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Power—and All About It

First of a Series of Articles to Make Clear to the
Lay Reader a Very Technical Subject.

H. Addison Johnston, Mechanical
Engineer.

One of the greatest causes of the
extraordinary advance of the present
era over all preceding states of civil-
ization lies in the application of nat-
ural forces in the place of human or
animal labor in the manufacture and
transportation of commercial products.

All processes of manufacture, the
production of light and heat, the driv-
ing of machinery and the running of
means for transportation require

power.

Force.

Force is that which tends to pro-
duce motion. When a gun is fired
certain forces are developed which
tend to produce motion in the bullet.

The force of gravity tends to draw
all things to the earth. When we are
lifted to the top of a building in an
elevator, the force of gravity tending
to draw us down is overcome by the
force transmitted through the ropes of
the elevator tending to draw us up.

If the rope breaks, the force of grav-
ity being then unopposed, quickly gen-
erates rapid motion earthwards.

Pressure, weight, magnetic attrac-
tion and repulsion are all manifesta-
tions by which we recognize force, and
the unit by which we measure the ex-
tent of a force is the pound. A 10-

pound weight requires a force of 10
pounds to lift it, or a bar of iron may
require a pull of 50 pounds to pull it
away from a magnet.

Work is the product of force, and
the distance through which it acts.

A force cannot produce power unless
it moves something. A clock weight
does no work when the clock is not
running, altho it pulls just as hard
on the chain. If it moves, it does work,
weights 5 pounds, and it has a range

of movement of 4 feet, then the work
done by the weight in falling is 5
times 4 equals 20 foot pounds.

A force may act forever without
costing anything, but as soon as it
begins to produce work then some-
thing begins to be used up. When the
clock was wound up the muscle of
the man who wound it put into the
weight 20-foot pounds of work or en-
ergy, and as long as the clock was
not started and the weight remained
at the top, its energy remained latent
at full value.

As soon as the clock is started and
the force of gravity is allowed to move
the weight the energy begins to be
given up and when the weight has
reached the bottom of its 4-foot drop
all its store of energy has gone. It
may be noted here that the force of
gravity is not a source of energy, but
only a storage battery, which returns
the energy put into it. Attempts to
construct perpetual-motion machines
run by the force of gravity must, there-
fore, result in failure; gravity never
supplies any energy gratis; it merely
retains what has been given it with-
out interest and without discount.

To raise a weight of 1000 pounds 5
feet would require 5 multiplied by
1000 equals 5000-foot pounds of work.

It is evident that with a single
pulley the force would be equal to the
weight and the travel of the force equal to
the lift. But if we were to use a
small pulley, the force would be only
one-half as much, or 1000 pounds,
but the distance traveled would be
twice the amount of the lift.

To do any given amount of work,
expressed in foot pounds, the amount
of the force may be as high as we
please, provided that the distance through
which it acts is

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made less or greater in proportion, so
that the product of the two factors re-
mains constant and equal to the
amount of work to be done.

Power.

The power of a machine is the mea-
sure of the work which it is able to
do in a given time. It is expressed
as foot pounds per minute, or foot
pounds per second.

If one motor could do 1000 foot
pounds of work in one second, it would
be a very slow engine. It would require
to do the same amount of work it is
quite evident that the first-mentioned
has twice the power to the second.

It requires a certain amount of
work to raise one million gallons of
water from the lake to the reservoir.
A very slow engine could pump this
amount if it were given time enough,
but if a million gallons must be raised
every half-hour then engines of
great power must be used.

There is no time factor in work or
energy, but in power time is consid-
ered, as well as force and distance. Power
is expressed as force multiplied by
distance, divided by time, thus:

Force multiplied by distance, divided
by time equals power.

Horse Power.

When the steam engine first came
into use it was apparent that work
that had been previously done by
horses. It had been found that a good
horse could do work at the rate of
2500 foot pounds per minute. Watt,
to make sure of good measure, design-
ed his engines so that they would do
30 per cent. more, 3250 foot pounds
per minute for each rated horse-pow-
er. This has been the standard horse-
power ever since.

A weight of 33,000 pounds raised one
foot high or 330 pounds 100 ft. high, or
3300 lbs 10 ft. high in one minute re-
quires one horse-power.

If we have an elevator and load
weighing 6000 pounds raised 60 feet
in 2 minutes we know that the num-
ber of foot pounds of work done per
minute is 6000 multiplied by 60 and di-
vided by 2 equals 180,000 foot pounds
per min. And we find the horse-power
by dividing the total number of foot
pounds per minute by the number of
foot pounds per minute in the horse-
power, 33,000. I. e. 180,000 by 33,000,
which gives 5 h. p.

While six horse power is the net
amount of power required to lift the
load, it must not be as-
sumed that a six horse power motor
would run the elevator under actual
conditions. The motor must be of
greater power than the load, and pul-
leys and gearing would probably
amount to two or three horse power, so
that a 10 horse power motor might
be required under commercial operation.

The amount of work a horse power
would do in ten hours if our machinery
were 100 per cent. efficient, is something
astounding.

One horse power in ten hours would
pump 10,000 gallons nearly 200
feet high, or pump 100,000 gallons 20
feet high. It would raise a ton weight
to a height of nearly 10,000 feet or
a locomotive weighing 200,000 lbs. nearly
100 feet.

While the minute is generally the unit
of time used in computing horse
power, the second, or any other unit
may be used; 33,000 foot pounds per min-
ute is equivalent to 550 foot pounds per
second, or 1,980,000 foot pounds per
hour.

Before leaving the subject of power
it may be well to touch on the commer-
cial electrical power unit, the kilowatt.
Without going into details at present,
it may be stated that the watt is the
unit of electrical power, and the kilo-
watt is of the same nature as foot
pounds per second in mechanics. The
product of the voltage and amperage
of an electric current gives the number
of watts. As the watt is a very
small quantity, for commercial purposes
1000 watts, or the kilo-watt is used
for the unit. The prefix "kilo" is used
by the French to denote 1000, throug-
hout their whole system of measurement.
Kilo-gram means 1000 grams; kilo-
meter, 1000 meters, etc.

The equivalent of a horse power in
electricity is 746 watts, hence a kilo-
watt is equivalent to one and one-third horse
power. This does not mean that when
you pay for a kilowatt of current
you have received one and one-third
horse power from your motor. It means
that the motor has used up one and
one-third horse power of current, but
it has not delivered to your factory more
than one horse power, owing to losses within
the motor itself.

H. Addison Johnston.

The next article of the series will be
"The Source of Power."

**NATURAL HISTORY FOR
BEGINNERS.**

The Cat.

This four-footed quadruped is found in
a free state in back-gardens and else-
where. It is sometimes very fond of
more often than cats are domesticated.
and scratching, tho they prefer pet
canaries to either. Of carnivorous habits,
he or she-for there are two kinds of
cats-has a voice of rare power and mus-
ical excellence. It is not a domestic
animal, tho it is often kept as a pet,
and when it has run the gamut of these
its coat is made into seal-skin jackets.

The horse usually has four legs and a
tail. Naturalists have not yet discovered
the purpose of the latter adornment, tho
experiments have demonstrated the fact
that its legs are chiefly used for kick-
ing purposes. The horse is a very in-
tellectual animal, tho it is often kept as a
pet, and when it has run the gamut of these
its coat is made into seal-skin jackets.

The Editor (genus, homo scribens).

This curious little animal is to be found
in most large towns, where it inhabits lit-
tle huts, or rooms, which are called
"benches." In its wild state the editor
should be carefully avoided. It is, how-
ever, easily tamed. Editors feed chiefly
on blue-pencil and ink, which it con-
sumes in vast quantities, but it will some-
times take kindly to leading-articles and
fiction. It has also a weakness for large
suppers.

The Policeman.

This animal, on account of its great
strength, is sometimes called the arm of
the law. It is to be found at most street
corners, and anywhere that it does not
happen to be wanted. It is provided by
nature with a helmet, or head-covering,
and when it has run the gamut of these
its coat is made into seal-skin jackets.

The Boy.

Of all members of the animal kingdom,
this is the only one who has no con-
stant war with the pre-historic age. Al-
tho it is very old, especially about the
head, it seldom dies. At thirteen or there-
abouts, this little creature loses its identity
and develops into a man, who is chiefly
concerned with the acquisition of money,
cigarettes and other injurious diversions.
It has a decided aversion to water and
moral.

Hugh Polson Dead.

Word has been received in the city
that Hugh Polson, widow of the
late Frank B. Polson, of the death
of her little son, Hugh Gordon, which
occurred at Bermuda, where Mr. Pol-
son had gone to spend the winter for
the benefit of her health.

The Greatest Sale

Toronto's History

Thousands take advantage of the enormous price reductions

THAT a genuine sale is appreciated by the buying public was emphasized at the opening of our doors at 8 Saturday morning. We can truthfully say it is the hit of our career, PLEASED CUSTOMERS--Pleased, because they weren't "fooled"--P. T. Barnum said the people liked to be humbugged--we don't believe it. The Great Sale will continue all this week. Come Monday if possible, Tuesday, Wednesday, Thursday, or any day you can get here. Something doing every day. If we used every page in this paper it would not tell of all the wonderful bargains. Get price lists at store for further particulars.

DOORS OPEN 8 A.M. CLOSE 6 P.M.

A Square Deal
Philip Jamieson
YONGE ST. AND QUEEN ST.
At Rounded Corner

York County and Suburbs

World subscribers in Toronto Junction
are requested to register com-
plaints of carelessness or late delivery
at The World Branch Office, 22 Dun-
can-street East, Toronto Junction, or
The World Office, 83 Yonge-street,
Toronto. Intending advertisers may
also transact business at the Junction
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TORONTO JUNCTION.

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son had gone to spend the winter for
the benefit of her health.

(Monday), after having an extra week
of Christmas holidays.

Presbyterian.
Rev. W. G. Back of the Eglinton
Presbyterian Church will preach an-
niversary services at Maple to-day, to
which church he has been appointed
moderator till a permanent pastor has
been chosen.

Rev. George Little of Toronto will oc-
cupy Mr. Back's pulpit at Eglinton and
Brimley to-day, at 3 p.m.

Next Wednesday evening the annual
congregational meeting will be held.
The pastor of the Eglinton Methodist
Church, Rev. W. Wellwood, will occupy
his own pulpit to-day, both at the 11
a.m. and 7 p.m. services. For the even-
ing sermon his subject will be, "Rob-
bing a Bird's Nest."

Sunday school at 3 p.m.
At the Davisville Methodist Church
the supply minister, Rev. J. W. Wilkin-
son, is still taking charge of the pas-
toral duties of that congregation, owing
to the long and severe illness of the
pastor, Rev. Newton Hill, who, how-
ever, is improving steadily but slowly.
Sermons will be preached at 11 a.m. and
7 p.m. Sunday school at 3 p.m.

**At the Zion Baptist Church, the pas-
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MINERAL PRODUCTION

Less Gold and More Silver, Mint Di-
rector Estimates.

WASHINGTON, Jan. 12.—The production
of gold in the United States fell off \$4,753,-