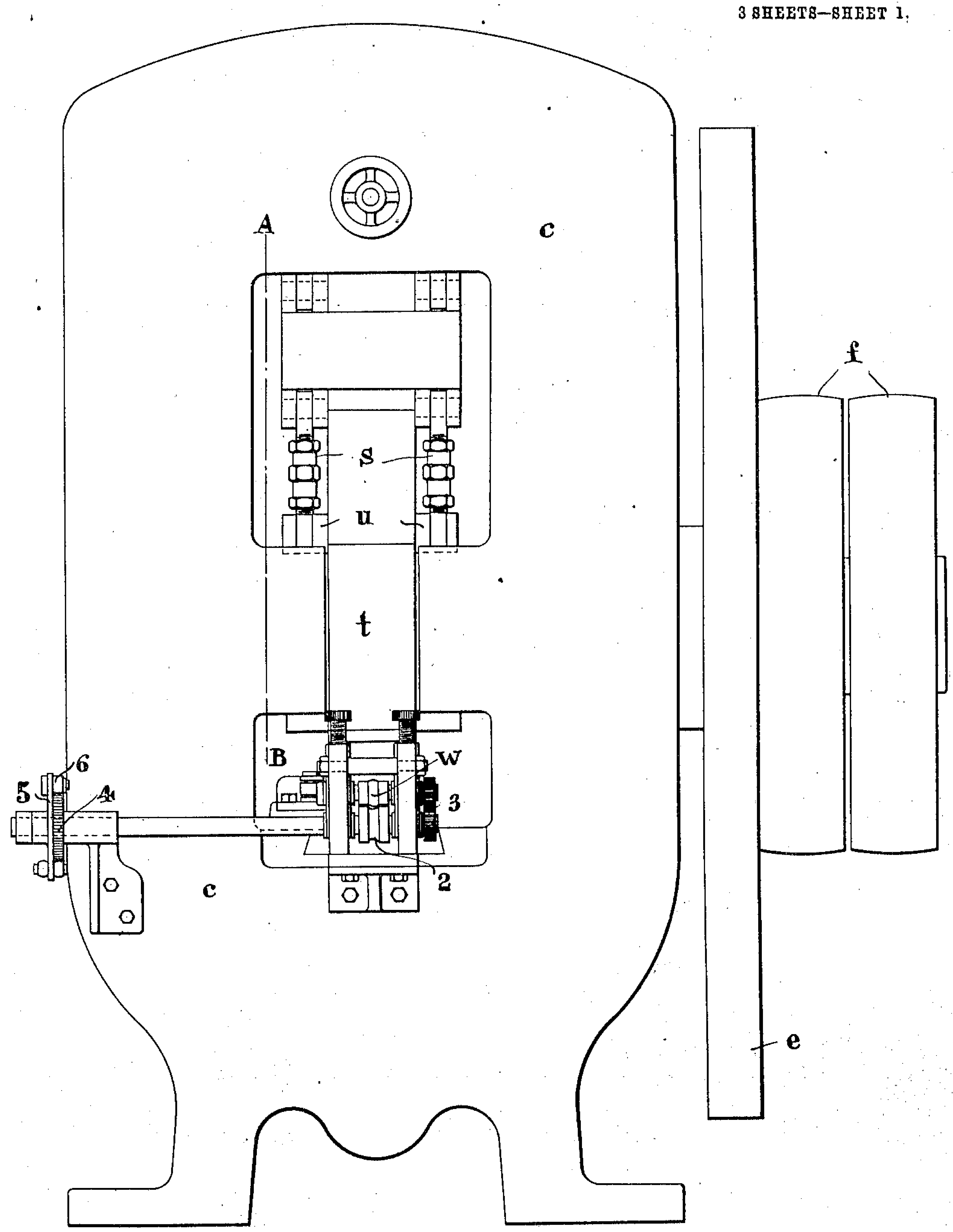
S. Z. DE FERRANTI.

MANUFACTURE OF STRIP MATERIAL SUITABLE FOR THE BLADES OF TURBINES, TURBO-PUMPS, AND THE LIKE.

APPLICATION FILED FEB. 18, 1907.

960,161. Patented May 31, 1910.

3 SHEETS—SHEET 1.



Attest.

Fig. 1.

Inventor.

Benj. M. Stahl.

Edw L. Tolson.

Sebastian Ziani de Ferranti

By Spear, Middleton, Donaldson & Spear

Atty's.

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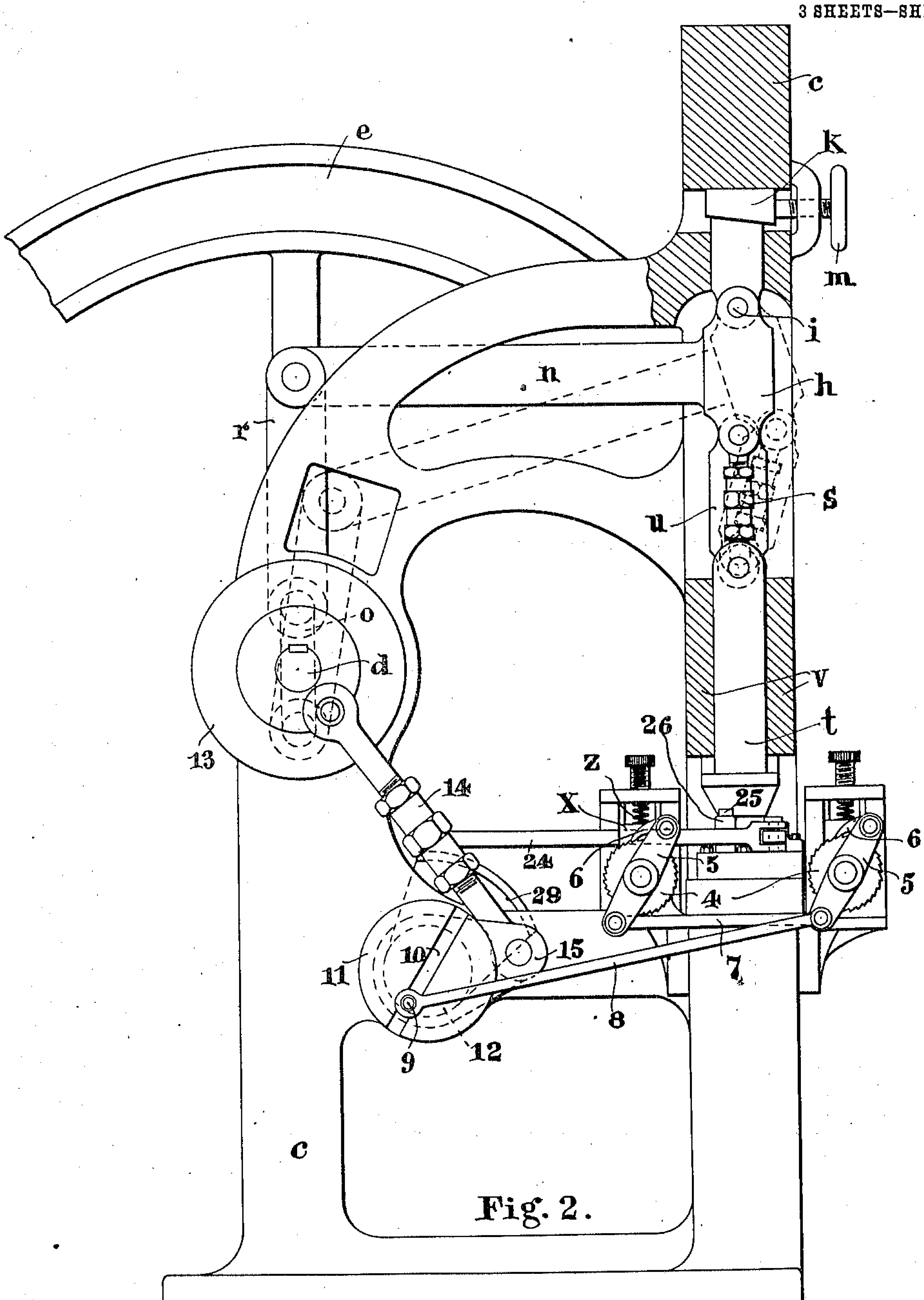

Fig. 2.

Attest.
Benthm Pahl
Edw L. Tolson

Inventor.
Sebastian Ziani de Ferranti
By Spear, Middleton, Donaldson & Spear
Atty's.

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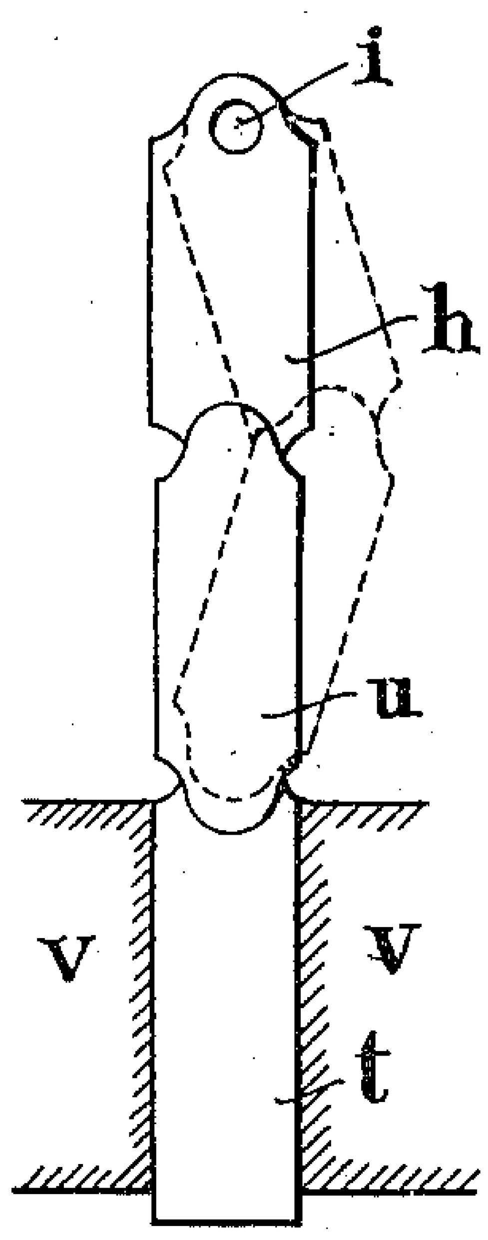

Fig. 3.

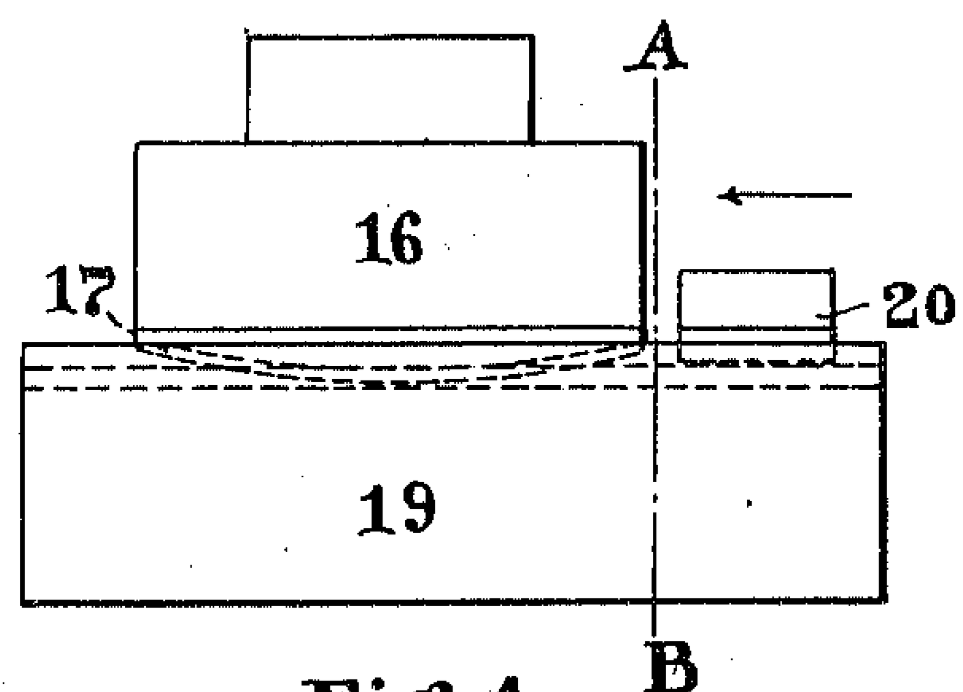

Fig. 4.

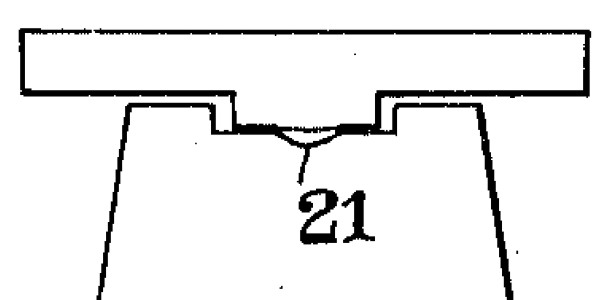

Fig. 6.

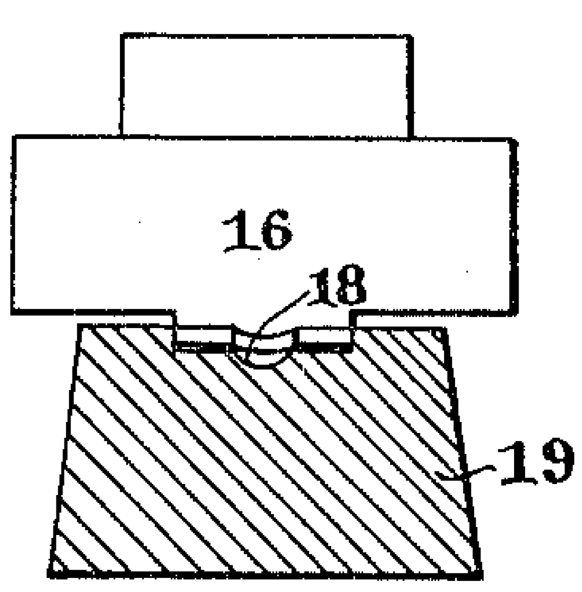

Fig. 5.

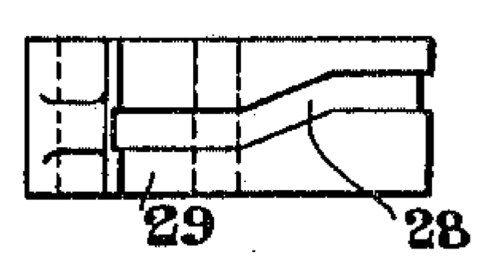

Fig. 8.

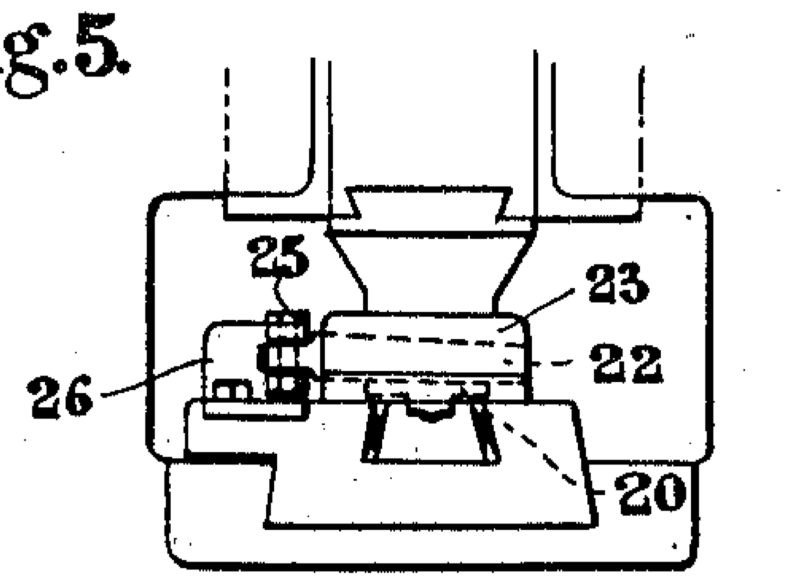

Fig. 7.

Attest.

Benj. H. Stahl.

Edw. L. Tolson.

Inventor.

Sebastian Ziani de Ferranti.

By Spear, Middleton, Donaldson & Spear

Atty's.

UNITED STATES PATENT OFFICE.

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

MANUFACTURE OF STRIP MATERIAL SUITABLE FOR THE BLADES OF TURBINES, TURBO-PUMPS, AND THE LIKE.

960,161. Specification of Letters Patent. **Patented May 31, 1910.**

Application filed February 18, 1907. Serial No. 358,047.

To all whom it may concern:

Be it known that I, SEBASTIAN ZIANI DE FERRANTI, engineer and electrician, subject of the King of Great Britain and Ireland, residing at Grindleford Bridge, near Sheffield, England, have invented new and useful Improvements in the Manufacture of Strip Material Suitable for the Blades of Turbines, Turbo-Pumps, and the Like, of which the following is a specification.

This invention relates especially to improvements in the methods of manufacture of blades for turbines, turbo-pumps and the like, such methods being also applicable to the production of metal strips of other cross sections.

The primary object of the invention is the production of blades having one or more of their edges of such an extreme degree of fineness as to render the processes of drawing, rolling and so forth at present in use unsuitable for their manufacture.

My invention however is equally well adapted to the production of blades other than those referred to above as having extremely fine edges, since the smooth and polished surface necessary to minimize frictional losses, whether superficial or produced by eddies, is directly secured by my process during the actual operation of shaping the blade and thus the subsidiary buffing or other polishing operations so often required in connection with rolling or drawing processes in order to remove the resulting longitudinal ridges or grooves, are dispensed with. Further, blading produced by rolling or drawing is apt to be bent, and it then requires straightening, a process which is liable to produce distortion of the cross section; this difficulty is also overcome by the use of my invention.

My invention consists essentially in a process for the production of turbine blades or metal strip according to which strip material is subjected to a series of step-by-step swaging *i. e.*, squeezing operations to give it its ultimately desired section.

In carrying the invention into effect according to one method as applies for example in connection with the production of turbine blades, the 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 operation 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 effects of the swaging operations (which may be considered as a succession of steady squeezes performed progressively step by step along the strip) 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 my improved process 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 Fig. 8 shows a plan of the clamp-operating cam.

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 up stroke of the machine while the lower toggle member, *u*, interposed between the upper member, *h*, and the top of the die carrier, *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 operations 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 approximated 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 form of the strip, 21, as clamped before swaging being shown in Fig. 6.

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, engaging with the groove, 28, in the cam segment, 29, (Fig. 8) which is itself keyed to the rocking shaft 12, motion of which thus serves in conjunction with the suitable 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.

I wish it to be understood that the machine hereinbefore described is simply to be regarded as one embodiment of a suitable apparatus for carrying my process into effect and not in any way limiting my invention thereto, as it is obvious that various modifications may be made in the details of the machine without departing from the scope of my invention; for example, any suitable means other than those which I have illustrated and described may be adopted for clamping the blade strip, which clamping means may be situated either in front of or behind the dies or both behind and in front thereof, according to the circumstances of the case; also any form of press actuated by hydraulic or other power may be adapted to give the intermittent pressure for the swaging operations, the other operations of clamping, unclamping and feeding being arranged to take place in their proper sequence.

Blades thus constructed, if made, for example, of nickel, 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.

What I claim as my invention and desire to claim by Letters Patent is;—

1. A process of manufacturing strip material, consisting in first producing by any suitable process strip material of any desired degree of approximation to the cross section ultimately desired and subsequently defining the cross section of the strip length by length by a series of longitudinally progressive and overlapping swaging operations acting to cause a transverse flow of the metal of the strip.

2. A process of manufacturing strip material of a certain cross section, consisting in first producing by any suitable process strip material having a comparatively thick part and a comparatively thin part at a given cross section and subsequently defining the cross section of the strip length by length by a series of longitudinally progressive and overlapping swaging operations causing transverse flow of the metal of the strip from said comparatively thick to said comparatively thin part.

3. A process of manufacturing turbine blades or blade strip consisting in first producing by any suitable process strip material of any desired degree of approximation to the cross section ultimately desired and subsequently defining the cross section of the strip length by length by a series of longitudinally progressive and overlaping swaging operations acting to cause a transverse flow of the metal of the strip.

4. A process of manufacturing turbine blades or blade strip consisting in first producing by any suitable process strip material having a comparatively thick body portion tapering away to a comparatively thin edge portion at a given cross section and subsequently thinning and extending transversely said edge portion by a series of longitudinally progressive and overlapping swaging operations.

5. A process of manufacturing turbine blades or blade strip consisting in first producing by any suitable process strip material having a comparatively thick body portion tapering away to a comparatively thin edge portion at a given cross section and subsequently by a series of longitudinally progressive and overlapping swaging operations causing metal to flow transversely from said thick portion to said edge portion to extend the same laterally.

6. A process of manufacturing strip material having a continuous fine edge, consisting in first producing by any suitable process strip material having a comparatively thick part and a comparatively thin part at a given cross section and subsequently by a series of intermittent squeezing operations performed successively step by step along the length of the strip, causing transverse flow of the metal of the strip from said comparatively thick part to said comparatively thin part to form the continuous fine edge.

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

SEBASTIAN ZIANI DE FERRANTI.

Witnesses:
ALBERT HALL,
WILLIAM HERBERT DONNER.