CHAPTER V.

ARTICLE 74.

RULES AND CALCULATIONS.

THE fundamental principle, on which are founded all rules for calculating the motion produced by a combination of wheels, and for calculating the number of cogs to be put in them, to produce any motion that is required, has been given in Art. 20; and is as follows:—

If the revolutions that the first moving wheel makes in a minute be multiplied by the number of cogs in all the driving wheels successively, and the product noted; and the revolutions of the last leading wheel be multiplied by the number of cogs in all the leading wheels successively, and the product noted; these products will be equal in all possible cases. Hence, we deduce the following simple rules:—

1st. For finding the motion of the mill-stone; the revolutions of the water-wheel, and the cogs in the wheels, being given:—

RULE.

Multiply the revolutions of the water-wheel per minute, by the number of cogs in all the driving wheels successively, and note the product; and multiply the number of cogs or rounds in all the leading wheels successively, and note the product; then divide the first product by the last, and the quotient is the number of revolutions of the stone per minute.

EXAMPLE.

Given, the revolutions of the water-wheel per minute, - - - - -		10,4
No. of cogs in the master cog-wheel -	78	Drivers.
No. of do. in the counter cog-wheel -	48	
No. of rounds in the wallower - -	23	Leaders.
No. of do. in the trundle - -	17	

Then 10,4 the revolutions of the water-wheel, multiplied by 78, the cogs in the master-wheel, and 48, the cogs in the counter-wheel, are equal to 38937,6; and 23 rounds in the wallower, multiplied by 17 rounds in the trundle, are equal to 391, by which we divide 38937,6, and it gives 99,5, the revolutions of the stone per minute; which are the calculations for a 16 feet wheel, in the overshot table.

2d. For finding the number of cogs to be put in the wheels, to produce any number of revolutions required to the mill-stone, or to any wheel.

RULE.

Take any suitable number of cogs for all the wheels, except one; then multiply the revolutions of the first mover per minute, by all the drivers, except the one wanting (if it be a driver,) and the revolutions of the wheel required, by all the leaders, and divide the greatest product by the least, and it will give the number of cogs required in the omitted wheel, to produce the desired revolutions.

Note. If any of the wheels be for straps, take their diameters in inches and parts, and multiply and divide with them, as with the cogs.

EXAMPLE.

Given, the revolutions of the water-wheel		10,4
And the cogs in the master wheel -	78 } Drivers.	
Ditto in the counter wheel - -	48 }	
Rounds in the wallower - - -	23	

The number of the trundle is required, to give the stone 99 revolutions.

Then 10,4, multiplied by 78 and 48, is equal to 38937,6; and 99, multiplied by 23, is equal to 2277, by which divide 38937,6 and it gives 16,66; instead of which, I take the nearest whole number, 17, for the rounds in the trundle, and find, by rule 1st, that it produces 99,5 revolutions, as required.

For the exercise of the inexperienced, I have constructed fig. 7, Plate XI.; which I call the circle of mo-

tion, and which serves to prove the fundamental principle on which the rules are founded; the first shaft being, also, the last of the circle.

A is a	cog-wheel of	20	cogs, and is a	driver.
B	do.	24	-	leader.
C	do.	24	-	driver.
D	do.	30	-	leader.
E	do.	25	-	driver.
F	do.	30	-	leader.
G	do.	36	-	driver.
H	do.	20	-	leader.

But if we trace the circle the backward way, the leaders become drivers.

I is a	strap-wheel	$14\frac{1}{2}$	inches diameter,	driver.
K	do.	30 do.	-	leader.
L	cog-wheel	12 cogs	-	driver.
M	do.	29 do.	-	leader.

MOTION OF THE SHAFTS.

The upright shaft, and first driver, AH 36 revs. in a min.
BC 30 do.
DE 24 do.
FG 20 do.
HA 36 do.
M 4 do. which is the shaft of a hopper-boy.

If this circle be not so formed, as to give the first and last shafts (which are here the same) exactly the same motion, one of the shafts must break as soon as they are put in motion.

The learner may exercise the rules on this circle, until he can form a similar circle of his own; and then he need never be afraid to undertake to calculate any other combination of motion.

I omit showing the work for finding the motion of the several shafts in this circle, and the wheels to produce said motion; but leave it for the practice of the learner, in the application of the foregoing rules.

EXAMPLES.

1st. Given, the first mover AH 36 revolutions per minute, and first driver A 20 cogs, leader B 24; required, the revolutions of shaft BC. Answer, 30 revolutions per minute.

2dly. Given, first mover 36 revolutions per minute, drivers 20—24—25, and leaders 24—30—30; required, the revolutions of the last leader. Answer, 20 revolutions per minute.

3dly. Given, first mover 20 revolutions per minute, and first driver, strap-wheel, 14½ inches, cog-wheel 12, and leader, strap-wheel, 30 inches, cog-wheel 29; required, the revolutions of the last leader, or last shaft. Answer, 4 revolutions.

4thly. Given, first mover 36 revolutions, driver A 20, C 24, leader B 24, D 30; required, the number of leader F, to produce 20 revolutions per minute. Answer, 30 cogs.

5thly. Given, first mover 36 revolutions per minute, driver A 20, C 24, E 25, driver pulley 14½ inches diameter, L 12, and leader B 24, D 30, F 30, M 29; required the diameter of the strap-wheel K, to give the shaft 4, four revolutions per minute. Answer, 30 inches diameter.

The learner may, for exercise, work the above questions, and every other than he can propose on the circle.

ARTICLE 75.

The following are the proportions for finding the circumference of a circle, its diameter being given, or the diameter by the given circumference; namely:

As 1 is to 3,1416, so is the diameter to the circumference; and as 3,1416 is to 1, so is the circumference to the diameter: Or, as 7 is to 22, so is the diameter to the circumference; and as 22 is to 7, so is the circumference to the diameter. The last proportion makes the diameter a little too large; it, therefore, suits mill-wrights best

for finding the pitch circle; because the sum of the distances, from centre to centre, of all the cogs in a wheel, makes the circle too short, especially where the number of cogs is few, because the distance is taken in straight lines, instead of on the circle. In a wheel of 6 cogs only, the circle will be so much too short, as to give the diameter $\frac{3}{22}$ parts of the pitch or distance of the cogs too short. Hence, we deduce the following

RULES FOR FINDING THE PITCH CIRCLE.

Multiply the number of cogs in the wheel, by the quarters of inches in the pitch, and that product by 7, and divide by 22, and the quotient is the diameter in quarters of inches, which is to be reduced to feet.

EXAMPLE.

Given, 84 cogs $4\frac{1}{2}$ inches pitch; required the diameter of the pitch circle.

Then, by the rule, 84 multiplied by 18, and by 7, is equal to 10584; which, divided by 22, is equal to $481\frac{2}{22}$ quarter inches, equal to 10 feet $\frac{12}{4}\frac{2}{22}$ inches, for the diameter of the pitch circle required.

ARTICLE 76.

A true and expeditious method of finding the diameter of the pitch circle, is to find it in measures of the pitch itself that you use.

RULE.

Multiply the number of cogs by 7, and divide by 22, and you have the diameter of the pitch circle, in measures of the pitch, and 22d parts of said pitch.

EXAMPLE.

Given, 78 cogs; required, the diameter of the pitch circle. Then, by the rule,