material increase in the ratio of steam consumption to output. In tests of a 9000 kilowatt Curtis turbine using steam of about 200 lb pressure and 80° C. superheat, with a vacuum of 291/2 in. the consumption of steam is reported to have been only 13 lb per kilowatt-hour, and this figure remained almost constant for loads ranging from 8000 to 12,000 kilowatts. In a 5000 kilowatt turbine under very similar conditions the consumption is reported to have been 131/2 lb per kilowatt-hour. In the usual arrangement of the Curtis turbine the shaft is vertical and the wheels lie in horizontal planes, the weight of the re­volving parts being taken by a footstep bearing with forced lubrication, and the electric generator is mounted on the top. There are usually in the large sizes four stages of expansion, each stage being separated from the one above it by a diaphragm plate containing the nozzles in which the next step in velocity is acquired. The expansion has been divided into as many as seven stages in a Curtis turbine for marine use, the shaft being then horizontal, and in all except the first stage in that example the pressure drop is so comparatively small as not to require divergent nozzles.

118. *Parsons Turbines,—*In the turbines of De Laval and Curtis the action on the moving blades or buckets is entirely one of impulse. No drop of pressure occurs while the steam is passing the moving blades, and its velocity relative to the blade surface undergoes no change except such as is brought about by friction. In the Parsons turbine, on the other hand, there is a *reaction* effect. The steam acquires relative velocity and loses pressure as it passes each ring of moving blades : in this respect the action in the moving blades is like the action in the fixed blades. Each pair of fixed and moving rings makes up what is called a “ stage ” and may be said to constitute a separate turbine: the whole is a series of many such stages. In each stage the drop in pressure and in heat is divided equally between the fixed and moving element, the exit and entrance angles and the form of the blades generally being alike in both. The number of stages depends on what peripheral speed it is convenient to use. Where comparatively high blade speeds are practicable, as in tur­bines for driving electric generators, the steam is allowed to acquire a fairly high velocity at each ring of blades, and in such cases so few as 45 stages may be suitable. In large marine turbines, on the other hand, where the number of revolutions per minute has to be kept low in the interests of propeller efficiency, the blade speeds cannot be kept high without making the diameters unduly great, and consequently more stages are required: in such turbines the number of stages may be from 100 to 200. The general relation of fixed to moving blades and the characteristic form of both will be seen from fig. 59.

Fig. 60 shows a complete Parsons turbine of 1000 kilowatts capacity in longitudinal section through the casing. The fixed blades are caulked with separating distance-pieces into grooves turned on the inner surface of the case and project in­wards: the moving blades are similarly secured in grooves which are turned on the surface of the rotating drum. Between drum and case there is an annular space fitted in this way with successive rings of fixed and moving blades. There is con­siderable longitudinal clearance from ring to ring, but over the tips of the blades the clearance is reduced to the smallest pos­sible amount consistent with safety against contact (generally from 15 to 30 thousandths of an inch in turbines of moderate size). Steam enters at A, expands through all the rings of blades in turn and escapes to the condenser at B. To provide for the increase in its volume the size of the blade passages enlarges progressively from the high to the low pressure end. In the ex­ample shown this is done partly by lengthening the blades and partly by increasing the circumference of the drum, which has the further effect of increasing the blade velocity, so that the expanded steam not only has a larger area of passage open to it but is also allowed to move faster, and consequently each unit of the area is more effective in giving it vent. Instead of attempt­ing to make the change in passage area continuous from ring to ring, as the ideal turbine would require, it is done in a limited number of steps and the several rings in each step are kept of the same size. Thus in the example shown in the figure the first step consists of seven pairs of rings or stages, the next two also of seven each, the next three of four each, the next of two and so on. This is convenient for constructive reasons and gives a sufficiently good approximation to the ideal conditions as regards the relation of steam volume to blade-passage-area and velocity.