

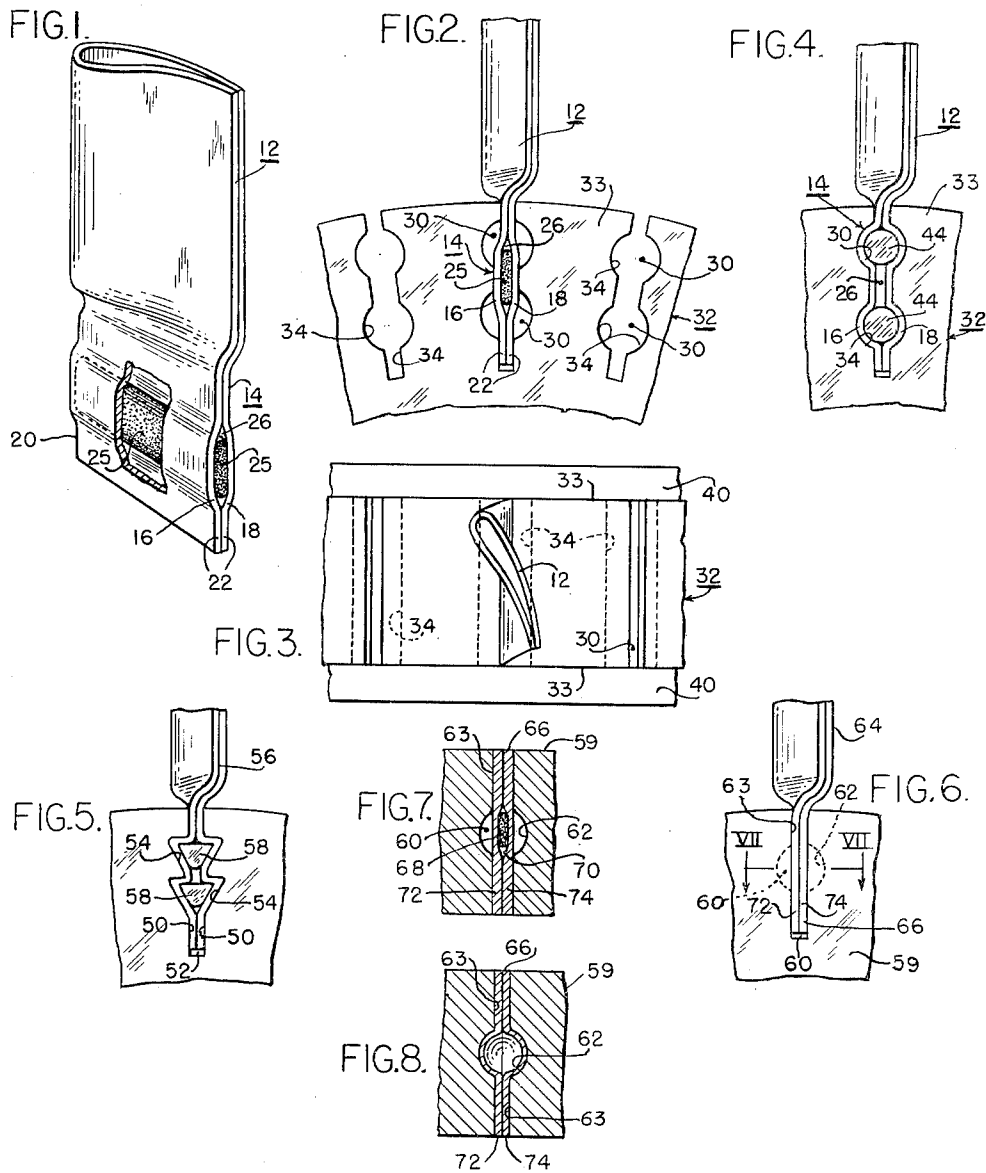
April 11, 1961

G. A. KEMENY

2,978,796

METHOD OF SECURING USING AN EXPLOSIVE CHARGE

Filed April 7, 1958



INVENTOR
GEORGE A. KEMENY

BY *Frank Christiano Jr.*

1

2,978,796

METHOD OF SECURING USING AN EXPLOSIVE CHARGE

George A. Kemeny, Export, Pa., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Filed Apr. 7, 1958, Ser. No. 726,953

4 Claims. (Cl. 29—156.8)

This invention relates to the securing of a first member to a second member. Also, this invention relates to novel root portions of blades and to improved methods of forming the root portions. Furthermore, this invention also includes methods for shaping and securing, simultaneously, root portions of fluid utilizing blades to support members.

Some of the blades which are utilized in elastic fluid utilizing devices, such as turbines, employing gases at high temperatures are formed from alloys containing molybdenum. Preferably, such alloys are treated with a thin surface coating of corrosion resistant material to protect the molybdenum against corrosion. In forming the blades from materials having such a coating, one must be careful not to mar or remove any of this coating. Some of the previous methods of forming blades, particularly previous methods of forming root portions thereof, have involved the removal or marring of a portion of this protective coating, resulting in subsequent corrosion in these areas. It is one feature of this invention to provide an improved method of forming blade root portions that minimizes the removal or marring of these protective coatings.

Certain previous methods for forming and securing root portions to support members have involved first shaping the root portions and then securing them to the support members. Another feature of the present invention is to simultaneously shape and secure the root portions to the support members.

In one embodiment of the present invention a sheet metal blade is secured to a suitable rotor disc. The blade is initially provided with an airfoil portion and a depending integral root portion, the latter initially comprising two flat deformable thin sheet metal plates of polygonal shape. The two sheet metal plates are disposed with one of the large surfaces of one plate opposite and abutting one of the large surfaces of the other plate. Portions of the abutting surfaces are separated and an explosive charge is inserted therebetween. The explosive charge maintains the sheet metal plates in spaced relation, forming an open ended chamber.

The root portion with the explosive charge in place is inserted into an open ended undercut recess, of the side entry type, that is partially defined by opposed side walls of the rotor disc. Retaining plates are then placed on opposite sides of the recess and in closing relation with the open ends of the chamber and of the recess.

The explosive charge is then ignited, a sufficient charge having been provided to generate a sufficient gas at a pressure, within the chamber, which will deform or shape the sheet metal plates to the shape of the side walls. Thus, the sheet metal plates are placed in abutting and keying relation with the side walls of the undercut recess and secured to the latter. Simultaneously, the chamber is enlarged by the gases confined momentarily within the chamber by the retaining plates. Thereafter, suitable wedges may be inserted, if desired, through the

2

open ends of the enlarged chamber to bias or hold the root portion against the side walls.

The foregoing and other objects are effected by the invention as will be apparent from the following description and claims taken in connection with the accompanying drawings, forming a part of this application, in which:

Fig. 1 is a perspective view of a partially completed elastic fluid utilizing blade to which the present invention has been partially applied;

Fig. 2 is a fragmentary elevational view, showing a support member in which the root portion of the blade illustrated in Fig. 1 has been inserted;

Fig. 3 is a fragmentary plan view of the support member illustrated in Fig. 2, retaining plates having been added;

Fig. 4 is a fragmentary elevational view of a portion of the structure illustrated in Fig. 2 after one root portion has been shaped and wedging pins added thereto;

Fig. 5 is a view similar to Fig. 4; but showing a modification of the present invention;

Fig. 6 is a view similar to Fig. 2, but showing a further modification of the present invention;

Fig. 7 is a sectional view taken along the line VII—VII of Fig. 6; and

Fig. 8 is a sectional view similar to Fig. 7, but showing the root portion after it has been shaped.

In one embodiment of the present invention, an elastic fluid utilizing blade is provided with a suitable airfoil portion 12 and a deformable root portion 14, as illustrated in Fig. 1. The root portion 14 may be integral with the airfoil portion 12 and depend therefrom, as shown. The blade is formed from a thin sheet metal plate and the airfoil portion 12 is shaped first, by bending around the left-hand edge portion, as viewed in Fig. 1, in a suitable manner. The root portion 14 is integral with the airfoil portion 12 and the sheet metal is bent and pressed together, providing two substantially flat separable sheet metal plates 16 and 18. The two metal plates are disposed with one of the large surfaces of one plate opposite and abutting one of the large surfaces of the other plate. The plates 16 and 18 are substantially rectangular in shape, having aligned parallel sides 20 and 22. The sides 20 and 22, as viewed in Fig. 1, are formed by suitably shaping the left and right edge portions of the root portion 14. Thus, the portion of the sheet metal plate where the bending took place is removed, permitting access to the abutting surfaces of the plates 16 and 18 from either the left-hand side or the right-hand side.

The plates 16 and 18 are separated, by a suitable tool, approximately midway between the juncture of the airfoil portion 12 and the root portion 14 and the lowermost portion of the root portion, as viewed in Fig. 1. An explosive charge 25, utilized subsequently to shape or form the root portion 14, is placed therebetween. Preferably, the explosive charge 25 is of elongated shape and extends along substantially the entire length of the root portion 14. The explosive charge 25 spaces the plates 16 and 18, so as to form a chamber or opening 26, and the explosive charge is held therein. If desired, the plates 16 and 18 may be formed from resilient material, the resilience serving to hold the explosive charge 25 in place.

The root portion 14 is placed in an open ended undercut recess 30 of the side entry type provided in the peripheral rim portion of a rotatable circular disc or support member 32 that has parallel sides or faces 33. The present invention will be described in terms of one blade, for the sake of clarity and brevity, but it is equally applicable to a plurality of blades. Similarly, as illustrated in Fig. 2, the support member may be provided

3

with a plurality of recesses 30 but the invention will be described in terms of securing one blade to one recess.

The recess 30 extends transversely to the plane of rotation of the support member 32, being illustrated in Fig. 3 at a right angle thereto. The recess 30 is defined by opposed side walls 34 each having two spaced approximately semi-circular undercut grooves and a bottom wall. The recess 30 has a middle portion disposed between the undercut grooves, as viewed in Fig. 2, which is wider than the top and bottom portions thereof. The root portion 14 with its explosive charge 25 in place is slidably inserted through one of the open ends of the recess 30, and is positioned therein so that the sides 20 and 22 lie in approximately the same planes as the faces 33 and the explosive charge is disposed within the recess 30. The root portion 14 is disposed in the recess 30 with the upper, middle, and lower portions of the opposed side walls 34 in abutment with corresponding sections of the root portion 14 and the enlarged portion of the latter is centrally disposed in the middle portion of the recess 30.

After the root portion is positioned in the recess, a pair of retaining rings or plates 40 are secured (by suitable clamps not illustrated) to the faces 33 of the support member, in closing relation with the recess 30 and the chamber 26.

The support member 32 and retaining plates 40 are then heated until the explosive charge ignites. The quantity of the explosive charge 25 provided is sufficient to generate a gas, when ignited, at a pressure within the chamber 26 that will deform the sheet metal plates 16 and 18 until they abut with (and assume the shape or form of) the side walls 34. Thus, the shape of the side walls 34 will be imparted to the plates 16 and 18. As illustrated in Fig. 4, when the plates 16 and 18 assume the shape of the side walls 34, the chamber 26 becomes enlarged and assumes the form of a longitudinally extending upper circular bore and a similarly extending lower circular bore, connected by a narrow neck portion, keying the root portion 14 to the recess 30 and preventing radial movement of the blade 12.

The gases which are generated by the explosion are restrained from rapidly escaping from the chamber 26 by the retaining plates 40. Thus, the required pressure may be attained and contained, for a limited time, within the chamber 26.

The gases which are generated by the explosive charge are gradually vented or exhausted through the various leakage paths inherent in the structure, for example, upwardly between the plates 16 and 18 and out the sides between the retaining plates 40 and the support member 32. After the gases are fully vented, the retaining plates 40 are removed and solid cylindrical pins 44 may be wedged into the bores, for biasing the sheet metal plates 16 and 18 against the side walls 34 and preventing movement of the blade relative to the support member 32.

A modification of the present invention is illustrated in Fig. 5. In this instance, the side walls 50 of the undercut and open ended recess 52 of the side entry type are formed with approximately V-shaped radially aligned notches 54. A blade 56 having a root portion and an explosive charge similar to the blade of the previous embodiment is inserted in the recess 52 and a root portion is formed, as described in connection with the first embodiment. In this instance, triangularly shaped longitudinal bores are formed in which elongated triangular rods 58 are placed to bias or wedge the sheet metal plates against the side walls. In all other respects this embodiment is similar to the first embodiment.

A further modification is illustrated by Figs. 6, 7 and 8. As illustrated in Figs. 7 and 8, there is provided a support member 59 having an open ended longitudinally extending recess 60 defined by side walls. The recess 60 is undercut for a portion of its length by a cen-

4

tral bulbous or approximately semi-spherical cavity 62 which is disposed inwardly of, and is larger than, narrow entry portions 63, the latter being defined by marginal portions of the side walls. As illustrated, the cavity 62 enlarges the recess both in a plane parallel to the longitudinal axis of the recess and in a plane transverse thereto. A blade 64 (Fig. 6) having a root portion 66 with an explosive charge 68 (Fig. 7) positioned in a chamber or cavity 70, formed by thinning opposed portions of the plates 72 and 74, is inserted into the open ended recess 60 through either the entry portion 63 located at the top, as viewed in Fig. 6, or the entry portions 63 located on both sides of the cavity 62, as viewed in Figs. 7 and 8. If desired, retaining plates (not illustrated) may be employed and clamped to side faces of the support member 59, as and for the purpose described in connection with the first embodiment. Thereafter, the explosive charge is ignited and the sheet metal plates are deformed to the shape of the side walls, as described previously in connection with the first embodiment. In this manner, portions of the plates 72 and 74 will lodge within the enlarged cavity 62, preventing radial and axial movement (with reference to the axis of rotation of the support member) relative to the support member. In all other respects this embodiment is similar to the first embodiment described.

It may be desirable to heat the blade, the support member, and the retaining plates simultaneously to the temperature required for heat treating and adding ductility to the blade, thus minimizing the probability of its fracturing when the explosive charge ignites. If desired, an explosive charge may be provided which will ignite at the termination of sufficient heat treating. Where the blade material utilized requires heat treatment above the ignition temperature of the explosive charge, the explosive charge may be contained within a suitable insulating jacket (not illustrated) and the rate of heating made rapid enough to insure proper heat treatment of the blade prior to the ignition of the explosive. Obviously, if the heating to increase ductility to the blade is not desired, localized heat may be applied for igniting the explosive charge.

Where the rate of venting through the inherent leakage paths is not sufficiently rapid, additional leakage paths may be provided by suitable radial or circumferential grooves (not illustrated) formed in the retaining plates and in communication with the chambers 26, for example, chamber of the first embodiment and the atmosphere.

Preferably, the explosive charge utilized is a progressively burning explosive and not a detonating explosive. One progressively burning explosive which may be utilized is a nitro-cellulose powder contained in a suitable package or formed in a single suitably shaped member to fit into cavity 26, first embodiment.

The first and second embodiments herein described utilize wedging pins. Obviously, if the sheet metal is of substantial thickness and an explosive charge sufficiently large is utilized, it is possible to dispense with the wedging pins and to merely deform (with a suitable tool) the sides 20 and 22 (first embodiment) of the root portion 14 into engagement with the faces 33, for the purpose of preventing axial movement of the blade relative to the support member.

In forming the root portion in the manner of this invention, it may be found that the root portion may reduce to slightly below the size of the recess after the gases within the root portion are fully vented. That is, when the gases are fully vented the sheet metal plates 16 and 18 (first embodiment) may contract or part from the side walls. When a loose-fitting root portion is desired this parting is beneficial. When a tight-fitting root portion is desired the pins 44 and 58 may be inserted, as previously described in connection with the first and second embodiments, to bias the sheet metal plates against the side walls of the recess. In addition, this

parting may be substantially eliminated if an explosive charge is utilized which is in excess of the minimum required to shape the sheet metal plates to the shape of the side walls.

The present invention has been described in terms of one blade. As is obvious, the present invention may be applied to a plurality of root portions. By inserting a plurality of root portions within a suitable support member all of the root portions may be shaped and secured to the support member simultaneously, by clamping to the support member retaining rings which will be in closing relation with all the chambers and recesses and heating all the blades, retaining plates and support members simultaneously until all of the explosive charges have been ignited.

While the invention has been shown in several forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications without departing from the spirit thereof.

What is claimed is:

1. A method of forming a sheet metal root portion of a fluid utilizing blade and of securing it to a support member having an undercut recess defined partially by side walls, said method comprising the steps of, providing said blade with a pair of flat sheet metal plates having the large surface of one plate opposite and abutting a similar surface of the other plate, deforming at least a portion of the large surfaces of said plates to provide a chamber therebetween, placing an explosive charge in the chamber between said sheet metal plates, inserting said sheet metal plates with the explosive charge in place in the recess, igniting the explosive charge, and providing means for containing the gas pressure produced by the charge between the sheet metal plates, whereby to build up between said sheet metal plates a gas at a pressure sufficient to force said sheet metal plates against said side walls and impart to said sheet metal plates the shape of said side walls.

2. A method of forming a root portion of a sheet metal blade and of securing said root portion to a support member having wall structure defining an open ended undercut side entry recess, providing said blade with a pair of flat thin sheet metal plates with one of the large surfaces of one plate opposite and abutting a similar surface of the other plate, deforming at least a portion of the large surfaces of said plates to provide a chamber therebetween, placing an explosive charge in the chamber between said sheet metal plates, inserting said sheet metal plates with said explosive charge in said recess, substantially closing the open ends of said recess with retaining members, heating said sheet metal plates and said support member, igniting said explosive charge to generate a gas at a pressure between said sheet metal plates sufficiently high to form said sheet metal plates to the shape of the wall structure, removing said retaining members, and inserting a wedge between said sheet metal plates after they have assumed the shape of the wall structure for biasing them against the wall structure.

3. A method of forming a root portion of an elastic fluid utilizing blade and of securing said root portion to a support member comprising the steps of: providing said

blade root portion with two flat sheet metal plates with one of the large surfaces of one plate opposite and abutting a similar surface of the other plate, deforming at least a portion of the large surfaces of said plates to provide a chamber therebetween, placing an explosive charge in the chamber between said sheet metal plates, providing said support member with wall structure including side walls defining an open ended undercut recess, placing said sheet metal plates in said recess so that said explosive charge is within said recess, heating said sheet metal plates and said support member for increasing the ductility of the sheet metal, igniting the explosive charge to generate a gas pressure between said sheet metal plates, substantially restraining the escape of said gas to cause a sufficient gas pressure within said chamber to deform said sheet metal until it assumes the shape of said side walls and enlarges said chamber and inserting a wedge member into the enlarged chamber for maintaining the sheet metal against said side walls.

4. A method of making a blade root portion and of securing it to a support member comprising the steps of: providing an open ended undercut recess defined partially by side wall structure of said support member, forming said blade root portion from two oppositely disposed abutting resilient sheet metal plates which are longitudinally coextensive with each other and said recess, spreading said sheet metal plates to form therebetween a chamber open at opposite ends, inserting an explosive charge within said chamber sufficiently large to provide a pressure therein to deform said sheet metal to the shape of said recess, placing said blade root portion in said recess, substantially closing the open ends of said chamber and recess with retaining members, heating said support member, retaining members, and blade root portion until said explosive charge ignites and produces a gas pressure, said restraining members restraining the escape of said gas to cause a sufficient gas pressure within said chamber to deform said sheet metal until it assumes the shape of said side wall structure and enlarges the chamber, removing the retaining members from their closing relation with said chamber and recess, and inserting a wedge member into the enlarged chamber for biasing said sheet metal plates against the side wall structure.

References Cited in the file of this patent

UNITED STATES PATENTS

941,375	Loud et al. _____	Nov. 30, 1909
2,412,886	Huston et al. _____	Dec. 17, 1946
2,642,263	Thorp _____	June 16, 1953
2,656,146	Sollinger _____	Oct. 20, 1953
2,699,598	Daugherty _____	Jan. 18, 1955
2,707,897	Beeson _____	May 10, 1955
2,779,279	Maiwurm _____	Jan. 29, 1957
2,779,565	Bruckmann _____	Jan. 29, 1957
2,787,049	Stalker _____	Apr. 2, 1957

FOREIGN PATENTS

764,771	France _____	Mar. 28, 1934
477,301	Canada _____	Sept. 25, 1951
766,741	Great Britain _____	Jan. 23, 1957