Tidal power station

The present invention relates to a low-head hydroelectric installation intended to operate under variable heads of water or pressure heads that can fall to very low values, in the region of zero, as for example is the case of a hydroelectric installation equipping a tidal power station.

Traditionally a distinction is made between low head hydroelectric power stations, of river or tidal type, that operate under a head of water or pressure head of between zero and a maximum of twenty meters, and high-head hydroelectric power stations, of dam power station type, that operate under much higher heads of water or pressure heads, often in the order of several hundred meters.

For certain low-head power stations, in particular for tidal power stations, the head can vary widely, but each turbo-machine, such as turbine, turbine-pump or pump, is calculated and therefore constructed to have its best efficiency in the region of the most frequent head, called the nominal head. For tidal power stations for example, this most frequent or nominal head is in the order of 5 to 10 meters.

Unfortunately the efficiency of these turbo-machines decreases very rapidly below these head values such that the lowest heads, for example less than half or a quarter of the nominal head, are not used for turbine actuation as they are not sufficiently profitable and that in pumping it becomes necessary to consume a rather considerable amount of power.

Taking, by way of illustrative example, the case of a tidal power station in which the head of water for turbine actuation varies from 7 to 1 meters and for pumping from 0 to 2 meters, approximately 300

GWh is consumed in pumping while 430 GWh are produced by turbine action.

SUMMARY OF THE INVENTION

The purpose of the invention is to overcome these disadvantages, and therefore to enable a larger production by turbine action and a lower consumption in pumping, due to means enabling a considerable increase in the efficiency of the turbo-machine when the head becomes less than a specified fraction of the nominal head.

The low-head hydroelectric installation in accordance with the invention is of the type including:

(a) at least one hydraulic turbo-machine, turbine, turbine-pump or pump, subject to the head of water and constructed to give maximum efficiency at a defined head, called the nominal head, corresponding to a nominal power of the installation, and for a speed of rotation corresponding to the speed of synchronism with the frequency of the electrical network,

(b) at least one rotary electrical machine, alternator under turbine action and motor in pumping, drive-coupled to the said turbo-machine and electrically connected to the network,

(c) means of automatic control, regulator or more generally automatic installation control, enabling the said turbo-machine to be rotated at the synchronous speed,

(d) means making it possible, when the head of water is less than a defined fraction of the said nominal head, in all cases less than half of the latter, to make the said turbo-machine rotate at a speed lower than the said synchronous speed, and consequently to insert between the network and the said electrical machine a frequency

matching device of maximum power at least less than half the said nominal power.

By these means the efficiency of the installation is considerably increased for the lowest heads of water only, such that it results for certain applications in a considerable reduction in the power consumed in pumping that reduces, for example in the previously used illustra tive example, from about 300 GWh to about 200 GWh, and an appreciable increase in the power produced by turbine action, that increases in this example from about 430 GWh to about 500 GWh. The total power produced by this tidal power station, cited to give orders of magnitude, increases therefore, due to the means of the invention, from 130 to 300 GWh. Obviously, the embodiment of the invention necessitates the installation of a frequency converter which, if it were to operate over the whole range of head of water, would have to prohibitively expensive; it would, in fact, be costly in order to be able to support high powers, and its own efficiency could easily drop to values in the order of a few percent. By using, in accordance with the invention, a frequency converter solely for the very low heads, and therefore low powers, this converter can be constructed for a much lower maximum power; in addition, since its own loss of efficiency then becomes negligible compared to the gain in performance due to the reduction in the speed of rotation of the turbo-machine, its use becomes very profitable. This does not naturally spring to mind, as a specialist in the field calculating an installation of a certain nominal power is normally inclined to include in it a frequency converter of the same power, which shows itself to be economically unacceptable as has been shown above.