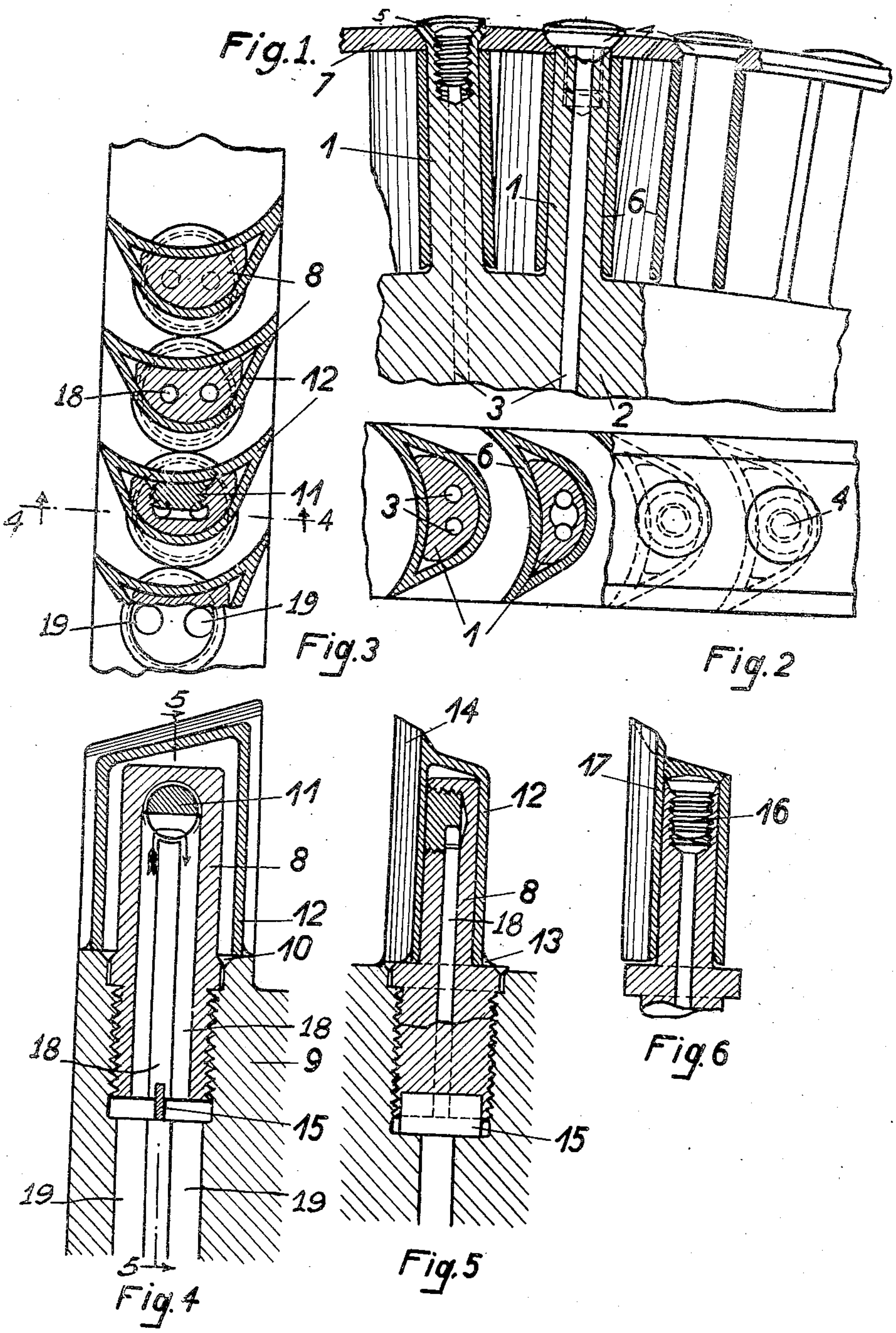
July 10, 1934.

W. G. NOACK

1,966,104

TURBINE ROTOR CONSTRUCTION

Filed Jan. 18, 1932



INVENTOR
Walter Gustav Noack
BY Harold E. Gregory
ATTORNEY

Patented July 10, 1934

1,966,104

UNITED STATES PATENT OFFICE

1,966,104

TURBINE ROTOR CONSTRUCTION

Walter Gustav Noack, Baden, Switzerland, assignor to Aktiengesellschaft Brown Boveri & Cie., Baden, Switzerland, a joint-stock company of Switzerland

Application January 18, 1932, Serial No. 587,187
In Germany January 19, 1931

6 Claims. (Cl. 253—77)

My invention relates to improvements in turbine rotor constructions.

In turbines constructed heretofore, and particularly those wherein the driving medium is a gas, difficulty has been experienced due to some manner of failure of the blades either directly or indirectly on account of the extremely high temperatures necessary for efficient operation. To avoid this, it has been proposed to make the blades hollow, or to bore out solid blades and thereby provide passages through which water or air can be circulated for cooling purposes. There was then the problem of connecting the cooled blades to the rotor disk or drum so that the connections would be strong enough to withstand the high centrifugal forces on the blades themselves and would also be tight enough to prevent leakage of the cooling water at the connections under the high pressure to which the water was raised by the high peripheral velocity. Welding was resorted to for the purpose of making the tension-resisting and watertight connections between the blades and the rotor disk. The welded connections or joints were satisfactory for these purposes, but they made removal and replacement of the blades very difficult, if not impossible.

Furthermore, in the various constructions referred to, there were high losses due to the cooling action, particularly when the hot driving gases performed work in more than one stage or ring of blades. That is, the high velocity at which the hot gases flowed through the blade passages was accompanied by a corresponding high rate of heat transfer to the blade walls. For this reason, a high percentage of the available heat energy was conducted through the blade walls and wasted by dissipation in the cooling water. In other words, there was found to be the problem of causing cooling of the blades only to the point necessary for protection of those parts of the blades which were subjected to great mechanical stresses, and, with this in mind, the problem of limiting the rate of heat-conduction from the hot driving gases to the stressed blade parts.

With all the foregoing in mind, one of the objects of my invention is to provide improved turbine rotor construction which has all the advantages of those proposed heretofore, but which does not have the disadvantages and give rise to the problems referred to.

Other objects and advantages will hereinafter appear.

In accordance with my invention, each blade unit is made in two parts, namely, a core part rigidly connected to the rotor disk or drum and provided with passages for the cooling fluid, and a blade part in the form of a sheath disposed about the core part and having a relatively close fit thereon, the sheath being made of heat-resistant material. In this way, the power-transmitting or core part of each blade unit is, in effect, separate from the blade part which guides the hot driving gases. The core part can therefore be rigidly secured to the rotor disk by a strong and watertight welded connection which need not be disturbed in making repairs, this being done by removing and replacing only the outer blade part or sheath.

My invention resides in the improved construction of the character hereinafter described and claimed.

For the purpose of illustrating my invention, an embodiment thereof is shown in the drawing, wherein

Figure 1 is an elevational, fragmentary view, partly in section, of a turbine rotor constructed in accordance with my invention;

Fig. 2 is a plan view of Fig. 1, partly in section;

Fig. 3 is a view similar to Fig. 2, showing a modification;

Fig. 4 is a sectional view, the section being taken on the line 4—4 in Fig. 3;

Fig. 5 is a sectional view, the section being taken on the line 5—5 in Fig. 4; and

Fig. 6 is a view similar to Fig. 5, showing a modification.

Referring to Fig. 1, the reference numeral 2 designates a rotor disk. The core parts 1 of the blade units are machined out of the disk, and are each provided with a pair of longitudinal passages 3 for the flow of cooling fluid from the interior of the disk into the interior of the core part, and then back into the disk.

Each blade part is shown as being in the form of a sheath 6 disposed about the respective core part and having a relatively close fit thereon. The sheaths 6 have the required shape for the operating surfaces of the blades, and can be bent from sheet metal and welded at one or both edges, as the case might be, or they can be pressed out from a piece of tubing. The material used for the blade parts is highly resistant to heat, such as sheet steel or a sheet of any chromium or chromium alloy or the like.

A shroud ring 7 operates to hold the sheaths 6 on the core parts, and is apertured to receive the outer ends 5 of the latter which are flared over the ring, as shown, to lock the latter to the core parts. In operation, the sheaths bear against the shroud ring 7 under the action of the centrifugal forces.

The outer end of each core part is bored into the outer adjacent ends of the passages 3 to connect the same, and the bores are then threaded to receive closing plugs 4. As indicated in Fig. 1, the plugs 4 may then be welded to the core ends 5.

As the sheaths have a tight fit on the core parts, they are well supported and have to withstand very little force. For this reason, the sheaths can be made of thinner sheet metal and can be brought up to a very high temperature without danger. Furthermore, the amount of heat which the sheaths impart to the core parts by radiation and contact therewith is much less than would be the case if the hot driving gases came into direct contact with the cooled core parts. On account of this desirable action, it is possible to maintain the core parts at a desirable, relatively low temperature without withdrawing an excessive amount of heat from the hot driving gases.

In the embodiment of my invention shown in Figs. 3, 4 and 5, the core parts 8 are made as separate pieces which are screwed, as shown, into the rotor disk 9. As indicated at 10, a light weld may be employed to seal the screw connection. Practically all of the forces, however, are taken up by the screw threads. Plugs 11, corresponding to the plugs 4 in Figs. 1 and 2, operate to close the bores or openings which are made to connect the outer adjacent ends of the cooling passages 18 which are aligned respectively with the passages 19 in the rotor disk. A suitable insert 15 separates the adjacent ends of the passages 18 and 19.

As in Figs. 1 and 2, the blade parts are in the form of sheaths 12 of sheet metal which have a close fit on the core parts 8, and which are welded at 13 to the disk 9. Since the sheaths 12 are relatively light, the welding is sufficient to hold them in place on the core parts, and therefore serves the same purpose as the shroud ring 7 in Fig. 1, which is omitted in this construction. The edge 14 of each blade part is sharpened, as shown more clearly in Fig. 5.

The construction shown in Fig. 6 is similar to that in Figs. 3, 4 and 5, except that the closing plugs 16 are screwed into the ends of the core parts, as in Figs. 1 and 2, and then welded, as indicated. This welding also serves to fix the outer end of the blade part 17 to the core part, and is the only point of fixation between these parts. The blade part, therefore, which is heated to a higher temperature than the core part, is free to expand from the outer point of fixation thereof with the core part, and is made slightly shorter, as shown, to prevent distortion.

Other modifications, within the conception of those skilled in the art, are possible without departing from the spirit of my invention or the scope of the claims.

I claim as my invention:—

1. In turbine rotor construction, a rotor member provided with blade units, said units comprising a supporting core part and a separate structural piece of relatively high heat-resistive material providing a blade part in the form of a sheath disposed about and having a relatively close fit on the core part, said rotor construction being provided with passages for the flow of cooling fluid from the interior of said rotor member to the interior of said core parts.

2. In turbine rotor construction, a rotor member provided with blade units, said units comprising a supporting core part provided with a passage for a cooling fluid, and a separate structural piece providing a blade part in the form of a sheath having a relatively close fit on said core part and made of relatively high heat-resistive material.

3. In turbine rotor construction, a rotor member provided with blade units, said units comprising a supporting core part and a blade part fitted to said core part for longitudinal movement relatively with respect thereto due to occurring unequal expansion and contraction of said parts, said blade part being fixed only at one end thereof to said core part to permit such unequal expansion and contraction.

4. In turbine rotor construction, a rotor member provided with blade units, said units comprising a supporting core part and a blade part in the form of a sheath disposed about the core part and fitted thereto for longitudinal movement relatively with respect to said core part due to occurring unequal expansion and contraction of said parts, said blade part being fixed to said core part only at the outer end of the latter, the length of said blade part, measured inwardly from the point of fixation thereof, being less than such length of said core part.

5. In turbine rotor construction, a rotor member provided with blade units, said units comprising a supporting core part and a separate structural piece providing a blade part in the form of a sheath disposed about the core part, said rotor construction being provided with passages for the flow of cooling fluid from the interior of said rotor member to the interior of said core parts, and an apertured element for holding the sheaths on the core parts, the outer ends of said core parts extending through the apertures in said element and locked over the latter.

6. In turbine rotor construction, a rotor member provided with blade units, said units comprising a supporting core part provided with a pair of longitudinal passages and a blade part in the form of a sheath disposed about and having a relatively close fit on the core part, an apertured element for holding the sheaths on the core parts, the outer ends of said core parts extending through the apertures in said element and being flared into locking engagement with said element, the flared end of each core part being provided with an opening communicating with the adjacent outer ends of the longitudinal passages, and means closing said openings.

WALTER GUSTAV NOACK.