S. Z. DE FERRANTI.

TURBINE BLADING.

APPLICATION FILED OCT. 15, 1908.

**916,400.**

Patented Mar. 23, 1909.

3 SHEETS—SHEET 1.

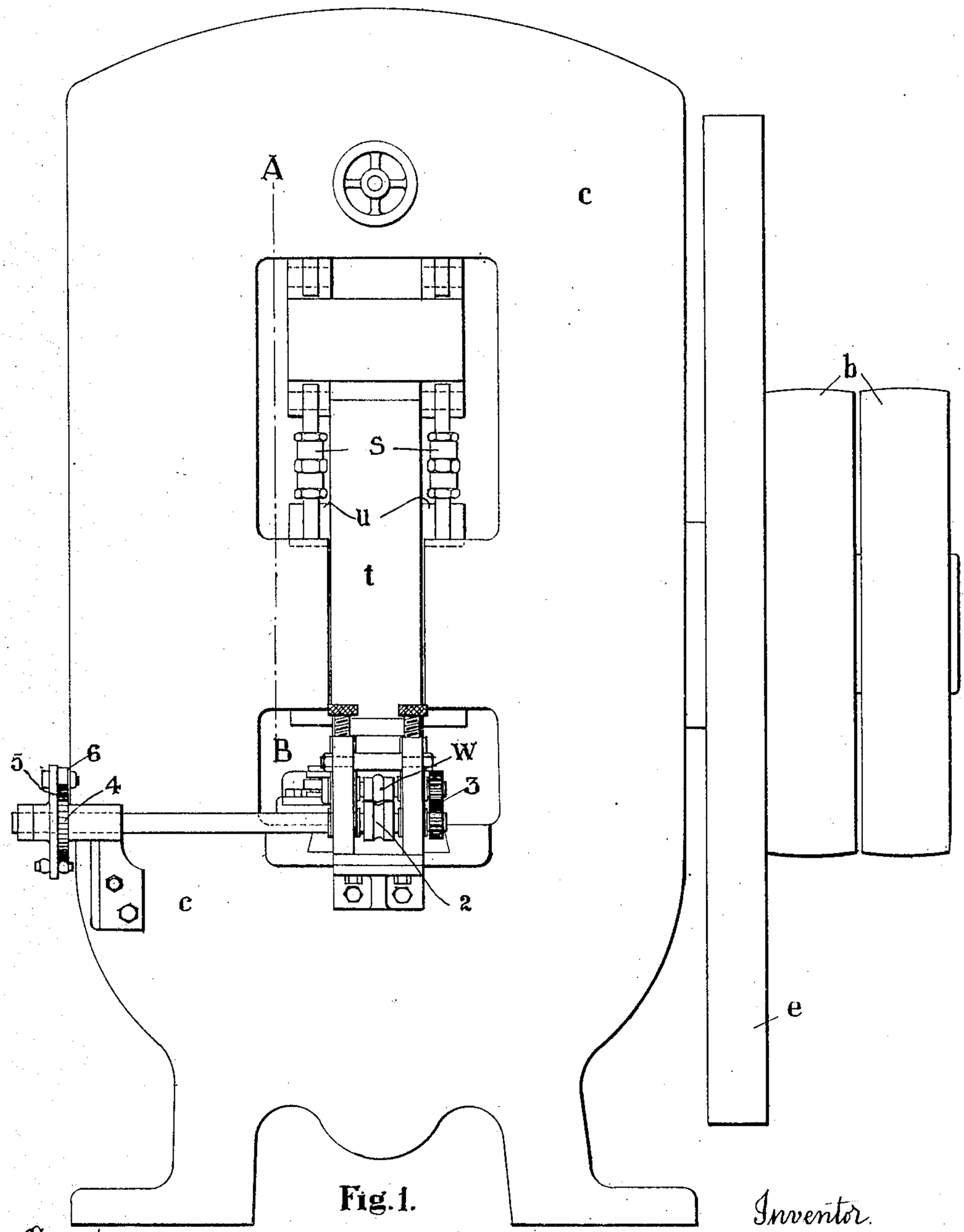


Fig. 1.

Inventor.

Sebastian Ziani de Ferranti.

Attest.

Benth. Stahl.

Edward N. Sarton

by Spear, Middleton, Donaldson & Spear

Atty's

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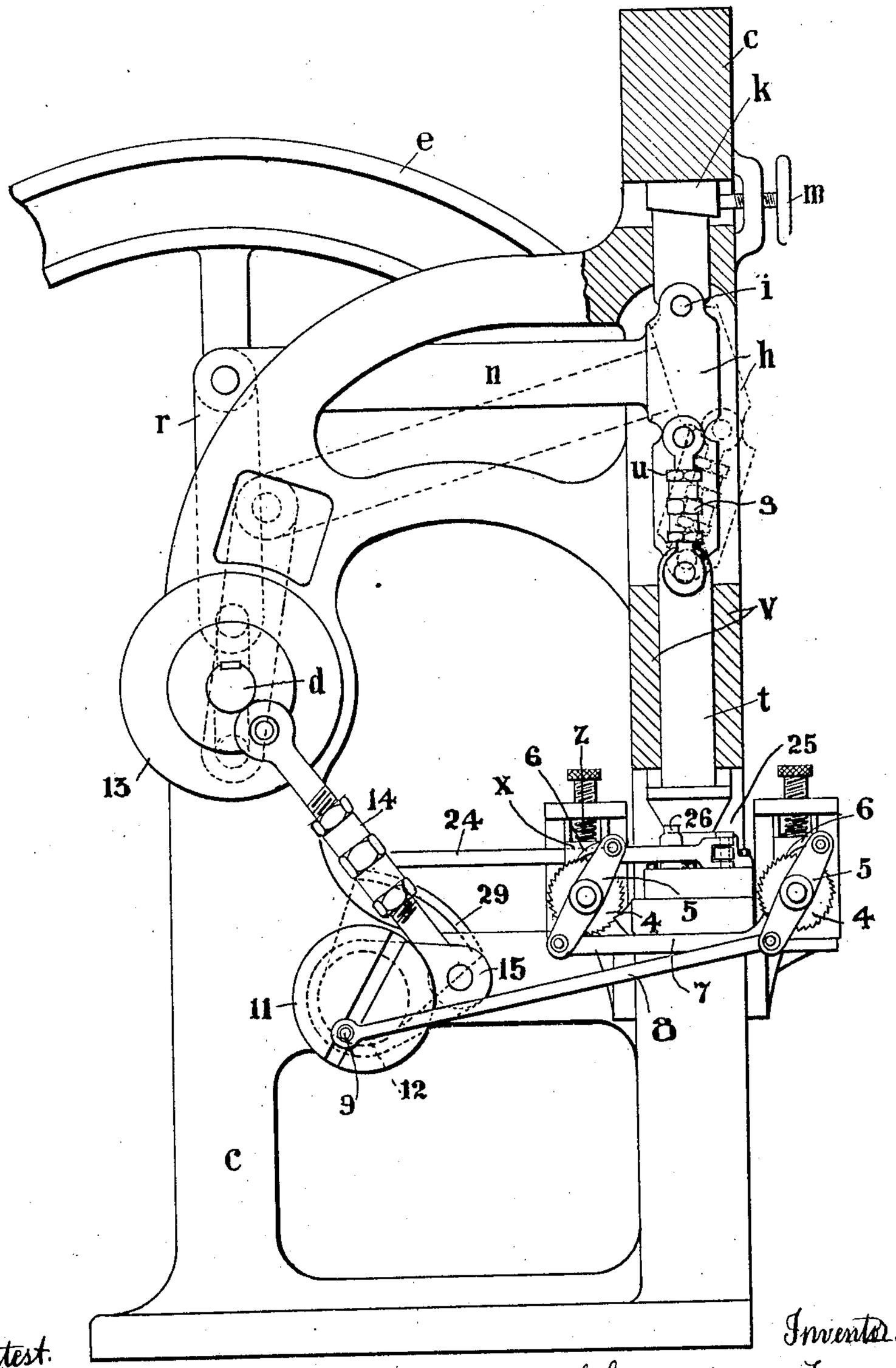


Fig. 2.

Attest.

Bent. McStahl.

Edward N. Sartor

Inventor.

Sebastian Ziani de Ferranti.

by Spear, Middleton, Donaldson & Spear

Atty's

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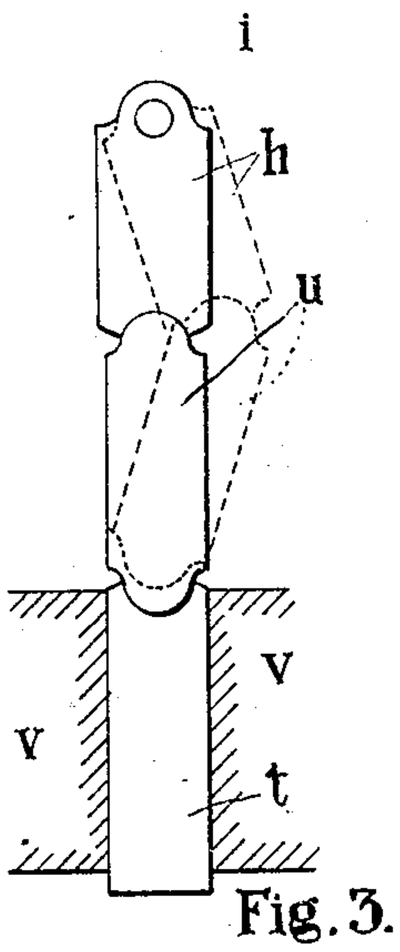


Fig. 3.

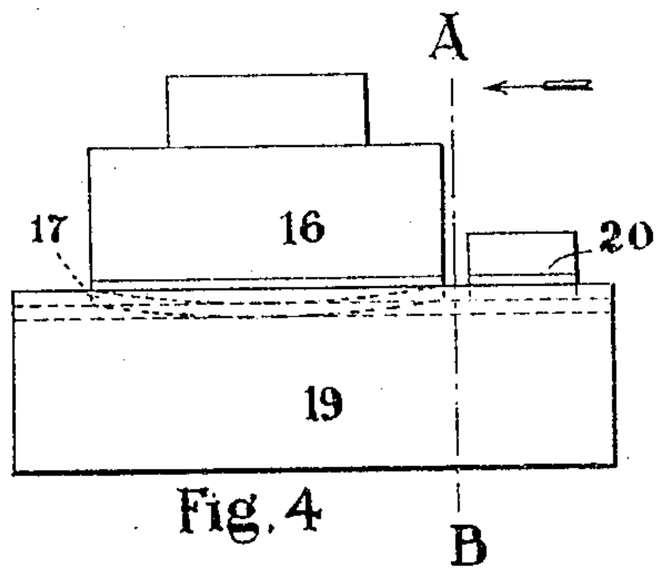


Fig. 4

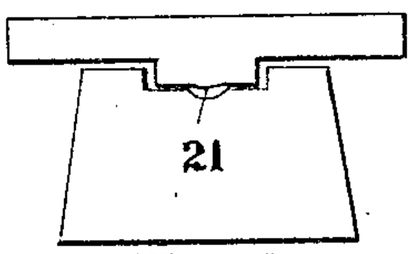


Fig. 6.

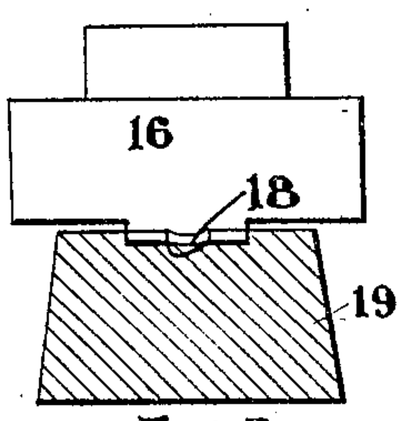


Fig. 5.


Fig. 8.

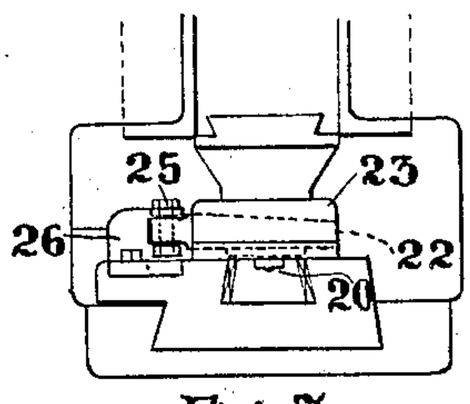


Fig. 7.

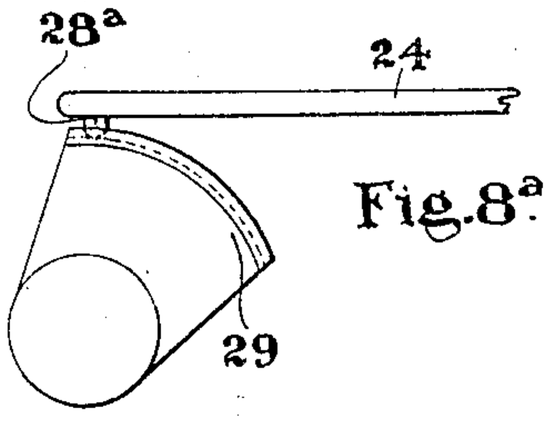


Fig. 8a.

Attest.

Bent. McStahl.

Edward N. Slaton

Inventor.

Sebastian Ziani de Ferranti.

by Spear, Middleton, Donaldson & Spear

Atty's

# UNITED STATES PATENT OFFICE.

SEBASTIAN ZIANI DE FERRANTI, OF GRINDLEFORD, NEAR SHEFFIELD, ENGLAND.

## TURBINE-BLADING.

No. 916,400. Specification of Letters Patent. Patented March 23, 1909.

Original application filed February 18, 1907, Serial No. 358,047. Divided and this application filed October 15, 1908. Serial No. 457,854.

*To all whom it may concern:*

Be it known that I, SEBASTIAN ZIANI DE FERRANTI, a subject of the King of Great Britain and Ireland, and residing at Grindleford, near Sheffield, England, have invented a certain new and useful Turbine-Blading, of which the following is a specification.

This invention relates to turbine blading of the common type having a face or faces straight longitudinally and curved transversely. Such blading is produced for commercial purposes by rolling or drawing, the blades produced being in consequence frequently marked by longitudinal striæ or other surface markings and in blades with a very thin edge by small cracks or lines of weakness parallel to the edge and due to the longitudinal run of the grain or fiber of the metal.

The present invention consists in blading produced by swaging, such blading being of greatly improved quality as compared with that now in use and free from the objections mentioned above.

The action of the swages causes metal to flow transversely from the body of the blade to form the sharp edges so that in the finished blade the run of the grain or fiber is transverse to the edge instead of parallel thereto as heretofore with a consequent absence of the cracks or lines of weakness indicated above; such a minute structure of the metal of the blade is of special importance in the case of blades with a very thin edge of considerable lateral extension. Moreover apart from the highly polished and perfectly smooth surface of the blade due directly to the action of the swages, the surface portions are hardened and consolidated by the heavy pressures employed so that the pores of the metal are closed and the blade, if of steel, is thereby better able to withstand the attacks of rust. Where the blade is of iron or steel sheathed with an electro-deposition of nickel or other metal the action of the swages in closing the pores of the metal sheathing entirely prevents the iron core rusting through the sheath in the manner well known in connection for example with bicycle handles.

I believe that I am the first to produce swaged turbine blading (for motors, compressors or otherwise), having *inter alia* the hard non-porous surface and transverse graining of the edges pointed out above, and such improved blading forms the subject matter of the present invention.

I will now describe a process and machine suitable for the production of my improved blading. In manufacturing such blading according to the method described in my application, Serial No. 358,047, filed February 18th, 1907, from which the present application is divided, strip material is first roughed out by any suitable process such as drawing, rolling or otherwise, to a section approximating to that ultimately desired, except that it is narrower and thicker. The rough strip is then annealed and subjected, preferably cold or nearly so, to a series of step-by-step swaging operations between dies working under an extremely high pressure, the dies being relatively long as compared with the corresponding pressure areas used in rolling or drawing, so as to provide a suitable resistance to longitudinal flow of the material. The dies must, further be of special hardness to enable them to stand the severe stresses involved and should be finished with a very smooth and bright surface. The effect of the swaging operations is thus on the one hand to cause transverse flow of the strip, thereby producing the fine or sharp edges desired, and on the other hand to condense or compress the material so as to render it extremely hard and at the same time to render its surface very smooth and polished. Finally, the finished strip may be cut into blades of the desired length by any suitable means.

I will now describe by way of example, a form of machine adapted to carry certain of the above steps into effect, reference being made for this purpose to the accompanying drawings which form part of the specification and of which,

Figure 1 shows an end and Fig. 2 a side view partly in section of a suitable form of machine, Fig. 3 being a detail view of a part of the toggle mechanism taken as a section on the line A B of Fig. 1. Fig. 4 shows a side view of the swaging and clamping dies, Fig. 5 being a section on the line A B of Fig. 4, looking on the swaging die and Fig. 6 an end view looking on the clamping die; Fig. 7 shows a detail of the clamping mechanism as it would appear in Fig. 1 with the feed gear

therein shown removed, while finally Figs. 8 and 8ª show details of the clamp-operating cam and co-acting lever.

According to the form of machine shown, by way of example, in these drawings, a main frame, *c*, is provided in which a rotatable shaft, *d*, is mounted, this shaft carrying a fly wheel, *e*, and being driven by any suitable means such for instance, as the belt pulleys, *f*, shown in Fig. 1.

The upper member, *h*, of the toggle is pivoted about the axis, *i*, the position of which can be adjusted by means of the wedge piece, *k*, and hand wheel, *m*, shown in Fig. 2. Attached to the upper toggle member, *h*, is an arm or rocker, *n*, the free end of which is linked to a crank, *o*, on the shaft, *d*, by the connecting rod, *r*. Adjustable links, *s*, pivotally connected on the one hand to the upper toggle member, *h*, and on the other hand to the die carrier, *t*, serve to lift the latter element on the upstroke of the machine while the lower toggle member, *u*, interposed between the upper member, *h*, and the top of the die carrer, *t*, serves to transmit the whole power of the machine to the dies on the down or swaging stroke. Guides, *v*, of strong construction and conveniently forming part of the main frame, *c*, serve to define the motion of the die carrier and thus prevent any possibility of side motion due to unsymmetrical blade sections.

The position of certain parts of the mechanism at about the beginning of the down stroke is indicated by chain lines in Figs. 2 and 3. In order to feed the strip forward after each swaging action in the direction shown by the arrow in Fig. 4, two pairs of feed rolls are preferably provided disposed one pair on each side of the dies as regards the passage of the strip between them. The upper roll, *w*, of each pair is carried in bearings slidably mounted in a suitable frame or housing, *x*, and is pressed by adjustable springs, *z*, against the lower roll, 2, with which it is connected by gearing, 3. The axle of each lower roll carries a ratchet wheel, 4, while loosely mounted on the end of each of these axles is an arm, 5, carrying a pawl, 6, engaging with the teeth of the corresponding ratchet wheel, the two arms being linked together by the coupling rod, 7, so as to move in unison. The pawl arms, 5, receive an oscillating motion by means of a link, 8, pivoted to one of them at one end and at the other end to a pin, slidable for purposes of feed adjustment in the groove, 10, formed in the disk, 11, carried by the rocking shaft, 12, this shaft in turn receiving its motion from the main shaft, *d*, by means of the disk crank, 13, drag link, 14, and lever, 15. The effect of the continued revolution of the shaft, *d*, is thus to give an intermittent and uniform feed to the metal strip being operated upon.

Details of the swaging dies are shown on a larger scale in Figs. 4 and 5. The upper swaging die, 16, which is secured to the die carrier, *t*, in any suitable manner is made relatively long, so that the resistance to end-flow of the material may be very great while it tapers off to some extent at each end, as shown at 17, so as to avoid transverse marking of the blades. The relatively great length of the dies also causes the successive swaging operation to overlap or in other words each particular portion of the length of the strip is acted upon more than once by the dies. When the surfaces of the male and female swaging dies are proximated to their closest extent, they leave a space, 18, (see Fig. 5) exactly representing the section of the blade to be produced. The lower die block, 19, also serves to co-act with the clamping die, 20, to hold the strip firmly in place during the swaging operation.

The clamping of the strip is performed automatically at the proper moment by means of the mechanism shown in Figs. 2 and 7. A wedge, 22, rests on the clamping die, 20, and is contained within a suitable guide box, 23, so shaped that transverse movement of the wedge operates the clamping die. This transverse movement is given to the wedge by means of the lever, 24, pivoted at one end to it and fulcrumed about the pin, carried, for example, by the bracket, 26. On the other end of the lever is mounted a screw pin, 24ª, engaging with the groove, 28, in the cam segment 29, (Figs. 8 and 8ª) which is itself keyed to the rocking shaft, 12, motion of which thus serves in conjunction with the suitably shaped cam groove, 28, to operate the clamping die intermittently at the proper moment.

The essential operations of the machine are thus automatically performed in cycles of the following nature, viz., clamping, swaging, unclamping, and feeding.

Blades thus constructed, if made, for example, of nickel steel or certain nickel alloys are extremely hard and have the required burnished surface but they may be made of other suitable materials, according to the purpose for which they are to be used, viz., whether they are to stand the high temperatures required in gas turbines, or whether they are for the lower temperatures required in ordinary steam turbine practice.

Having now described my invention what I claim as new and desire to secure by Letters Patent is:—

1. Swaged turbine blade strip.
2. A swaged turbine blade.

In testimony whereof, I have affixed my signature in presence of two witnesses.

SEBASTIAN ZIANI DE FERRANTI.

Witnesses:

ALBERT HALL,

WILLIAM DUNCAN DAVIDSON.