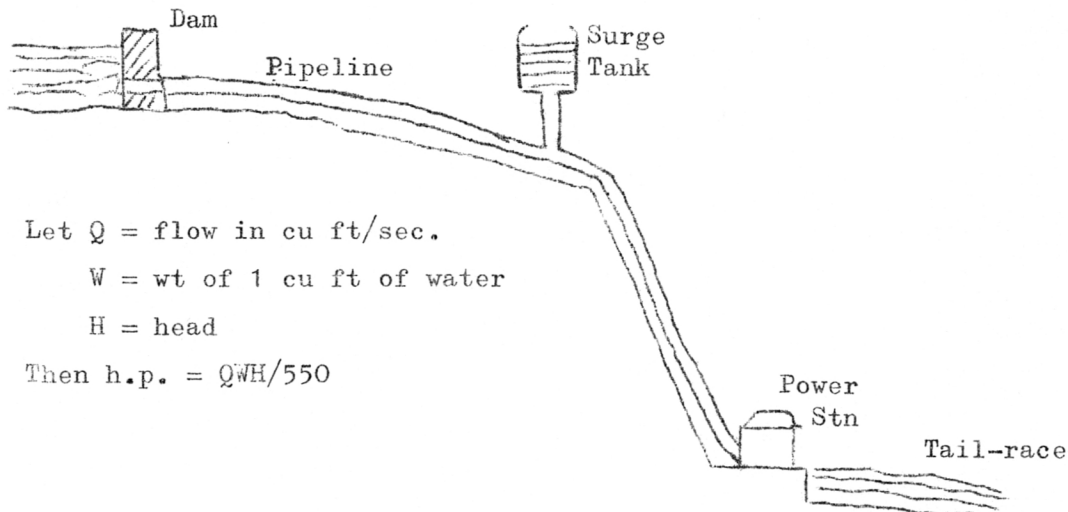


## DEVELOPMENT OF HYDRO-ELECTRICITY

- 1 First hydro-electric (HE) plant in the world was installed at Craggside, Northumberland, in 1879 to light Sir W.G. Armstrong's house with 45 of Swan's newly-invented incandescent electric lamps. 6 h.p. turbine driven by water from an ornamental lake. Drove a d.c. generator by belt drive;
- 2 Westbrook Mill, Godalming, Surrey, 1881, lit 3 street lamps
- 3 Appleton, Wisconsin, 1882, first H.E. plant in America.
- 4 Portrush, Co. Antrim, N. Ireland, 1883 - two turbines driving dynamos through vertical shafts and bevel gears, generating  $\sim 100$  h.p. with 27 ft head of water. Supplied Giants Causeway Electric Tramway, which was opened on 3.9.1883, the first HE - driven electric traction system in the world.

### Principles of modern system.



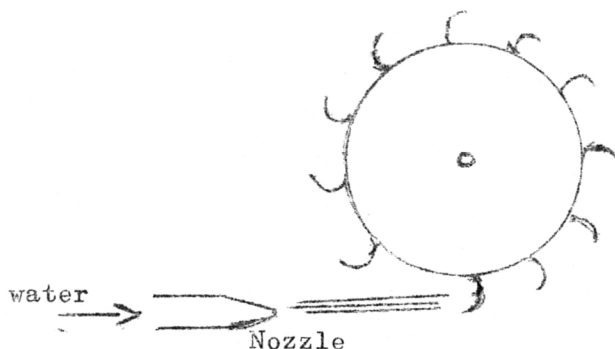
Let  $Q$  = flow in cu ft/sec.

$W$  = wt of 1 cu ft of water

$H$  = head

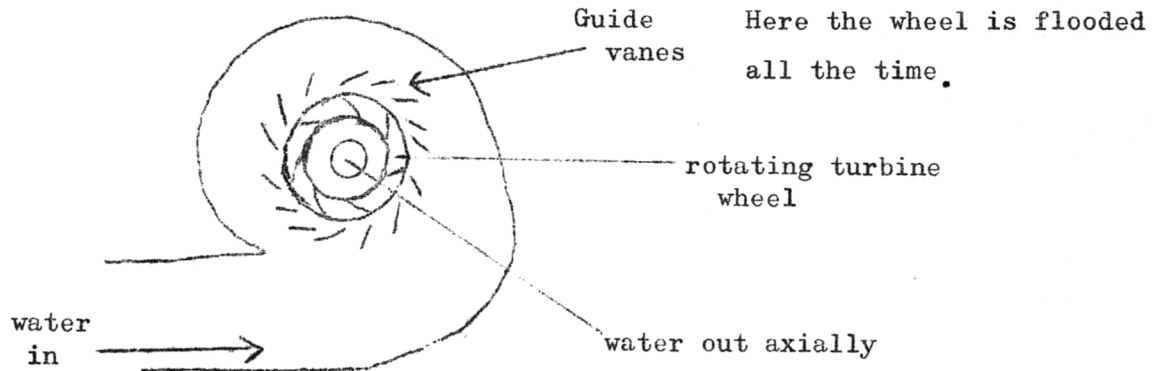
Then h.p. =  $QWH/550$

For high heads, Pelton turbines used:



here the wheel must be well above tail-race, since flooding of wheel prevents operation. Thus a bit of the head is lost, but negligible if head large.

For low heads, reaction turbine used.



Both may have 85% efficiency.

Surge tank is to absorb surges when turbines are suddenly stopped or started (A kind of low-pass filter).

---

Even in the leading industrial countries, probably less than 25% of available water power has been harnessed.

In Gt. Britain, total HE power is probably not much more than 1000 MW - about the same as one large thermal station.

The Galloway HE system is one of our Scottish HE systems, a fairly early one built between 1931 and 1936. It has capacity of 107 MW, with five power stations using the water from about 400 sq.miles of land with high rainfall ( $\sim 64$  in/yr). It cost £3 m at a time of acute depression, but has long since paid off its capital costs.

#### References on hydro-electric generation.

- 1 A Stowers, "Observations on the history of Water power",  
Trans.Newcomen Soc., 30, 1960, p.239.
- 2 E.N. Marriott, "Hydro-electric installations", Chambers Encyc.,  
7, 1950, p.334.
- 3 Brochure, "Hydro-electric Power", issued by South of Scotland  
Electricity Board, c.1966.

GALLOWAY HYDRO-ELECTRIC SCHEME

	Catchment Area Sq. Miles	Average Net Head ft.	No. & Size of Sets	Total Gen. Capacity kW	Water Consumption on Full Load Cusecs	Normal Annual Output kWh. Millions	Spillway Level ft. Above O.D.	Storage Millions of cu.ft.	Storage kWhs. Millions
and	393	102	3 x 11,000	33,000	4,500	68	120	31	0.065
ee & tering-	40	365	2 x 12,000	24,000	900	40	585	1,270	12.00
on	152	150	2 x 10,500	21,000	1,950	36	510	40	0.23 *
oun	193	65	2 x 7,000	12,000	2,500	20	245	-	0.01
ad	171	64	2 x 6,000	12,000	2,580	18	338	-	0.02 †
oon							705	2,900	23.00
Ken							148	321	0.65
				102,000					

comprises energy generated at Lendoon, Carsfad and Earlstoun. Fish Ladders - Tongland (Rise of 70 feet).

comprises energy generated at Carsfad and Earlstoun. - Earlstoun.

length of Glenlee Tunnel ... 3.6 miles - 11 ft.6ins. diameter. Cost of Scheme £ 3m. - approx. £29 per kW.

length of Deugh Tunnel ... 1.4 miles - 8ft. 0ins. diameter. Commercial Operation started March, 1935.

length of Loch Doon Tunnel ... 1.0 miles - 8ft. 0 ins.diamter. Average Annual Units Generated - 225 million.

HYDRO-ELECTRIC POWERWorld Potential Estimated about 1950

Total between 500,000 and 1 m MW

Africa 41.1% Asia 22.8% N.American 12.7%

Europe 10.3% S.America 10.1% Oceania 3.0%

Installed capacity 1957 in 1000 MW's.

USA ~ 30 USSR ~ 10

Canada ~ 12 France ~ 9

Italy ~ 11 Sweden ~ 5.5

Japan ~ 10 Norway ~ 4.7

Scotland ~ .75

Growth of H.E. Power in Scotland MW

1949	87	1955	559
1950	285	1956	660
1951	368	1957	729
1952	391	1958	813
1953	399	1959	866
1954	431	1960	875

Total H.E. Power in Great Britain 1964 ~ 1650 MW

figures quoted in H.Alswick: "A Geography of Commodities", revised  
by H.Rees, Harrap 1963.

HYDRO-ELECTRIC POWER IN FRANCE

	1 Jan 1946		1 July 1954		1 May 1966	
	No.	MW capacity	No.	MW	No.	MW
Power Stns > 100 MW	5	680	17	2760	35	6340
< 100 MW	323	3360	374	4920	460	6450
Total	328	4040	391	7680	495	12,790

Hydroelectric power generation is 45.5% of total in France.

(From "Voies navigables de France", Service de Propa, Edit et Info, 1967, p.60)

CANADIAN HYDRO-ELECTRIC POWER, 1963

	<u>Installed Capacity (MW)</u>	<u>Potential power in waters</u> (MW)
Atlantic Provinces	750	3,000
Quebec	9500	18,000
Ontario	6000	6,000
Prairie Provinces	1100	9,000
British Columbia	2700	15,000

from B. Carlson, "North America",  
Univ. Tut. Press 1969.

U.S.A. Miscellaneous facts on Hydro-electricity

New England 15% of electric power is hydro-el.

Tennessee River 2000 MW H.E.

But this represents only 30% of T.V.A. electricity-- rest thermal.

Niagara 2200 MW on U.S. side (similar on Canadian side)

Missouri Basin Project -- potentially 1000 MW H.E.

Columbia Basin Project (Western U.S.A): 10,000 MW already.

Grand Coulee Dam alone gives 2500 MW

Potential H.E. power is 35% of U.S.A. total H.E. Potential.

Colorado: Hoover Dam gives 1300 MW H.E.

(Data probably for 1963 or thereabouts)

from B. Carlson, "North America",  
Univ. Tut. Press, 1969.