, an opening 5 in. high being provided for the door. The front simply fits into the grooves prepared for its reception in the front edges of the sides, and is fixed in position with nails, as shown in Fig. 5. The back of the box *E* must next receive attention, and it is fitted and fixed in a similar manner to the front. A slit must be provided in the back of the box, and it should come exactly behind and corre-

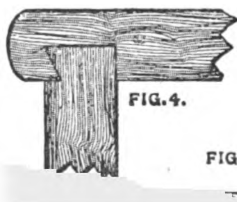


FIG. 4.

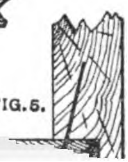
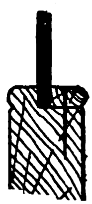


FIG. 5.



spond with the slit in the street door. If the slit is made in the horizontal door rail it should be cut in a horizontal position, but if it is in the middle vertical rail it should be in a vertical position, and a convenient size would be about 5 in. long by 1½ in. wide.

The small door which is fitted at the bottom of the box is framed together, and fitted with a glass panel. The framework should be 1⅛ in. wide by ½ in. thick. A rebate, 5/16 in. wide and ⅛ in. deep, is cut in the back edge of the framework, and the front edge is beaded, as shown in Fig. 6. The framework is put together with mortise and tenon joints, similar to that shown in Fig. 7, and the joints are finally fixed with glue. The door should be hung to the box, on the right-hand side, with a pair of 1 in. butt hinges, and a small lock or suitable fastener should also be fitted to the door.

Two small wood fillet pieces are fixed on the inside of the box, directly behind the door, to act as stops, as shown in Figs. 2 and 3. The glass panel, which is fitted to the door, should then be cut to fit in the rebates in the framework, and it is fixed in position with small fillet pieces, as shown in Fig. 6.

The box may now be finally cleaned off, and the exterior should be either stained and varnished, or painted. The box is fixed to the door with two metal plates, similar to that shown in Fig. 8. The plates are first fixed to the back of the box with screws, and the box is then finally fixed to the door with screws, which are driven through the holes in the ends of the plates.—*Hobbies*.

HINTS FOR CARPENTERS

Little Things for the Woodworker to Note and Remember

Every woodworker discovers little short cuts in his work which materially help him to attain rapidity and perfection, says the *Blacksmith and Wheelwright*.

In measuring with a rule, tip it on edge so that the dimension marks are adjacent to the piece being laid out, and in taking a series of dimensions start from one point only.

Always tip a plane on its side when laying it on the bench so as not to dull the iron. For the same reason always raise the plane from the work on the return stroke.

In planing end grain never run the plane entirely across the end, but work from both edges toward the center of the piece. This prevents the splitting of corners.

In using an oil stone there are three things to observe: (*a*) Use plenty of good oil; (*b*) Clean the stone well before putting it away; (*c*) Use the entire face of the stone, not merely the center. If the hole from the other side after the worm penetrates.

Do not drive a screw into a board with a hammer, as its holding qualities will be greatly lessened.

Always drive nails and brads at an angle, as they will then hold more securely.

In sandpapering always use a block if possible, as this will prevent rounding edges where they are not wanted.

Sandpaper should be used for cleaning and smoothing purposes only. Do not depend upon it for doing the tool work.

Sandpapering should not be done across grain.—*American Carpenter and Builder*.

In the Carpenter Shop

"Life's a hard grind," said the emery-wheel.

"It's a perfect bore," returned the auger.

"It means nothing but hard knocks for me," sighed the nail.

"You haven't as much to go through as I have," put in the saw.

COMPARATIVE FUEL VALUES OF GASOLINE AND DENATURED ALCOHOL IN INTERNAL-COMBUSTION ENGINES

R. M. Strong and Lauson Stone, the authors of the bulletin just issued by the United States Bureau of Mines, say in their introduction: "Under the terms of the act establishing the Bureau of Mines, this bureau was authorized to carry on the work of testing and analyzing fuels which work had been previously conducted by the technologic branch of the United States Geological Survey. That work included in its scope an investigation of the availability and uses of liquid as well as solid fuels, for the original outline of the fuel-testing investigations contemplated, a study of the liquid-fuel resources of the country and the making of related researches to determine how these resources could be utilized with greatest efficiency.

"Owing to the fact that many difficulties were being encountered in the adaptation of the heavier fuel oils for convenient use in internal-combustion engines, it was deemed best to begin the investigation of liquid fuels with tests of gasoline, a fuel in more or less general use.

"When this investigation began, the extensive introduction, especially by foreign powers, of liquid fuels for small naval craft had awakened much interest. However, the quality of gasoline was reported to vary materially in different countries and the quantity available was said to be rapidly decreasing, with the probability of a prohibitive increase in price. At the same time the claim was made that denatured alcohol, of fairly uniform quality, could be procured in all parts of the world, that unlimited quantities could be readily produced at a low cost, and that this fuel could be used much more efficiently than gasoline in internal-combustion engines. Such statements naturally led to a widespread belief that the time was near at hand when denatured alcohol would entirely displace gasoline as engine fuel. Therefore, the first investigations of the liquid mineral fuels logically embraced a careful series of comparative tests of gasoline and denatured alcohol in engines. A series of over 2,000 such tests was conducted at the Government fuel-testing plants at St. Louis, Mo., and Norfolk, Va.

HEATING VALUE

"The low heating value of completely denatured alcohol averages 10,500 British thermal units per pound, or 71,900 British thermal units per gallon.

"The low heating value of gasoline having a specific gravity of 0.71 to 0.73 averages 19,200 British thermal units per pound, or 115,800 British thermal units per gallon.

"The low heating value of 1 lb. of alcohol is approximately six-tenths of the low heating value of 1 lb. of gasoline.

"One pound of gasoline requires approximately twice the weight of air for complete combustion that is required by 1 lb. of alcohol.

"The heating value of 1 cu. ft. of an explosive mixture of alcohol vapor and air having theoretically just sufficient air for complete combustion is approximately equal to that of 1 cu. ft. of a similar explosive mixture of gasoline vapor and air—about 80 British thermal units per cubic foot.

"Explosive mixtures of alcohol vapor and air in an engine cylinder can be compressed to much higher pressures, without pre-igniting, than explosive mixtures of gasoline vapor and air. The maximum compression that can be used in an engine without causing preignition depends on the quality of the explosive mixture, the design of the engine, and the speed at which it is operated.

"For 10 to 15 h.p. 4-cycle stationary engines of the usual type, a pressure of about 70 lbs. per square inch above atmospheric pressure was found to be the maximum that could be used for gasoline mixtures, and about 180 lbs. the maximum that could be used for alcohol mixtures, without causing preignition.

"The maximum compression that could be used without causing preignition was in each case found to be the most advantageous with regard to fuel economy.

"When the degree of compression in each engine is that best suited to the economical use of the fuel designated, some type of gasoline engines are better adapted to the service for which they are designed than similar alcohol engines, and *vice versa*. This is also true (the relative quantity of fuel consumed being disregarded) when the degree of compression is that ordinarily used for gasoline mixtures, as when denatured alcohol is used in gasoline engines. But, in general, the alcohol engine is or can be so designed and constructed as to be equal to the gasoline engine in adaptability to service.

"A gasoline engine having a compression pressure of 70 lbs., but otherwise as well suited to the economical use of denatured alcohol as gasoline, will, when using alcohol, have an available horsepower about 10 per cent. greater than when using gasoline."

Copies of the bulletin may be obtained by addressing the Director of the Bureau of Mines, Washington, D.C.

TUNGSTEN AND ITS USES

An Unusual and Important Mineral Widely Employed in Various Industries

Last year there was a sharp decrease in the production of tungsten ore owing to the decrease in the demand for tool steels, in which the bulk of the tungsten produced is used, according to Frank L. Hess, in a report on this metal just issued by the United States Geological Survey. The production of domestic tungsten ore in 1911 amounted to 1,139 short tons of concentrates, carrying 60 per cent. of tungsten trioxide, valued at $407,985; in 1910, the production amounted to 1,821 short tons, valued at $832,992.

Tungsten is used chiefly in making steels that will hold their temper when heated, but it is most generally known as supplying the filament of tungsten incandescent lamps. The great improvements in drawing tungsten wire and further notable improvements in the size of the globe of the tungsten lamp and in other mechanical details that add greatly to its efficiency are making it encroach upon the carbon-filament lamp and the arc lamp, and it is rapidly driving from the market the tantalum lamp, which was the first good incandescent lamp having a metallic filament. Diamonds are used for dies in drawing tungsten wire. At first it did not seem possible to drill small enough holes through the diamonds to make wire sufficiently fine for lamps of small candlepower, but wire 0.0006 in. in diameter can now be drawn in quantity. The total quantity

jectile is made of lead with a jacket of copper-nickel alloy. The principal advantage of lead over iron, which would of course be cheaper, is that it has a higher specific gravity. Because of this fact a lead bullet will have a smaller cross section and will therefore encounter less air resistance to its flight than will an iron bullet of the same weight, and it will consequently give a flatter trajectory and longer range. An iron bullet of the same diameter as the lead bullet could of course be made of the same weight by increasing its length, but this would at once necessitate giving it a higher rotational velocity to keep its axis tangential to its flight. To impart this added rotational velocity would call for the expenditure of energy and so leave less for velocity of translation. With the exception of tungsten, lead is the densest metal which can be considered for this purpose, for gold is the cheapest of the other elements having a higher specific gravity than lead.

For military purposes the softness of lead is not an advantage, a soft-nosed bullet being tabooed in civilized warfare. For this reason and because of the fact that it is too weak to hold the rifling, it has to be jacketed with copper-nickel alloy. To take the rifling and to act as a gas check, the tungsten bullet will require a copper band

PROGRESS IN DIRECTIVE WIRELESS TELEGRAPHY

A paper by Mr. F. Addey, on "Directive Wireless Telegraphy," was read before the British Institution of Post Office Electrical Engineers. He pointed out that at an ordinary wireless telegraph station the signals were radiated equally in all directions, and that, of course, for many purposes this was advantageous. In certain circumstances it was very desirable, however, to be able to restrict the signals sent out from a station to a definite line, and to receive signals only when they came from a definite direction. For instance, by directing the emitted waves in this manner, interference with stations lying off the line was avoided and energy was saved which would otherwise be wasted. At a receiving station a directive arrangement greatly reduced trouble due to interference from other stations and from atmospheric discharges.

After describing the directive arrangements devised by Brown, Marconi, Bellini, and Tosi, the Telefunken directive aerial, and the directive experiments of Kiebitz, the author discussed the various uses to which these arrangements had been applied in practice. He pointed out that the simplest use of a directive aerial was to increase the range of a station in a certain direction. The large transatlantic Marconi stations were provided with directive inverted L aerials, because they always worked in the same direction. A most important application of directive systems was to enable ships to obtain the bearings of wireless stations on shore. When a ship was navigating within sight of shore her exact position was ascertained by the process known as "cross-bearings," and Marconi, in 1906, patented an arrangement for attaining this end. A number of inverted L aerials radiating at equal angular distances from a point were erected on the shore. By means of a switch the receiving apparatus could be joined to any one of these aerials. vantages in such a method, and Bellini and Tosi had devised a very ingenious arrangement by which a resultant aerial could be rotated while the actual aerial system remained fixed.

The French Government had fitted a large wireless station at Boulogne with the Bellini-Tosi apparatus. The aerials, each consisting of six wires, were attached to the triatic stays between the four towers employed, and were brought outwards so as to make an angle of about 30 degrees with the vertical. The station was arranged for working with a 300-metre wave, and therefore, the length of the base of each compound aerial was about half this distance. Actually the length of the base was 388 ft., or 127 metres. Non-directive apparatus was provided at the Boulogne station in addition to the directive, and the station "stands by" on that arrangement so as to be able to receive from any direction. When a ship wished to find her bearings the directive was substituted for the non-directive apparatus, and the direction from which the ship's signals were received was observed. This information was then communicated to the ship. By this system it was possible to obtain bearings correctly to within two or three degrees.

In the methods described the observation of direction was made at the shore station, and the result communicated to the ship. It would obviously be better if the ship could observe the direction of the shore station, and methods by which this could be done had been devised. The shore station might have a number of radiating aerials from which signals were successively emitted, and the ship might be provided with means by which the signals from each of the aerials, the directions of which were known, could be distinguished. Then by observing the strengths of the signals received from the developed by the Telefunken Company. The second method by which the ship could obtain her bearings without the coöperation of an operator on shore, that, namely, in which the ship was fitted with a directive installation to ascertain the direction of a non-directive installation on the shore, had been developed by the Marconi Company, and was known as the Marconi wireless compass. In this system a modification of the Bellini-Tosi system was used, the opposite halves of each directive aerial being joined together at the top. In an actual installation fitted for experimental purposes on board the *Onward*, one of the Cross-Channel boats of the Southeastern & Chatham Railway, the widths of the bases of the triangular aerials were only 42 ft. and their height only 40 ft. The ordinary aerial and wireless installation were not altered in any way when the compass system was fitted, and were used for the wireless business of the ship as before.

With the Marconi wireless compass bearings could be taken to within two degrees. The reduction in the size of the aerials from the dimensions originally used by Bellini and Tosi had not made the arrangement very insensitive, and, indeed, on board the *Onward*, using a 600-metre wave, signals were occasionally received from ships in the Mediterranean while the *Onward* was making her passages between Boulogne and Folkestone.

The utility of these methods of taking bearings to ships depended on sufficient wireless stations being built on the coasts to give the necessary coöperation. With the systems in which the bearings were actually measured on the ship, it was evidently desirable that the shore stations should be continuously in operation, and this necessitated the provision of some form of automatic transmitting gear. The French Government had taken up this question, and after experiments with two stations near Brest had decided to install wireless lighthouses or "radiophares" round the whole French coast. These stations were being fitted by the Société Française Radio-Electrique. In order to prevent interference between these continuously working radiophares and adjacent commercial stations, the recent Wireless Telegraph Conference in London had decided that they should be so fitted as not to have a range greater than 30 nautical miles and a wave-length not exceeding 150 metres.

Aviation Fatalities Analyzed

If the past year has done nothing else, it has demonstrated most conclusively that there can be no general use of aeroplanes except for war purposes until the question of safety has been solved. This is a matter which is now beyond argument. It may be true that Americans, as a result of carelessness, reckless show stunts, and the use of poor constructions have suffered far more than their due proportion of deaths, but this does not alter the basic fact that flying a machine is still a matter of balancing in the air, more or less of an acrobatic feat, and if once the equilibrium is lost, disaster is sure to come in the ensuing fall.

For 1912 the number of aviation deaths has increased from 82 in 1911 to 116. The proportion of deaths to aviators, or to distance flown, is probably no greater than in the preceding twelve months, but the difficulty lies in the treachery of the air. It may reach out and take the best, while a reckless fool escapes with a few bruises.

Americans take an unenviable prominence in the table of fatalities for 1912. Up to date there have been twenty-seven killed in this country this year, with not many more than one hundred aviators flying. France with four or five times this number in active operation has been the scene of only twenty-eight fatalities, just equaling the German record, where the military pilots alone number two hundred. England with more than double the total pilots in the United States has lost sixteen in the past twelve months; Italy, five; Russia, four, including Popoff, killed with the Bulgarian forces, and the remainder have been scattered through the smaller nations.

In 1911, France had a total of twenty-eight fatalities, just equaling those of the present year, but the added number flying makes the 1912 record by far the better. America stood second in 1911 with sixteen; Germany third, with fourteen, and then came England with five, Austria and Russia with four each, Japan, two, the rest being widely scattered.

QUESTIONS AND ANSWERS

Questions on electrical and mechanical subjects of general interest will be answered, as far as possible, in this department, free of charge. The writer must give his name and address, and the answer will be published under his initials and town; but, if he so requests, anything which may identify him will be withheld. **Questions must be written only on one side of the sheet, on a sheet of paper separate from all other contents of the letter, and only three questions may be sent at one time.** No attention will be given to questions which do not follow these rules.

Owing to the large number of questions received, it is rarely that a reply can be given in the first issue after receipt. Questions for which a speedy reply is desired will be answered by mail if fifty cents is enclosed. This amount is not to be considered as payment for reply, but is simply to cover clerical expenses, postage and cost of letter writing. As the time required to get a question satisfactorily answered varies, we cannot guarantee to answer within a definite time.

If a question entails an inordinate amount of research or calculation, a special charge of one dollar or more will be made, depending on the amount of labor required. Readers will, in every case, be notified if such a charge must be made, and the work will not be done unless desired and paid for.

1918. **Electromagnet Design.** F. M. Y., West Brooklyn, Ill., asks: Will you give me a design for an electromagnet that with a voltage of 1½ volts and current of 1 ampere or under will support about 250 lbs.? It is proposed to use one cell of dry battery of common telephone size, and the total weight of magnet and battery is to be under 10 lbs. Ans.—You are asking too much, as the space in this department is too limited for a lengthy reply. We would advise you to consult Chas. R. Underhill's book, "Electro-Magnets and Electrō Windings," which we can supply for $2.00.

1919. **Voltage Regulation.** J. B., Bridgeport, Wash., says: (1) I have thought out a device which will automatically regulate the voltage on a lighting or power system. It is in the form of two plungers working inside of two wire-wound magnets and an arm is attached to a sliding bar, on the current regulator. I want to know whether it is on the market or in use. (2) Cannot the telephone be arranged to ring the bell from the battery instead of using a generator to ring the bell, and have the bell ring by a push button contact in the battery circuit? Ans.—(1) In the absence of more detailed information, it is impossible to say whether or not your device infringes upon the patents of some of those already upon the market, but there is one whose operation is similar. (2) It would be necessary to replace the high resistance ringers of the magneto telephone with coils whose resistance would not exceed 5 ohms, and the bell would have to be of the vibrating type. Its operation probably would not be very satisfactory over a long line.

1920. **Storage Battery.** W. S. H., Carleton Place, Ont., says: An amateur here wishes me to write you thus: He has made the accumulator as per your directions in April, 1911, by Wm. C. Houghton, and has failed, *i.e.*, neither the oxide of lead nor the litharge will harden. He is under the impression that it will all chip or fall off when put to work. Please say what shall he mix in with the paste to make it hard? Reply fully. Also how

[illegible]

at that. After the grids are pasted let them dry for a day, then plunge them for the shortest possible instant in a suitable quantity of the weak solution, and let them dry for another day. If you hold them in the solution too long, the renewal of chemical action will evolve gas and the filling will be pushed out. Keep up this treatment for such a succession of days as will permit the immersion without visible chemical action. Then when the plates are finally assembled and placed in the electrolyte, no untoward action should be experienced. However, no delay must be permitted in getting the charging current into operation. If you have only a single cell, the full rate charging from a 110-volt circuit with lamps used for resistance will be very uneconomical. You can charge at a very slow rate, letting the current be that ordinarily flowing through some one or two lamps that are most used, say in some corridor. The theft of 2.5 volts might not be serious. You will find Watson's book on Storage Batteries will help you in a good many particulars.

1921. **Dynamo Construction.** A. J. A., Lithonia, Ga., says: Please find enclosed a drawing of a D.C. dynamo, and write me if the proportions are good for a machine that will generate 35 volts and 6 amperes at a reasonably low speed. If they are good, tell me what size wire for field and armature, and how many turns. The armature is 4½ in. in diameter and 3 in. long, and has 20 ½ in. round holes. The field cores are 2½ in. cross section and 3½ in. long, winding space 3 in.; coils to be form wound; field poles are of cast steel and field ring is 3 x ½ in., of wrought steel. Ans.—Unless you are counting on a very slow speed, the machine proposed is much larger than required—indeed, even at such a reasonable speed as 1,500 revolutions per minute the output could approach 1 k.w. 6 amperes at 35 volts means less than ¼ k.w., and Watson's machine of that output is as good a design as you can find. If you prefer a machine having an armature of the size you have shown, the proportions of the field

[illegible] Your

at least 4 sq. in. of section, say ¾ x [illegible] but if of cast iron, ⅞ x 5 in. With these new considerations in view, if you will make a new sketch, we will be pleased to compute suitable windings.

1922. **Dynamo Construction.** G. D. M., Bridgeport, Conn., says: I built a dynamo a while ago, and it was supposed to be 2 k.w., but could never get very much out of it. I wanted to get 110 volts, 15 to 20 amperes A.C. single-phase 160 cycles run at 3,000 revolutions per minute. It is a six-pole machine with laminated field pole cast in an iron ring. Fields are wound with No. 24 enameled wire requiring about 6 lbs. Have had anywhere from 1 to 150 volts D.C. for exciting current, but they never heated up at all under any conditions. The armature is of the single coil as per pole type, that is, it has 6 slots. It was wound with No. 19 d.c.c. magnet wire, 180 turns per slot, 1,080 total number of turns. It gave about 300 volts, 3 amperes, so rewound with No. 14 d.c.c. magnet wire but only got 40 volts 12 amperes. It seemed to be heavily loaded with one lamp (60 watts) and a voltmeter and armature heated up so bad that you couldn't touch it. So I thought the winding was wrong and went ahead and made another armature having 36 slots wound with No. 19 enameled wire, 60 turns per slot, 2,160 total number of turns, but gave only 20 volts 12 amperes. The belt slipped so much that I lost the speed of armature and the armature heated up worse than the other one. The 36-slot armature was wound with a regular D.C. winding connecting outside one coil to the inside of the next coil. The first coil was started in slot No. 1 and ended in slot No. 7, skipping 6 slots for every coil. Six leads were brought out, 3 to each collector ring. One collector ring having leads from coils 1–13–25, the other ring leads from coils 7–19–31. Both armatures have been tested in every way I could think of, and I can say that they are free from any short circuits or grounds. I also tested fields for the right polarity alternate north taken south, and they are O.K. tested with battery and galvanometer. This design of this machine was copied from a book entitled "Designs of Small Dynamos and Motors," by Cecil Poole. A couple of the field poles are out about 3-32 in. and in a D.C. dynamo it would cause sparking at the brushes, but shouldn't think it would kill it altogether. I enclose blueprint of field casting, also data on armature. Please look into it as far as possible. Let me know in what way I may cure the troubles. Tell me what the charges will be, and I will be ready to proceed if I send a reply to that effect. Ans.—We are very glad you sent the fine blueprint of the field magnet. In general we would advise you not to imitate the in slots 2 and 5, using No. 16 d.c.c. wire, 3 wide and 7 deep, 21 turns in the coil. Without cutting the wire, continue in the same direction but in slots 1 and 5. Slots 3 and 4 will be surrounded but will have no wire at all in them. Cut the wire, and in slots 8 and 11, 7 and 12 wind similar coils, and in the same direction. Similarly, in slots 14–17, 13–18; 20–23, 19–24; 26–29, 25–30; finally, 32–35 and 31–36. Thus, only 24 out of the total 36 slots will be utilized. This appears to be a defect, but is merely a recognition of the fact that a single-phase armature has only about two-thirds of the output of a three-phase machine of the same size. With the six groups of coils thus formed, join together the inside ends, or beginnings, of groups 1 and 2, then the two outside ends of groups 2 and 3, the inside ends of 3 and 4, the outside ends of 5 and 6, finally leading the outside ends of groups 1 and 6 to the collector rings. You will recognize that the connections follow exactly the same rule as for the six field coils. You can adopt the same procedure for the 6-slot armature, winding a coil around one tooth, but occupying only half the room in the slots, thereby leaving room for the coil that embraces the next tooth. You will find explicit directions for making a machine of just this sort in Watson's "How to make a 1,000-Watt Alternator." Your machine seems to be over-rated, for the most we can figure for it is 1 k.w. Watson's machine is larger, but rated at only 1 k.w., but at a lower frequency. Please let us know the results of following these directions.

1923. **Incandescent Lamp Manufacture.** C. C. B., Rochester, N.Y., asks: (1) Can you give me the procedure for obtaining a chemical vacuum after obtaining the best mechanical vacuum? (2) Why does the bulb of a small Tungsten lamp become blue when first lighted? It seems only to effect those in which the filament is close to the glass. (3) By what process are the small loops of the Tungsten filament formed? Ans.—(1) In the manufacture of carbon filament incandescent lamps, a small amount of red phosphorus is introduced into the neck of the tube through which the exhaustion is to be made. The mechanical vacuum pump removes almost all of the air, then current is turned through the filament, the heat expelling the air that was occulted in the mass of carbon. Also, when the temperature is sufficiently high, the phosphorus is ignited, the combustion being effected at the expense of the remaining traces of oxygen. At first the bulb is filled with bluish light, indicating a poor vacuum, but after the chemical combination of the phosphorus and the oxygen, the light becomes a clear white. The skilled operator closely watches for this transition in brilliancy. (2) Blueness is usually to make a dynamo and motor combined to use for starting a gasoline auto. As a motor it would need to be about ¼ h.p. or over. What size wire on armature and fields should I use; how many feet of wire; and how many divisions on commutator should I make? It is to be run on a 6-volt 20-ampere current of dry cells. Ans.—Your estimates are a little incorrect. If ¼ of a horse-power is required—almost 200 watts of effective energy—you cannot get this from a circuit involving 6 volts 20 amperes, which means only 120 watts. Further, the motor would have considerable losses, and you might have to put in 300 watts or more of electrical energy in order to get the desired ¼ h.p. Dry batteries are quite inadequate for the supply of current. The rating you have given means 6 volts on open circuit—when no current is flowing—and 20 amperes on short circuit—when the available voltage is zero. The effective condition is when a useful external circuit is connected, as, for illustration, the motor you desire to run. There might be a reasonably large current at the instant of closing the switch, but if the motor started, it would at once set up a counter electromotive force, which would reduce the current. About 1 volt and 3 amperes is all a dry cell can produce for useful effect.

1925. **Inductive Tuner.** W. H. W., Asbury Park, N.J., asks: Can you give me specifications for building an inductive tuner that will be capable of tuning to a wave such as is used by the Glace Bay, Clifden and new Arlington stations? This tuner to be used with an aerial 75 ft. in length, six-strand. Ans.—Your natural period is about 100 meters. With so small an antenna you will find it difficult to hear these stations unless you have a large tuning coil. The wave-length of Glace Bay is 6,000 meters, and Arlington about 3,800. The following is the method used by some commercial stations, and is very good, also simple. Build three coils, each 3 in. in diameter and long enough to wind 180 turns of No. 22 wire. Use No. 2 and No. 3 as the primary and secondary of an inductive tuner. Have them very close, and do not vary the coupling. Use No. 1 as a loading coil. When you wish to get long wave, have a switch to connect the dead end of No. 1 to the slider of No. 2 and a switch to throw the antenna from No. 2 to the slider of No. 1; have a ground at one end of No. 1 and No. 2. No. 3 will act as the secondary, and have the usual instruments in this closed circuit. Best results will be obtained if you have a variable condenser across the secondary.

1926. ½ **K.W. Transformer.** G. W. H., Tacoma, Wash., says: (1) Would like to know if core as shown in drawing is large enough to make a ½ k.w. transformer. If so, how much and what size wire should I use to wind primary and secondary coil to be used for wireless work? (2) What size condenser to be used with ½ k.w. transformer? Ans.—(1) The size iron you suggest would be very unsatisfactory for a transformer of this type. The August and September, 1912, issues of the *Electrician and Mechanic*, which can be furnished for 15 cents each, contain data for ½ k.w. transformers for wireless work. (2) Normally about .004 mf. is used, but with the requirement of a 200-meter wave-length it is impossible to use much over .001 mf. See the article by H. B. Richmond on this subject, in the December, 1912, *Electrician and Mechanic*.

1927. **Transformer.** C. E. P., Long Island City, N.Y., says: I have built a coil or transformer as follows: Core 1⅛ x 10 in., of No. 22 core wire; two layers empire cloth, and two layers friction tape around it; primary three layers of No. 12 D.C.C. wound in shellac and dried; insulation 1-32d micanite tube, three layers empire cloth, two layers of friction tape and cardboard tube about 1-16 in. thick. Secondary, 4½ lbs. No. 30 s.c.c. in 16 sections ¼ in. thick, those at the ends of coil being 4 in. in diameter, and in center 4½ in. Before assembling, the core and primary, and each section, were thoroughly cooked in parowax in a double boiler, allowed to cool off in wax, then carefully trimmed and scraped to size. Secondary placed in position cold, with four sheets waxed fiber between sections, and the coil again thoroughly cooked in parowax, allowed to cool in wax, then set in case, and melted wax poured in to fill the case, which was then set in oven until wax softened enough to fill all corners, after which it was cooled, and melted wax added to replace shrinkage on top. Please advise: (1) Probable efficiency and power rating of this coil as an open-core wireless transformer, and current required to operate it on 110-volt 60-cycle current. (2) What will I need as resistance or reactance in connection with it? (3) Size of secondary condenser (8 x 10 glass plates cast in parowax)? Ans.—(1) It is impossible to even approximate the efficiency of coils unless considerable work has been done on similar coils. The only way to find out is to test the coil. Unless it is very important that the efficiency be known, it is seldom worth while to find out. It would not be surprising if the coil required 150 watts on full load. (2) Use about 750 ft. of No. 8, 30 per cent. alloy German silver wire wound on asbestos-covered cores. If a reactance coil is to be constructed, make the core 1½ x 1½ in. and 8 in. long. Wind with 4 lbs. of No. 14 d.c.c. wire. After the first hundred turns, bring out taps every 25 turns. You will then have an impedance coil such as will prove valuable in experimenting. (3) From 6 to 10 pairs of elements will be required.

1928. **Inductance Coil.** J. C. W., Topeka, Kans., asks: (1) What should be the dimensions of an inductance coil for the wavemeter described in the September number of *Electrician and Mechanic*, to be used with wave-lengths under 200 meters? (2) How should the curve be plotted for this coil? (3) May a rotary condenser of different dimensions, but having the same capacity, be used? Ans.—(1) Use the same size wire and form as was used in the other coils, but reduce the number of turns to six. (2) To plot a curve for a coil it is necessary to have a standard wavemeter. By means of the standard wavemeter some oscillatory circuit is adjusted to a known wave-length, then the scale reading for the meter under consideration is noted. By using the scale reading for an abscissa and the known wave-length for an ordinate, one point of the curve is determined. By repeating this process it is possible to obtain sufficient points to determine the curve. (3) Yes.

1929. **Dynamo.** G. C., Upper Sandusky, Ohio, wishes to rewind a small dynamo that has a single coil field magnet, a 12-slot armature and a 6-segment commutator. If No. 22 wire is used on field magnet, what size should be put on armature? Ans.—In the absence of any actual dimensions of the machine, our answer can but be guesswork. The machine should work if you put No. 18 on armature, and connect the field as a shunt, or use No. 26 on armature and connect the field winding in series. For general experimental purpose the shunt connection is more useful. The commutator would be better if it had 12 segments rather than 6. You should have sent a carefully drawn sketch of the field magnet and armature core, specified the dimensions, the output desired, and the speed. Then we could have advised you much more definitely.

1930. **Medical Coil.** H. T., Brooklyn, N.Y., asks: Please give me directions for making a medical coil with four connecting or binding posts, two high and two low. Ans.—In the absence of explicit statements of just what output you want, we will suggest a simple construction for a small and inexpensive coil that will certainly be useful for many experiments or treatments. Of course we expect that you have access to use of suitable working tools. Find a stick of hard wood about 1½ in. square and 6 in. or 7 in. long. Bore a ½ in. hole lengthwise. Mount stick on an arbor and turn it to about 1⅛ in. in diameter. Leaving the ends at this size for ⅜ in. or more, turn the portion between to a diameter of ⅝ in. Similarly make four short wooden spools, 1¼ in. inside diameter, 2½ in. outside diameter, and 1½ in. long, flanges being about ⅛ in. or 3-16 in. thick. Soak all five in melted paraffin, and when dry, wind the long spool with four layers of No. 18 d.c.c. wire, and the small ones with No. 36 s.c.c. wire. Ends of the coarse wire may be led directly through the heads of the spool, but for the fine wires, slanting holes will be best, so the ends leading to the bottom will be left at the outer edge rather than near the center. To minimize danger of breaking off this inner end it is well to double or triple the wire and twist it in a sort of cable. Again soak the wound spools in melted paraffin for a few minutes. Wind several layers of tough paper around the long spool until a thickness is secured to make the other spools a snug fit. Slip those four in place, and connect inside end of one coil to outside of other, so as to give the effect of a continuous winding, and connect these junctions to a row of binding posts. Counting in the extremes there will be five posts in all for this secondary portion of the winding. The primary will have two more. Obtain some tinsmiths' annealed iron wire for the magnet core. This can be finely straightened by forcible stretching

or less of the secondary coils, a variation of voltage may be secured, and by connecting to the two parts that carry the platinum contacts, an interrupted primary effect may also be obtained.

1931. **Electric Pocket Book.** J. Y., Jr., Floreffe, Pa., says: Please let me know which is the best electric pocket book for the troubles of motors, how to repair them and how to run them slow or fast; also the price. Ans.—Perhaps the book published by the Cleveland Armature Works, or Crocker's book on Dynamo and Motor Troubles will suit. The latter can be furnished by us for $1.00.

1932. **Inductance.** T. C., Newport, R.I., asks: (1) What is the formula for finding the inductance (in centimeters) of a tuning coil? (2) At what time of night does Glace Bay, C.B., send out long distance press news? (3) The formula for the wave-length of a station contains the expression, $\sqrt{LC}$. In order to keep this a constant, an increase of one value would, of course, require a decrease of the other, yet if I increase the inductance in the secondary of my loose-coupler, it requires an increase of capacity to bring a station in tune again. The loose-coupler is one of Clapp-Eastham's old type—not a Blitzen. What causes this apparent impossibility? Ans.—(1) The February, 1911, *Electrician and Mechanic* contained an article on this subject, by Mr. E. C. Crocker. (2) We have heard them going about every hour of the night from early evening until morning. They send commercial messages for the most part. (3) There is a possibility that you are tuning to an overtone, that is, some wave-length such as twice the original. Are you sure that your condenser scale does not read degrees "out" instead of degrees "in," so that you are really decreasing your capacity instead of increasing it?

1933. **Wireless Station.** E. A. F., Sound Beach, Conn., asks: (1) Can a windmill tower be used to advantage as an antenna for a wireless station? (2) If not, could it be used for a support for such an antenna? (3) If it can be used to advantage in either of the above ways, would it be advisable to set the foundation in concrete as a sort of insulation? Ans.—(1) No, because of the absorptive and magnetic powers of iron. (2) Yes, for small power amateur stations it would serve very well. (3) It would be best to set it in concrete, but for amateur work it would hardly be worth the expense.

1934. **Auto Transformer.** H. A. V., Rochelle, Ill., says: I notice in your December issue, under "The Construction of an Auto Transformer," that you state that the supply current of 110 volts should enter at *A* and *J*. Is that correct? If so, what function do the ends *X* and *Y* do? Am constructing one of these coils but this item rather puzzles me.
Ans.—

BOOK REVIEWS

Motion-Picture Work. A General Treatise on Picture Taking, Picture Making, Photo-Plays and Theatre Management and Operations. By David S. Hulfish. Illustrated. Chicago, American School of Correspondence, 1913. Price, $4.00.

The field of motion-picture work is now so wide, and the industry has attained such commanding importance in the economic life of the United States, that a thorough compilation of our knowledge on the subject is not only desirable but fills a great want in technical information. This imposing volume, containing many hundred pages, the number being difficult to estimate because the illustrations are not included, is a comprehensive treatise which covers the whole subject in all its branches. Beginning with the simple optical lantern, it explains the principles of projection of lantern slides of the simple and the dissolving lantern with gratifying thoroughness. From this the transmission to the moving-picture machine is easy, and the motion head in all its parts is described. The various makes of moving-picture machines on the American market are then gone into in full detail. The second part of the book describes the making of motion-picture films, both photographically and as regards the construction of the equipment. The management of a moving-picture theatre is fully described, and finally the electrical principles involved are considered at length. There seems to be no department of the work which is not adequately treated, and we cordially commend the book as a thorough-going helper to anyone interested in the subject.

Popular Mechanics Shop Notes for 1913, Vol. IX. Popular Mechanics, Chicago, Price, 50 cents.

The title on the outside cover of this useful book is "Popular Mechanics Year Book," but it continues the series of shop notes which have proved so useful in the last nine years. It consists, as previously, of pages reprinted from "Popular Mechanics," and contains an enormous variety of useful hints on every kind of mechanical work. Anyone interested in mechanics of any kind will find many articles of value to him in this compilation.

Saw Filing and Management of Saws. By Robert Grimshaw, M.E. New York, The Norman W. Henley Pub. Co., 1912. Price, $1.00. A Practical Treatise on Filing, Gumming, Swaging, Hammering and Brazing Band Saws. Speed, Power and Work to Operate Circular Saws, etc. With Full Directions for Filing, Setting, Polishing, Joining, Straightening and Polishing Hand, Butchers, Band and Circular Saws. Files to Use, Useful Hints for Repairing and Caring for Saws. Coiling and Brazing Hand Saws, Home-made Sets [illegible]

Manual Training Toys for the Boy's Workshop. By Harris W. Moore, Supervisor of Manual Training, Watertown, Mass. The Manual Arts Press, Peoria, Ill. Price, $1.00.

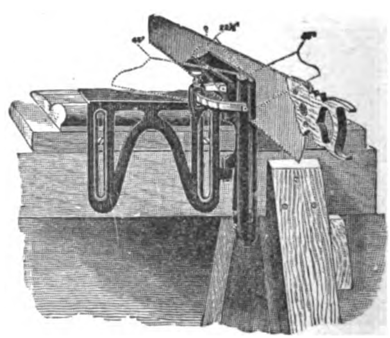
This book, while written for young manual training students, describes the making of many things which will appeal to older tool users, such as the ever popular "Happy Jack" windmills, and other interesting things, which will find ready sale, as well as prove interesting at home. The bulk of the toys described, however, are for the use of school boys, and the directions and work involved are well within their abilities. The choice of subjects is excellent and the treatment is thorough-going.

We acknowledge receipt from D. Van Nostrand Co., of a catalog of books on Electricity, classified by subjects, being Part II of their Catalog of Scientific Books. It will be sent to any interested reader on request addressed to D. Van Nostrand Co., 25 Park Place, New York.

TRADE NOTES

Our readers no doubt will be interested in a practical mitre box that weighs but 2 lbs., and that can be folded and carried in any ordinary tool chest. For cutting mitres in conduit or molding, it has no equal.

We refer to the "RED DEVIL" Mitre Box shown herewith. It is manufactured by the Smith & Hemenway Co., 150–152 Chambers St., New York, who also manufacture over 3,000 various styles of tools for carpenters, electricians and mechanics generally.



The "RED DEVIL" Mitre Box is all metal. It is light (2 lbs.) and is self-contained, that is, it is all complete, and has no extra parts to become misplaced or lost. It is so constructed that any width, depth or length of mitre can be cut, and any saw can be used. No special mitering saw is required. The mitering gauge is so simple that a child can use it. All that is re- [illegible] gauge at any angle [illegible] The

The Most Practical Electrical Library

The Electrical Engineering Library is part of the International Library of Technology that cost $1,500,000 in its original preparation. It contains the knowledge given from the life experience of some of the best electrical engineering experts in the country, edited in a style that nineteen years of experience in publishing home-study textbooks has proved easiest to learn, to remember, and to apply. There is no other reference work in the world that so completely meets the needs of the electrician as the Electrical Engineering Library. The volumes are recommended by the highest authorities and are used in nearly all the leading universities and colleges. Not only can they be used to great advantage by superintendents, foremen, and engineers as an authoritative guide in their work, but since they can be so clearly understood, even by persons having no knowledge of higher mathematics, they can be used by all classes of electricians that are desirous of advancing to higher positions.

A few of the many subjects contained in the Electrical Engineering Library are as follows: Electricity and Magnetism; Electrodynamics; Electrical Resistence and Capacity; Magnetic Circuit; Electromagnetic Induction; Primary Batteries; Electrical Measurements; Dynamos and Dynamo Design; Direct-Current Motors; Alternating Currents; Alternators; Electric Transmission; Line Construction; Switchboards; Power Transformation and Measurement; Storage Batteries; Incandescent Lighting; Arc Lighting; Interior Wiring; Modern Electric Lighting Devices; Electric Signs; Electric Heating; Elements of Telegraph Operating; Principles of Telephony; Telephone Circuits, Receivers, Transmitters, Apparatus, Bells, Instruments, and Installation; Magneto-Switchboards; Electric-Railway Systems; Line and Track; Line Calculations; Motors and Controllers; Electric-Car Equipment; Multiple-Unit System; Efficiency Tests; Energy Regulation; Central Energy Systems, Main and Branch Exchanges; Common-Battery Signaling Systems; Bell-Energy System; Bell Trunk Circuits; Bell Toll and Testing Circuits; Exchange Wiring; Telephone Cables, etc.

The Electrical Library con-
tains

International Textbook

TRADE NOTES

The new wireless laws applying to license and traffic regulation serve to emphasize more strongly if possible, the importance and responsibility of the wireless operator's position today. Those who intelligently follow the progress of modern events will not need to be informed of the international recognition as a safeguard on the high seas radio-telegraphic communication is receiving.

The steadily increasing demand for qualified ship operators and land station operators, directly resultant upon legislation which provides that a licensed wireless operator shall be continuously on duty, making a second or relief man necessary, was realized by Vincent T. Thomas, principal of The Massachusetts College of Telegraphy at 899 Boylston St., Boston, Mass. With the advent of the first license law in 1911, this school at once recognized the valuable and practical utility of a wireless institution which could specialize in the preparation of licensed operators for Government and Commercial services. To this end the college has been steadily compiling a system based upon the entire series of questions (both practical and theoretical) submitted at The Charlestown Navy Yard during the various first-class operator's license examinations, with the result that it has long since received the hearty endorsement of The Marconi Wireless Telegraph Company, which company is at present hiring its operators directly from the classroom of "M.C.T." after first-grade licenses have been secured by the graduates.

The college is now making a special lecture feature of The Marconi Auxiliary Storage Set, and the student is trained in its care and manipulation. The institution is already in possession of a standard auxiliary set which is operated by the student when competent, in addition to the regular loosely coupled 1 k.w. station.

The principal is informed by the Boston Marconi Manager that the company was never in greater need of good reliable men as a result of the dual operator law.

Amateurs are very cordially invited to visit the school during session hours, and will be given permits to visit some of the many ship station M.C.T. graduated operators, who sail from Boston port.

Mr. Thomas is particularly suited to take charge of an institution that has already earned the reputation of faithfully studying the best interests of student and company alike, having been one of the pioneer operators to serve with Manager A. E. Taylor under Signor Marconi at the time of the installation of M.C.C. long distance wireless station at South Wellfleet, Mass.

New England Wireless Society Meeting

The New England Wireless Society met January 4 at Harvard University to listen to a very interesting talk by Prof. G. W. Pierce assisted by Dr. E. L. Chaffee on the subject of "Resonance in the Receiving Set." The talk was illustrated by various physical and electrical experiments, including an oscillagraphic device for producing a visual record of the oscillations as actually occurring in a wireless telegraph transmitter. After the talk an informal discussion as to the probable and to what extent permissible amateur interference should take place under the provisions of the new law.

The next meeting will be held at 8 p.m., February 1, at the Walker Building, of Massachusetts Institute of Technology, corner of Boylston and Clarendon Sts., Boston. Dr. Reginald Fessenden will address the society. Other notable speakers of the year include Prof. A. E. Kennelly, who has done so much excellent work on high potential A.C. Information regarding the society may be obtained from Mr. E. W. Chapin, 43 Thayer Hall, Harvard University, Cambridge, Mass.

The following letter shows in a very practical way the appreciation of the L. S. Starrett Co. for the faithful work and co-operation of its employees:

To Our Employees:

The past year has been one of prosperity and progress.

The gradual and steady increase in our sales is gratifying, but not less significant and encouraging is the manifest improvement in conditions inside the factory.

Our employees have shown that they appreciate more than ever before the fact that their interests and the Company's are identical; that Quality in our product is the chief thing—the indispensable thing—and that next are efficiency and loyalty on the part of our co-workers.

When a man gets over the idea that he is paid for simply putting in so many hours a day and turning out just enough work to get by, and puts intelligent, interested effort into what he does, and even gets a bit enthusiastic over finding a way to improve the quality or increase the amount of his production, his value to the Company is largely increased, and he is in a way of making much more of a man of himself. We want men, not human machines; not time alone, but brains. A man who is worth twenty dollars a week takes up no more room than one who is hardly worth ten. We are glad to repay increased efficiency by increased wages. We have made many increases in pay during the year for this reason.

We feel, however, that the increase in efficiency due to intelligent and interested industry in our plant during the past year has been so general and has been such an important factor in the healthy growth of our business, that we may well make some special recognition of it at this time. It was therefore voted by our Directors at a meeting held the eleventh instant, to pay, as soon after the first day of January, 1913, as practicable, *to each person in the employ of the company on that date, a sum equal to two per cent. of the entire amount of wages paid to such employee during the year* 1912.

THE L. S. STARRETT CO.

Athol, Mass., 20 December, 1912.

The Massie Wireless Telegraph Co., located in Providence, R.I., advise us that they have sold out to The Marconi Wireless Telegraph Co. of America, and are disposing of all their extra instruments and parts at a very low figure. All those interested in wireless instruments or parts of wireless instruments had better communicate at once with this firm, whose advertisement appears elsewhere in the pages of our magazine, as they will no doubt make quick sales of the stock on hand. It will be "first come, first served."

Send for Copy of Our New Wireless Manual M1

It contains 96 pages and tells how to erect and maintain wireless telegraph stations. Shows a number of diagrams. Has the Morse and Continental Telegraph Codes. Illustrates the best instruments to use; tells what they are for and how to use them. Do not wait until some other time, but sit down now and send your name and address, and get one. It costs you nothing.

Send for Our Pocket Catalog M26

It contains 212 pages, with over 1,000 illustrations, and describes in plain, clear language all about **Bells, Push Buttons, Batteries, Telephone and Telegraph Material, Electric Toys, Burglar and Fire Alarm Contrivances, Electric Call Bells, Electric Alarm Clocks, Medical Batteries, Motor Boat Horns, Electrically Heated Apparatus, Battery Connectors, Switches, Battery Gauges, Wireless Telegraph Instruments, Ignition Supplies, etc.**

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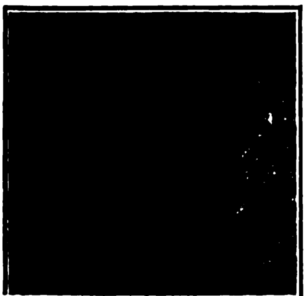

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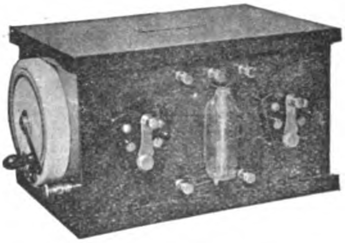

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"... I also wish to compliment you on the satisfactory way in which your Valve Detector stood the test, both as to sensitiveness and durability, on our trip down. While south of Cuba and off the South American coast we had considerable heavy weather, also bad static and lightning. While I could hear several other ships complaining of their detectors falling down under the strain, yours was acting in its usual manner, unexcelled. It seems impossible to knock it out of adjustment, and as a test, have transmitted without shunting; but it never varies a particle.

"I also heard stations up to 2,500 miles, previously getting only from 1,000 to 1,500 miles. Cannot recommend this instrument highly enough."

Price Complete with 4v. Storage Battery, $20.00
Without Storage Battery, $15.00

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WIRELESS TELEGRAPHY

In response to many requests, we publish below a list of books on wireless telegraphy, with the price at which we can furnish them, postpaid.

ASHLEY, CHAS. G., E.E., and HAYWARD, C. B.
Wireless Telegraphy and Telephony (Including Wireless on Aeroplane and Airship).—Contains 144 pages. Treats in a simple, concise manner earlier forms of wireless, electrical waves, development of radio-telegraphy, apparatus and systems. The section on Wireless Telephony covers Bell's radiophone, selenium cell, Bell's photophone, "light telephony," telephony by means of Hertzian waves, nature of a high-frequency telephone current, oscillation generators, telephonic control of oscillations, transmitting circuits, receiving arrangements, two-way transmission, and systems of radio-telephony, with a section on Aeronautics covering wireless on dirigibles, aeroplanes and balloons, dangers from electric discharge, preventive methods, wireless on the Zeppelins, Horton's experiments, recent records, and general problems. 1912. Cloth **$1.00**

BISHOP, LEON W.
The Wireless Operator's Pocketbook of Information and Diagrams.—Thoroughly describes latest transmitting and receiving instruments. 150 illustrations. All tables necessary for wireless operators, one showing how to compute roughly, sending and receiving distances. Full leather, flexible, pocket size **1.50**
Leatherette .... **$1.25** Cloth **1.00**

COLE and MORGAN.
Lessons in Wireless Telegraphy.—For the person who desires to take a glance into the art of wireless telegraphy it is hard to imagine where he could get more practical information for so small an expenditure than by the reading of this pamphlet. The complete subject as necessary for the practical operator or experimenter to be familiar with in order to construct and operate a set is treated in sufficient detail to enable him to get an excellent conception of the subject. The method of treatment is that of dividing the subject into thirty parts or lessons. 1912 .... **.25**

COLE, A. B., and POWELL, A. M.
Amateur's Wireless Handybook.—The authors have reprinted the navy list of stations, and have Morse and Continental speed code charts. Book is filled with transmitting and receiving circuit diagrams, very useful to have on hand .... **.25**

EDELMAN, PHILIP E.
Experimental Wireless Stations, Their Design, Construction and Operation, with particular respect to the requirements of the new wireless law.—Contains 224 pages. Complete, concise, clear, understandable. Written by an experimenter who knows just what the readers want. The first book to give standard experimental designs in accordance with the new requirements. Contains full instructions for complying with the law, building and operating apparatus and stations, modern up-to-date instruments, simplified calculations, formulas and designs. A real "How it works and how to make it" book. 1912. Cloth, **2.00**

FLEMING, J. A.
Principles of Electric Wave Telegraphy.—A comprehensive digest of wireless telegraphy in all of its branches. One of the most complete and practical books ever published on this subject; new and enlarged edition **7.50**
Elementary Manual of Radio-telegraphy and Radio-telephony f...

HARRISON, NEWTON, E.E.
Making Wireless Outfits.—A concise and simple explanation on the construction and use of simple and inexpensive wireless equipments, for sending and receiving up to 100 miles, giving full details and drawings of apparatus, diagrams of circuits and tables. 12 mo. cloth, **50c**; in paper covers .... **.25**
Wireless Telephone Construction.—How to make and use an inexpensive equipment. Cloth .... **.50**
Paper .... **.25**

HOWGRAVE-GRAHAM, R. P.
Wireless Telegraphy for Amateurs.—A handbook on the principles of Radio-telegraphy and the construction and making of apparatus for long-distance transmission. 51 illustrations. Cloth. **1.00**

KENNELLY, A. E.
Wireless Telegraphy and Telephony.—Enlarged and reprinted. The whole story of wireless telegraphy from its invention to its very latest development, including the most complete and popular explanation of its underlying principles and their application **1.14**

MORGAN, ALFRED POWELL.
Wireless Telegraph Construction for Amateurs.—A manual of practical information for those who wish to build experimental wireless instruments which can be considered as something more than toys, but are still considerably less expensive than a high-grade commercial set. No attention has been paid to the history of the art, the space, instead, being devoted to short but complete explanations of the uses of the various instruments, as well as the structural details. 1910 .... **1.50**

MORGAN, ALFRED P.
Wireless Telegraphy and Telephony Simply Explained.—A practical treatise embracing complete and detailed explanations of the theory and practice of modern radio apparatus and its present-day applications, together with a chapter on the possibilities of its future development. Has 150 illustrations of sets in actual operation and wiring diagrams of these sets shown in perspective. Each piece of apparatus used in a wireless station is completely described, and in most cases illustrated by actual photographs of various types of the instrument. This book should prove valuable both for the novice and to the experienced experimenter. 1913 .... **1.00**

PIERCE, GEO. W., Asst. Professor of Physics in Harvard University.
Principles of Wireless Telegraphy.—Just reprinted with corrections. The treatment of wireless telegraphy in this volume is strictly scientific. The book takes up the subject from the historical standpoint and develops each section of the art from its beginning to the present stage of knowledge. It shows fully why the earlier forms of apparatus in each instance have been discarded, and thereby enables the student to discover the merits which enabled present forms to survive. The chapters on detectors of all kinds are especially full and practical. While the book is not quite as full as Fleming's great manual, it covers all the points which the average specialist desires to know, and is an adequate presentation of the present state of the art. 1912 .... **3.00**

ROBINSON, Lieut. Com. S. S.
Manual of Wireless Telegraphy for Use of Naval ... complete and in- ... **1.50**

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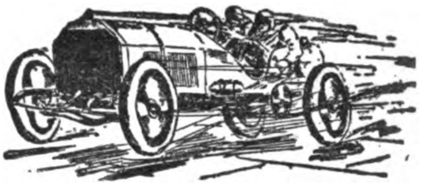

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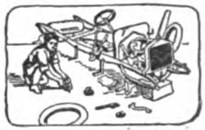
"**I am working in a repair shop.** Have increased my income $20 more per month so far, and expect to get as high as $50 more per month."—Jno. C. DeKoster, Lynden, Wash.



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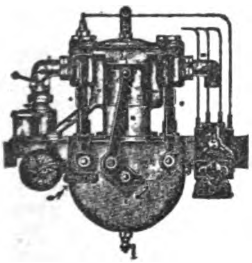

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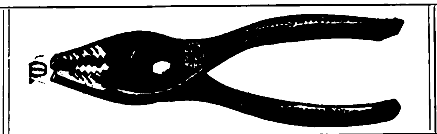

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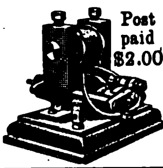

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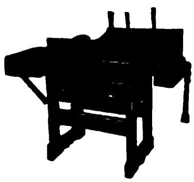

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For the convenience of readers who wish to subscribe to more than one magazine we have arranged this page, which contains a list of the leading general, photographic and mechanical magazines of the United States. It saves you time, money and trouble to order all your magazines at one time from a reputable house, which can always be reached to adjust complaints. Do not pay your money to unknown solicitors, but send your orders to us. Subscriptions may begin at any time, need not all be sent to one address or begin at the same time, and may be either new or renewal, unless otherwise specified. Remit by postal money order. If personal check is used, add 10 cents for collection. Periodicals sent to Canada and foreign countries cost more to cover the postage. Always ascertain from us the proper rates for such subscriptions.

If you do not find the periodicals you want listed on this sheet, write to us for terms. We will duplicate the prices quoted by any reliable agency on any periodical or combination.

DIRECTIONS

From the list below select your magazines, add their class numbers and multiply by five—the result is the cost in dollars and cents. For instance:

Class Number:	ELECTRICIAN AND MECHANIC	24
" "	POPULAR PHOTOGRAPHY	15
" "	AMERICAN PHOTOGRAPHY	24
		— Cost
		63 x 5 = $3.15

Class No.	Publication
25	Abel's Photographic Weekly
25	Adventure
53	Aeronautics
27	Ainslee's
30	All Story Magazine
17	Amateur Photographer's Weekly
35	American Art News
17	American Boy
55	American Homes & Gardens
80	Amer. Machinist (w)
23	American Magazine
24	**Amer. Photography**
19	Amer. Motherhood
30	Argosy
35	Arts & Decoration
47	Automobile
20	Auto. Dealer & Repairer
17	Black Cat
27	Blue Book
17	Boys' Magazine
20	Building Age
30	Bulletin of Photog.
22	Camera
20	Camera Craft
17	Camera Craft (new)
170	Camera Work
80	Cavalier
80	Century
23	Cosmopolitan
70	Country Life in America
53	Craftsman
50	Current Literature
23	Delineator
12	Designer
37	Dress
20	Electrical World (m)
60	Electrical World (w)
24	**Electrician and Mechanic**
26	Electric Journal
23	Etude (for music lovers)
23	Everybody's
23	Field and Stream
47	Forest and Stream
20	Foundry
23	Garden Magazine
18	Gas Engine
20	Gas Power
8	Gas Review
23	Good Housekeeping
20	Harper's Bazaar
70	Harper's Magazine
70	Harper's Weekly
23	Hearst's Magazine
12	Home Needlework
50	House & Garden
20	Housekeeper
8	Housewife
50	Independent
95	International Studio
100	Iron Age (w)
40	Iron Age-Hardware
8	Ladies' World
90	Life
35	Lippincott's
60	Literary Digest
20	Little Folks
30	Manual Training Magazine
9	McCall's Magazine
23	McClure's Mag.
40	Metal Worker
23	Metropolitan
56	Model Engineer & Electrician
23	Modern Electrics
17	Modern Priscilla (2 years, class 23)
17	Mothers' Magazine
60	Motor
35	Motor Boat
17	Motor Boating
18	Motor Cycle Illus.
17	Motor Print
23	Musician
45	National Geograp'ic Magazine
17	National Sportsman
70	North American Review
24	Outdoor Life
50	Outing
60	Outlook
25	Overland Monthly
20	Pearson's Magazine
24	Photo Era
20	Photographic News
27	Photographic Times
50	Photo Miniature
23	Physical Culture
17	Pictorial Review
23	Popular Electricity
60	Popular Magazine
15	**Popular Photog'y**
9	Poultry Herald
9	Poultry Keeper
7	Poultry Success
18	Practical Engineer
40	Printers' Ink
30	Railroad Man's Magazine
23	Red Book
35	Review of Reviews
35	School Arts Magazine
60	St. Nicholas
40	St. Nicholas (new)
55	Scientific American
60	Scribner's
23	Short Stories
45	Smart Set
30	Strand
50	Suburban Life
23	Sunset
40	System
23	Technical World
50	Travel
22	Violinist
10	Violin World
70	Vogue
47	Wilson's Photo. Magazine
25	Woman's Home Companion
37	World's Work
35	Yachting
40	Youth's Companion

The following magazines are sold only at the full subscription price and are never clubbed.

Ladies' Home Jrl.	$1.50
Munsey's	1.50
Popular Mechanics	1.50
Saturday Ev. Post	1.50

THESE RATES ARE SUBJECT TO CHANGE WITHOUT NOTICE

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ELECTRICIAN & MECHANIC
221 Columbus Ave., Boston, Mass.

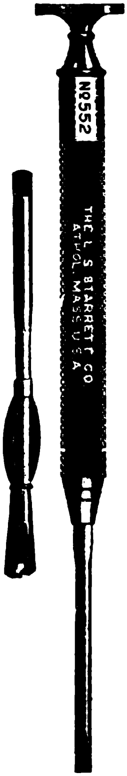
Enclosed find $..........in payment of my subscriptions to the magazines indicated. Begin with....................

Name ....

Address ....

....

24	Electrician & Mechanic
	× 5 =



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It has laminated field and armature cores. 20 section commutator of hard drawn copper, insulated with mica. End thrust carbon brushes. Phosphor bronze bearings with wick oil retainers. Black enamel finish with brass trimmings.

We furnish this standard winding, 60 cycle A.C., 110 volts, .21 amp. 23 watts. Speed with average load, 1,800 R.P.M. Size of pulley 1″. Size of shaft 3-16″. Space occupied 4 3-4 x 3 1-4 x 3 3-4.