

by means of a longitudinal shaft, which is fitted with mechanism, by means of which the impulsoria can be adjusted transversely, to keep the driving axle level, and to prevent the endless platform from sloping cross-wise, when traversing a road one of whose sides is higher than the other.

"And lastly, I claim in an apparatus adapted to propulsion by animals, substantially as herein described, the employment of a single driving wheel, arranged in such manner as to admit of being leaned towards the hill in traveling across slopes, to prevent a transverse sloping of the endless platform on which the animals walk, when the wheel thus arranged is steadied by a pilot before, and a follower behind, or their equivalent, substantially as herein set forth."

15. For an *Improvement in Circuit Changers for Electro-Magnetic Telegraphs*;
Chas. S. Bulkley, Macon, Georgia, September 2.

"In order to transmit intelligence by telegraph, for very long distances, it has been found necessary to have what are called "relay circuits;" the vibrations of making and breaking the circuits in writing being communicated from one to the other, by "receiving magnets." But by these means the writing can only be done in one direction, unless a re-arrangement is made in the connexions, which can only be done by the operators at the intermediate stations, and consequently, if they wish to write back, or if an error takes place, or any other difficulty occurs, the writer cannot be notified of it, without considerable difficulty. My invention is designed to obviate these defects, and to put it in the power of the operators at either end of the line to arrange the circuits at the intermediate or relay stations, suitably for them to transmit the message, and the operator at the opposite end having the power to interrupt and write back at pleasure; and besides, in the event of any of the circuits breaking, the operator is immediately aware of it, by his own instrument ceasing to operate."

Claim.—"What I claim as new is, the "circuit changer," substantially as above described, in combination with the arrangement of wires, magnets, &c., as set forth, for the purpose of enabling the operator at either one of two distant stations to arrange the connexions at the intermediate stations, so that he can write through to the other end station at pleasure."

MECHANICS, PHYSICS, AND CHEMISTRY.

For the Journal of the Franklin Institute.

A few Suggestions as to the Manner of Laying Out a Propeller, when the Dimensions of the Vessel are given. By J. W. NYSTROM.

When a propeller vessel is to be built, we first have the dimensions of *tonnage*, *length*, and *beam*. From them the ship-builder lays out the lines of the vessel, and ascertains the tonnage, greatest transverse section, area of the displacement, draft of water, &c. From these the propeller is to be constructed, and suppose the following to be the dimensions, viz:

Length on Deck,	230 feet.
Beam,	35 "
Draft of Water from bottom of keel,	15.5 "
Greatest transverse sectional area of displacement,	500 sq. ft.
Displacement,	1770 tons.

Diameter of Propeller.—The diameter depends on the draft of water, and in this instance can be made 14 feet, when the draft of water is 15.5.

Pitch.—The pitch of a propeller depends on the arrangement of the steam engine, as if it is with gearing or direct action.

Let the number of revolutions of the propeller be n , when the number of revolutions of the steam engine is n' , a proper pitch will be

$$P = 2.5 D \sqrt{\frac{n'}{n}}, \quad . \quad . \quad . \quad . \quad . \quad (1.)$$

in which D denotes the diameter of the propeller in feet, and P the pitch, also in feet.

If the propeller is to be centripetal, the pitch can, without detriment, be taken larger than with straight-bladed propellers, and in this instance we will construct the propeller for a direct action steam engine, and take the pitch

$$P = 2\frac{1}{2} D = 2.625 \times 14 = 36.75 \text{ feet.}$$

Slip.—The slip depends on the displacement, and greatest sectional area of displacement, when the propellers have equal pitch in proportion to the diameter.

$$S = \frac{\bigcirc^2 + \sqrt[3]{Q^2}}{10 A}, \quad . \quad . \quad . \quad . \quad . \quad (2.)$$

or
$$S = \frac{500 + \sqrt[3]{1770^2}}{1540} = \frac{646}{1540} = 0.42 \text{ per ct.}^*$$

$\bigcirc^2 = 500$ square feet, greatest sectional area.

$Q = 1770$ tons displacement.

$A = 154$ square feet, or $0.785 d^2$.

Propellers with less pitch in proportion to the diameter will give less slip, but in those instances the slip is not a measure of loss of effect or quality of propellers. The slip is nearly constant with different velocities until a certain limit; when it exceeds that, the slip will increase by the excess of velocity.

Velocity of the Propeller.—The velocity of propellers depends on the pitch, diameter, and slip, and can by them be proportioned to suit the steam engine. The proper velocity or number of revolutions per minute n , in order to give the vessel the highest speed with the greatest economy of fuel, is

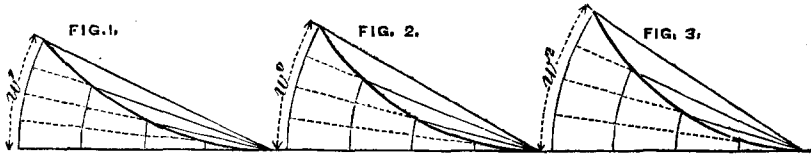
$$n = \frac{200}{S P} \sqrt{D}. \quad . \quad . \quad . \quad . \quad . \quad (3.)$$

$$n = \frac{200}{0.42 \times 36.75} \sqrt{14} = \frac{200 \times 3.74}{0.42 \times 36.75} = 48.5 \text{ revolutions.}$$

From this number of revolutions, pitch, slip, and diameter, the *power* of the steam engine is to be ascertained; but, before entering into that, we will finish the propeller. The propeller to be centripetal; (see Vol. XXI., 3d series, page 345,) we have the angle w° as follows:

* Perhaps it will be deemed that 42 per cent. slip is too much compared with the common announcement of slip; but in a calculation like this the *fact* must be followed. We often hear, and sometimes see, the slip *on paper* to be 10 or 20 per cent., which does not always correspond with the slip *in the water*.

$$\text{Fig. 1.} \left\{ \begin{array}{l} {}^{\circ}w = \frac{D n^2 S^2}{200}, \\ {}^{\circ}w = \frac{14 \times 48.5^2 \times 0.42^2}{200} = 29^{\circ}. \end{array} \right. \quad (4.)$$



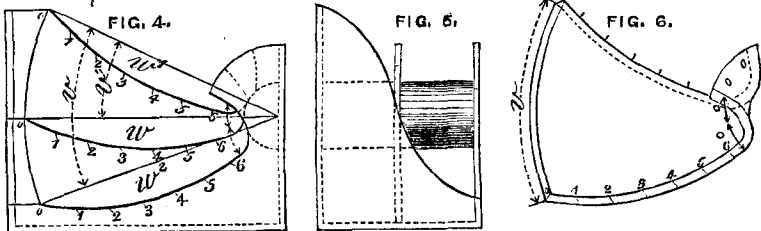
Compute two more angles, 1w and 2w , from the following formulæ:

$$\text{Fig. 2.} \left\{ \begin{array}{l} {}^1w = \frac{{}^0w}{2} (2-S). \quad . \quad . \quad . \quad . \quad . \quad (5.) \\ {}^1w = \frac{29}{2} (2-0.42) = \frac{29 \times 1.58}{2} = 22.91^\circ = 22^\circ 55'. \end{array} \right.$$

This is to be the first edge of the propeller, and the following the after edge:

$$\text{Fig. 3.} \left\{ \begin{array}{l} {}^{\circ}w = \frac{{}^{\circ}w}{2}(2+S). \\ {}^{\circ}w = \frac{29}{2}(2+0.42) = \frac{29 \times 2.42}{2} = 35.09 = 35^{\circ} 5' 20''. \end{array} \right. \quad (6.)$$

In each of these angles, 0w , 1w , 2w , construct a curved line, as in fig. 1, 2, and 3; place them on a common axis, fig. 4, so that the planes on which the curved lines are drawn shall be at right angles to the axis, and a distance between the two curved lines 1w and 2w equal to the length l of the propeller. See fig. 5 and 8.



Number of Blades.—The number of blades in a propeller depends on the *slip*, and the angle V , fig. 8. The more slip, and the larger the angle V , the less the number of blades should be. As to the number of blades in a propeller, it is known from experiment, that a less number do better or just as well as a greater; it may be so under some circumstances, but is not always. In canal and tow boats, where the slip is considerable, a two or three-bladed propeller will no doubt do the best execution, but for vessels which are to run fast, and the propeller to have a slight slip, a six-bladed propeller should give the greatest effect; but in such cases the propeller must be particularly constructed, and the length l , fig. 5

and 8, be only one-quarter ($\frac{1}{4}$) of the diameter. If this is disproportioned, and the blades are wrong, of course there ought to be a less number of them; but whatever the number of blades may be, take the length l from the following formula (7). The number of blades is denoted by the letter m , and in the propeller we are constructing we will take five (5) blades.

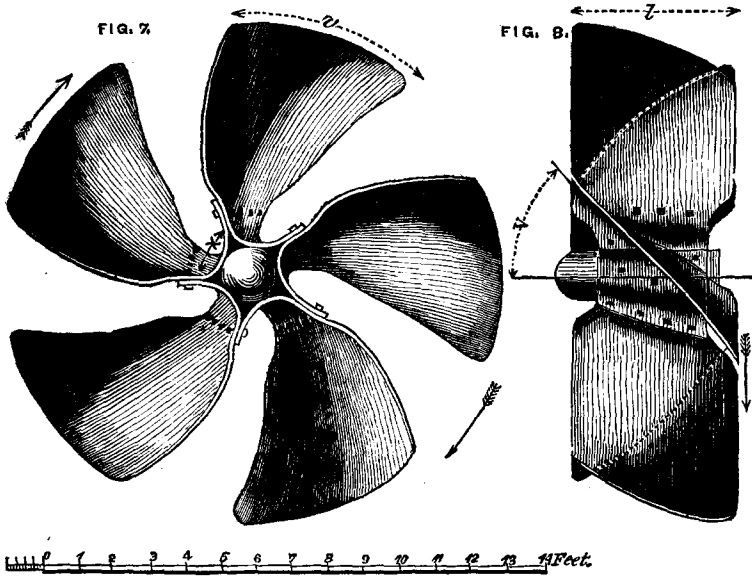


Fig. 5 & 8. $\left\{ \begin{array}{l} L = \frac{0.6 P}{m} \dots \dots \dots (7.) \\ L = \frac{0.6 \times 36.75}{5} = 4.2 \text{ feet.} \end{array} \right.$

Or say 4.5 feet, which will be the distance between the two curved lines 1w and 2w , fig. 4 and 5, on the axis. Place the plane of the curved line 0w in the middle between the planes of the curved lines 1w and 2w ; draw straight lines from the centre to the extremity of the curves; place the curved lines 1w and 2w so that the angle V will be as follows:

Fig. 4. $\left\{ \begin{array}{l} V = \frac{360 L}{P} \dots \dots \dots (8.) \\ V = \frac{360 \times 4.5}{36.75} = 44.2 = 34^\circ - 12'. \end{array} \right.$

Place the curved line 0w between the curves 1w and 2w , so that the angle 1V will be

Fig. 4. $\left\{ \begin{array}{l} ^1V = \frac{V}{4} (2+S) \dots \dots \dots (9.) \\ ^1V = \frac{44.2}{4} (2+S) = \frac{44.2 \times 2.42}{4} = 26.74^\circ = 26^\circ 44' 30''. \end{array} \right.$

When the curves are laid down in these positions, make a drawing of the propeller, as fig. 7 and 8, which represents a propeller made of wrought iron. If made of cast iron, these curved lines 0w , 1w , and 2w lay out in loom. Build to the curves a box, fig. 4 and 5; form it in the hub after the drawing, so that x is equal to x . In this box build a pattern of boards, about $2\frac{1}{2}$ by 3 inches. The boards are to run from the curve 1w to the curve 2w , so that the edges or seams may run parallel with the same figures on the curves, and form a regular curve, for instance an arc of a circle, touching the curve 0w . When the slip exceeds 50 per cent. it will be necessary to pay more attention to this curve, and lay out five w curves instead of three. From this pattern cast a block of cast iron, represented in fig. 6; bore holes in this block, corresponding to the holes for the screws by which the propeller blades are screwed together. Fit a pasteboard on the face side of the block, and make it the same shape as the propeller blades are to be; when fitted precisely, mark the holes on the pasteboard; from this cut out one propeller blade from the sheet iron, and bore the holes accurately from the pasteboard. From this blade cut out the rest of the propeller blades, and one more than the number of blades in the propeller. Afterwards bend these blades over the block, (fig. 6,) so that the holes correspond with each other; then the blades are ready to screw together. If the holes are not bored before the blades are bent, they must be marked on the block, (fig. 6,) if not the blades will never come in their proper position, and it will cause much trouble in putting them together.

The hub can be cast in the propeller after the blades are screwed together, or it can be cast separately as a round cylinder.

Now the speed of the vessel can be calculated, and will be in miles per hour,

$$M = \frac{60 n P(1-S)}{5280} \quad (10.)$$

$$M = \frac{36.75 \times 0.58 \times 48.5 \times 60}{5280} = 11.75 \text{ miles per hour.}$$

The distance from Liverpool to New York being 3100 miles, the vessel will run that in a time of $\frac{3100}{24 \times 11.75} = 11$ days. To Boston, in 10 days $7\frac{1}{4}$ hours. To Halifax, in 8 days $21\frac{1}{2}$ hours.

The effect of a steam engine, sufficient to drive the propeller 48.5 revolutions per minute, will be found by the following formula, in horse power:

$$H = \frac{n^2 A}{1950} \sqrt{PS} \quad (11.)$$

$$H = \frac{154 \times 48.5^2}{1950} \sqrt{36.75 \times 0.42} = 735 \text{ horses.}$$

To be two direct action condensing engines. Let us determine the effectual pressure per square inch to be 25 pounds, say pressure in the boiler to be 20 pounds, cutting off at $\frac{1}{2}$ stroke; the mean pressure will be 14 pounds, vacuum 11 pounds, effectual pressure, $p_e = 25$ pounds.

The area of the cylinder piston, in square inches, will be found by the following formula:

$$a = \frac{4 \cdot 24 \pi A \sqrt{P S}}{p s (1-f)} \quad (12.)$$

In which s denotes the stroke of the piston in feet, and f =friction, working pumps, and per cent., which, in this intended steam engine, will be $f=0.32$ per cent. Let the proportions of stroke and diameter of the piston be as 2 to 3, we have the diameter in inches:

$$d = \sqrt[3]{\frac{94 \pi A \sqrt{P S}}{p (1-f)}} \quad (13.)$$

$$d = \sqrt[3]{\frac{94 \times 48.5 \times 154 \sqrt{36.75 \times 0.42}}{25 \times (1-0.32)}} = 54.7 \text{ inches.}$$

Say 56 inches diameter and 36 inches stroke, the effect of the steam engine, in horse power:

$$H = \frac{a p s \pi}{33000} \cdot 4 (1-f) \quad (14.)$$

$$H = \frac{2463 \times 25 \times 3 \times 48.5}{33000} \cdot 4 (1-0.32) = 740 \text{ horses.}$$

Cut off the steam at one-third of the stroke, c being the cubic feet of steam for each revolution, and k denotes the volume of steam compared with water at the given pressure.

$$c = \frac{56^2 \times 0.785 \times 12 \times 4}{1728} = 68.4; \text{ say } 70 \text{ cubic feet.}$$

The consumption of coal, if anthracite, will be:

$$\text{Coal} = \frac{c n}{x k} \quad (15.)$$

$$\text{Coal} = \frac{70 \times 48.5}{4.8 \times 770} = 0.918 \text{ tons per hour.}$$

That is when one pound of anthracite coal evaporates 8 pounds of water per hour; or call the number of pounds of water = w , evaporated per pound of coal, we have for x ,

x	:	w		x	:	w
3.5	:	6		5.08	:	8.5
4.18	:	7		5.35	:	9
4.45	:	7.5		5.67	:	9.5
4.77	:	8		6	:	10

Plate xiii. represents a section of a vessel, of the aforesaid dimensions. On the bottom lays two inclined, direct action, condensing steam engines.

A, The Engineer's Room.

B, First Class Cabin.

C, Ventilator and Sky-Light.

D, State Rooms.

E, Store Rooms.

F, Passages.

G, House on Deck.

H, Berths.

The engine is manœuvered in the engine room A, by the three rods *a*, *b*, and *c*, which run through the columns in the engineer's room.

The four gauges on each side are the steam gauge, vacuum gauge, water gauge for the boiler, and salinometer; in the front is a clock and counter.

a is for regulating the injection water, connected with the injection cock *k*.

b for reversing the eccentrics, to back and go ahead, connected with a conical cog wheel.

c for regulating the steam to the engine; by the same rod steam can be given to full stroke.

d Cylinder heads.

e Injection water pipe.

f Steam pipe.

g Steam chest.

h Exhaust pipe.

i Discharge pipe.

k Injection cock.

l Condenser.

m Air pumps, double and direct action.

n Feed and Force Pumps, double and direct action.

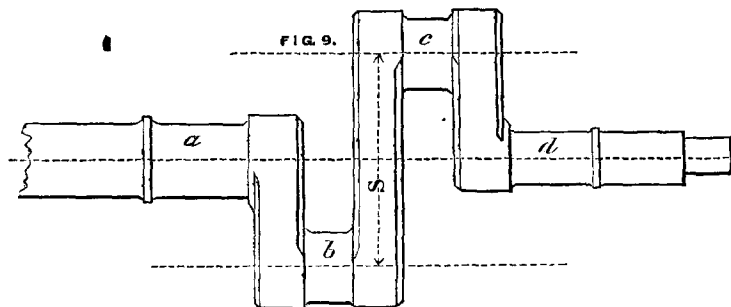
o Air vessels.

p Eccentrics for the steam valves.

q Frames and guides.

r Steam cylinders.

The engines are working on a double crank, represented in fig. 9. The scale is $\frac{3}{8}$ -inch to a foot. The cranks are opposite to each other; therefore the steam engines *do not work at right angles*; but if it is thought more desirable that they should, the cranks can be set in any angle; this is a matter of small consequence compared with the friction in the bearings *a* and *d*, which the opposite cranks prevent, and it is the reason why the stroke of the piston can be taken so short in proportion to the diameter.



Now for the *strength* of this crank, which, at first sight, promises little for durability. Let the end *a* be the continuation of the propeller shaft, and the steam engines be applied at *b* and *c*; let the force which is applied at *c* be denoted by the letter *c*. The force which acts to twist the crank

at b will be $c s$; but as there is a bearing at d , the resistance at b acts to twist the crank at c with a force $= b s$; if the crank should break, the force c must break it both at c and b at the same time, which will require twice the power that would break it only at b ; or $\frac{c s}{2}$ will be the force by which the crank should be twisted at b , which is exactly the same as the force c applied to b , to twist the shaft at a , or if the diameter at a , b , and c be equal, the strength of the *opposite cranks* will be the same as a common single crank.

Let D be the diameter of the propeller shaft in inches, and of wrought iron.

$$D = 8.15 \sqrt{D P S}. \quad . \quad . \quad . \quad . \quad . \quad (16.)$$

$$D = 8.15 \sqrt{14 \times 36.75 \times 0.42} = 12 \text{ inches.}$$

The diameter at d will be the same as the diameter for a crank pin of a common single crank; or

$$\delta = \sqrt{D^2 + 1.2 S^2} - 1.1 s. \quad . \quad . \quad . \quad . \quad (17.)$$

$$\delta = \sqrt{12^2 + 1.2 \times 3^2} - 1.1 \times 3 = 8.5 \text{ inches.}$$

This kind of crank was tried and tested by a Swedish Engineer, O. E. Carlsund, and the results were most satisfactory. The engines were 30 inches in diameter and 18 inches stroke; they made from 105 to 110 revolutions per minute. The air pumps were direct action, working at the same speed with 18 inches stroke; pressure in the boiler, 30 pounds to the square inch, cutting off at one-third of the stroke; the air pumps and valves worked silently.

In direct action propeller engines, the arrangement of the air pumps and their valves, is of the greatest importance. Many engineers are of the opinion that the more vacuum the better. There is, however, an exception with propeller engines, when the engines and air pumps are direct action. As an example, in an experiment made by the same engineer, O. E. Carlsund, he placed a small cock on the condenser; while the steam engine was working with a good vacuum he opened the cock, letting in a little air to the condenser. The number of revolutions increased from 15 to 20 per cent.; the *cause* of it, I leave to engineers for solution.

When an air pump makes more than n double strokes per minute, it does not work well, or rather works to a disadvantage. This number n , will be found by the formula

$$n = \frac{121 \alpha}{A s} \sqrt{p}. \quad . \quad . \quad . \quad . \quad . \quad (18.)$$

in which α denotes the area of the valves, and A = area of air pump piston; s being the stroke of air pump piston in feet. p = pressure in the condenser.

When the number of double strokes per minute are given, the area of the valve will be

$$\alpha = \frac{n A s}{121 \sqrt{p}} \quad (19.)$$

When we get from this formula $\alpha = \mathcal{A}$ or $\alpha > \mathcal{A}$ the air pump will work with disadvantage; or when the valve α is applied in the air pump piston, we only get $\alpha = \frac{2}{3} \mathcal{A}$ then, s and p are the only quantities which can be modified, and s will be

$$s = \frac{121 \alpha}{n A} \sqrt{p}. \quad (20.)$$

In the steam engine represented on plate xiii. the valves are round and move on vertical spindles. The stroke of the air pump piston is equal to the stroke of the cylinder piston, and the diameter is 14 inches. In that case, the diameter of the valve must be calculated, and will be as follows:

$$D = \frac{\sqrt[n]{n \cdot g}}{\sqrt[p]{p}} \quad (21.)$$

$$d = \frac{14\sqrt{48.5 \times 3}}{11\sqrt{4}} = 10.5 \text{ inches.}$$

or, say 11 inches, as the spindle in the centre takes a few square inches. These formulæ, (18, 19, 20, 21,) undergo a little modification with different arrangements of condensers and air pumps, for instance, if the air pumps are vertical or horizontal.

In this steam engine, the air pumps have an inclination of 16 degrees to the horizon.

It is of no consequence what angle the steam engines make with each other but rather make it to suit the bottom of the vessel. There will always be angle enough for one engine to help the other over the centre, and the greater the angle the better for the friction in the bearings. With those kind of steam engines, there is sufficient room in the breadth of any vessel to get the connecting rod twice the stroke. The entire engine comes below the load line, and makes an arrangement with every convenience.

Under full motion, all the parts of the machinery are accessible for the engineer. The weight of the engines, including air pumps and condensers, will be, stationary parts, 22 tons, moving or working parts, 8 tons, total weight, 30 tons; occupying a space in the length of the vessel of only 8 feet 4 inches. Lower hold is 12 feet; on the first deck, 7 feet; on the second deck, 8 feet.

A Table of Equations Collected for Convenience and Reference.

$P = 2.5D \sqrt[n]{\frac{n}{n}}$ 1.	$D = 8.15 \sqrt{D P S}$ 16.
$S = \frac{\sqrt[3]{Q^2} + \sqrt[3]{Q^2}}{10 A}$ 2.	$\delta = \sqrt{D^2 + 1.2 s^2} - 1.1 s$ 17.
$n = \frac{200}{P S} \sqrt{D}$ 3.	$n = \frac{121 a}{A s} \sqrt{p}$ 18.
$^{\circ}w = \frac{D S^2 n^2}{200}$ 4.	$a = \frac{n A s}{121 \sqrt{p}}$ 19.
$^1w = \frac{^{\circ}w}{2} (2 - S)$ 5.	$s = \frac{121 a}{n A} \sqrt{p}$ 20.
$^2w = \frac{^{\circ}w}{2} (2 + S)$ 6.	$d = \frac{D \sqrt{n s}}{11 \sqrt[4]{p}}$ 21.
$L = \frac{0.6 P}{m}$ 7.	$p = \frac{4.24 n A \sqrt{P S}}{a s (1 - f)}$ 22.
$v = \frac{360 L}{P}$ 8.	$n = \frac{a p s (1 - f)}{4.24 A \sqrt{P S}}$ 23.
$^1v = \frac{v}{4} (2 + S)$ 9.	$S = 1 - \frac{88 M}{P n}$ 24.
$M = \frac{P n}{88} (1 - S)$ 10.	$P = \frac{200}{S n} \sqrt{D}$ 25.
$H = \frac{A n^2}{1950} \sqrt{P S}$ 11.	$P = \frac{360 L}{v}$ 26.
$a = \frac{4.24 n A \sqrt{P S}}{p s (1 - f)}$ 12.	$P = \frac{\pi D L}{e}$ 27.
$d = \sqrt[3]{\frac{94 n A \sqrt{P S}}{p (1 - f)}}$ 13.	$P = \frac{\pi D L}{\sqrt{b^2 + L^2}}$ 28.
$H = \frac{a p s n}{33000} \cdot 4 (1 - f)$ 14.	$P = \cot. V n D$ 29.
$\text{Coal} = \frac{c n}{x k}$ 15.	$\text{Cot. } V = \frac{P}{\pi D}$ 30.

- D** = Diameter of the Propeller in feet.
P = Pitch.
L = Length of the Propeller in feet.
A = Area in square feet.
S = Slip in decimal fractions.
m = Number of Blades in the Propeller.
n = Number of Revolutions per minute.
b = Extreme Breadth of the Propeller Blade over its extremity in feet.
e = Length of the Circle Arc in the angle v in feet.
 \otimes^2 = Transverse Sectional Area of Displacement.
Q = Displacement in tons.
 $^{\circ}w, {}^1w, {}^2w, v, {}^1v$, and **V** = Angles in degrees of a Circle.
M = Statute miles per hour.
H = Actual horse power.
a = Area of the Piston in square inches.
d = Diameter of Cylinders in inches, when there are two direct action Cylinders, and stroke of Piston $d = 1.5s$.
p = Effectual Pressure on the Piston per square inch, including the vacuum.
s = Stroke of Piston in feet.
c = Cubic feet of Steam for each revolution.
k = Volume of Steam compared with Water.
x = Coefficient of Water evaporated per pound of coal per hour.
f = Friction and working the Pumps, per cent.
Coal = Anthracite, in tons, per hour.
A = Area of the Air Pump Piston.
a = Area of the Air Pump Valve.
D = Diameter of Air Pump Piston.
d = Diameter of Air Pump Valve.
s = Stroke of Air Pump Piston.
D = Diameter of Propeller Shaft.
 δ = Diameter of Crank Pin.
p = Pressure in the Condenser.

Table for Finding the Pitch of Propellers.

By this table (plate xiv.) the pitch of a propeller can be found in an instant, with any diameter and angle of the propeller blades, between 45° and 70° . The degrees will be found on the circular arc; the diagonals show every tenth minute where the pitch arm crosses the same at a .

The pitch will be found on the pitch-arm, where the diameter lines cross the same, when set on a given angle at a . If the angle is to be found, when the diameter and pitch are given, move the pitch-arm until the given pitch crosses the given diameter line; the corresponding angle will be found at a .

Propeller makers not fully acquainted with the theory of the propeller, will sometimes find it difficult to lay out the propeller with a certain pitch, or when a few dimensions are given, to ascertain the pitch; for that purpose there are some tables, which will probably meet with their approbation, for convenience in practical use.

When the centripetal propeller has been fully tested by experiment, it is intended to publish a small work, containing those Tables, and directions relating to propellers in general.

As the screw propeller is the most valuable instrument for the propelling of vessels, and thus far, behind the paddle wheels in the employment of steam for propelling, its friends therefore, ask for the screw propellers and their engines, that they should be submitted to a series of patient and impartial experiments; extending through two or more different vessels, and six or more different propellers. These experiments I feel confident, will result in *proving its equality* to paddle wheels, and as the screw propeller (if rightly made,) is a direct action propelling instrument, as well as the paddle wheels, why should the preeminence be justly on the side of the latter?

Experiments, we know, have been made again and again, but the principal feature has been too often overlooked.

In reference to propeller engines with gearings, it is worthy of inquiry what is *gained by them*? If they are intended to increase the number of revolutions of the propeller, we see where ever they are applied, that they do not. They only increase the size, weight, and expense, and occupy more room in the vessel. Propellers with equal diameter and pitch, will make rather more revolutions from a direct action steam engine with the same quantity of steam.

The mechanical law says, "*Apply the power as near the object as possible.*" And the words *stationary* and *DIRECT ACTION*, (no trunks,) are perfect teachers on the subject.

Philadelphia, September, 1851.

Translated for the Journal of the Franklin Institute.

Experiments on the Application of Electro-Magnetism as a Motive Force.

By M. ARISTIDE DUMONT.

The author announces in the following terms, the consequences to be deduced from the experiments reported in his memoir:

1. The electro-magnetic force, although it cannot yet be compared to the force of steam in the production of great power, either as it regards the absolute amount of power produced, or the expense, may nevertheless, in certain circumstances, be usefully and practically applied.

2. While in the development of great power, the electro-magnetic force is very far inferior to that of steam, it becomes equal and even superior to it in the production of small forces, which may be thus subdivided, varied, and introduced into trades and occupations using but small capitals, where the absolute amount of mechanical power is less exerted than the facility of producing it instantaneously and at will.

3. In this point of view, the electro-magnetic force assists, as it were, the usefulness of steam, in place of uselessly competing with it.

4. Other things being proportional, electro-magnetic machines with direct alternating movement, present a great superiority of the power developed over rotating machines; since in the first there are no compo-