Nov. 16, 1954 E. W. STEVENS 2,694,458

ROTOR BLADE CONSTRUCTION

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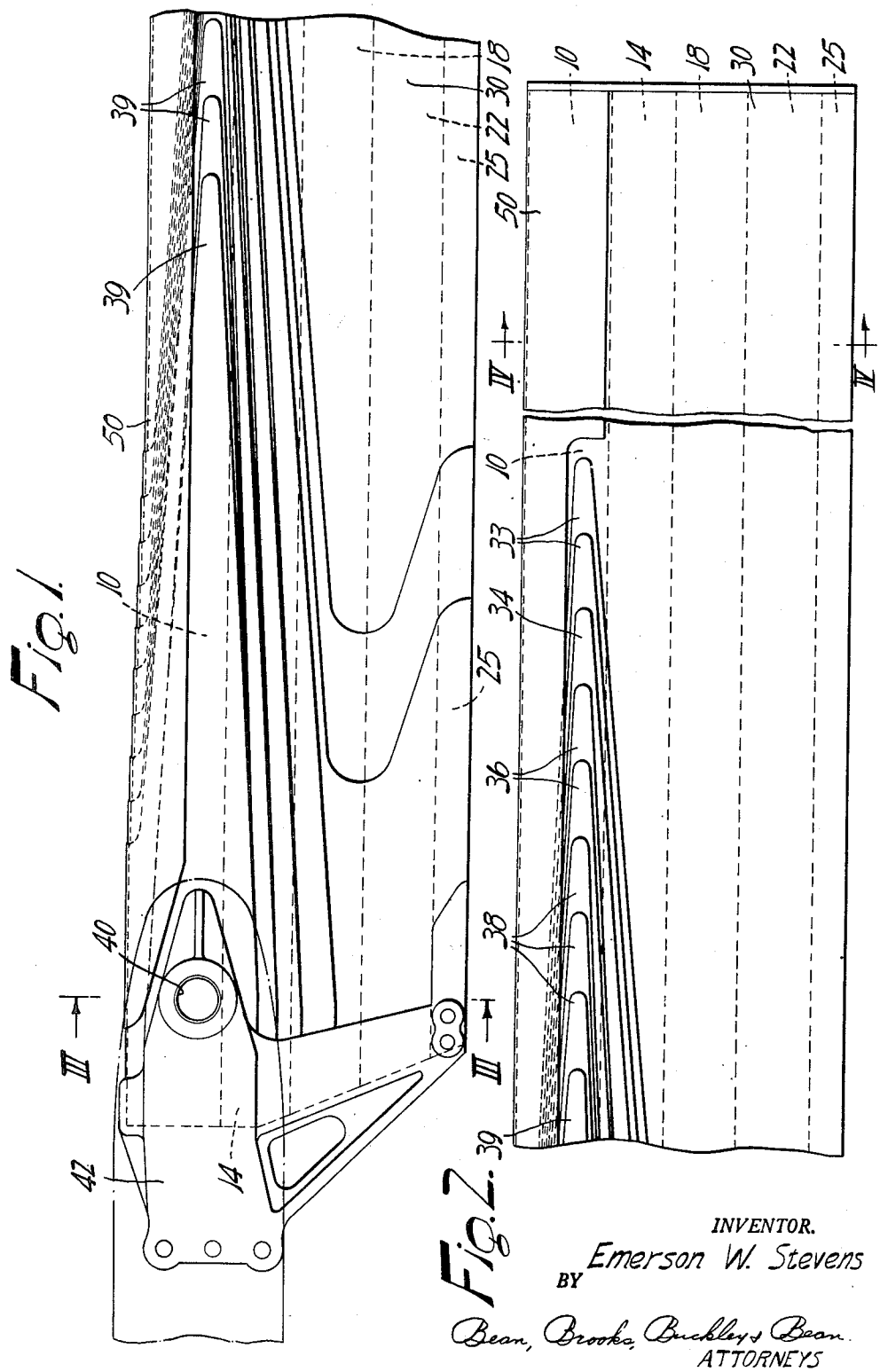


Fig. 1.

Fig. 2.

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Fig. 3.

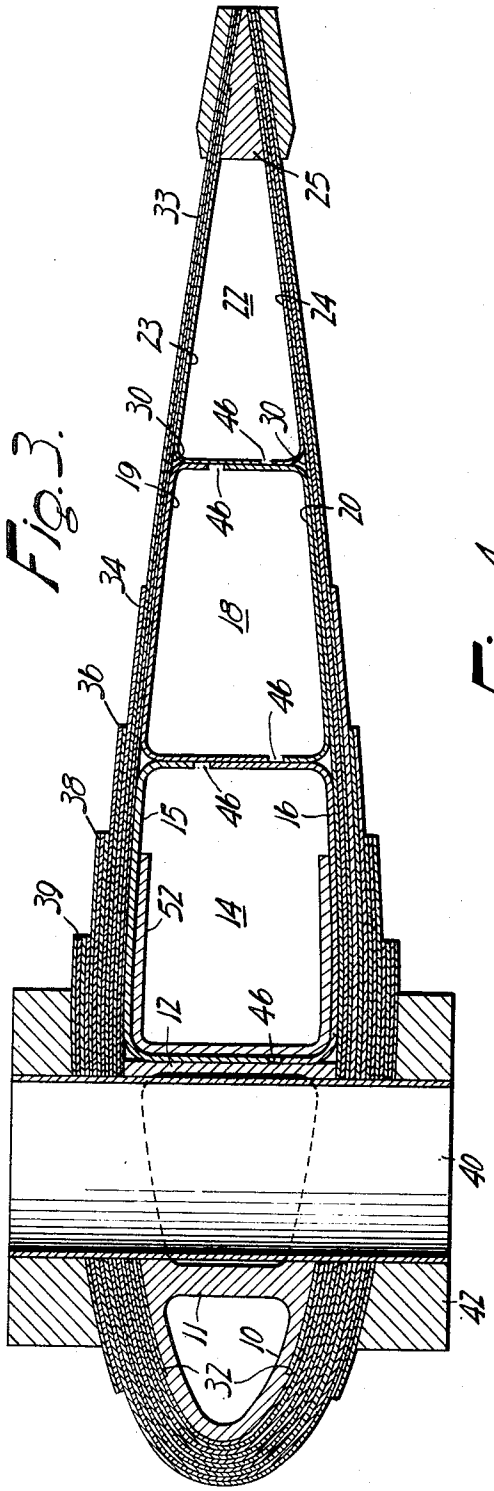
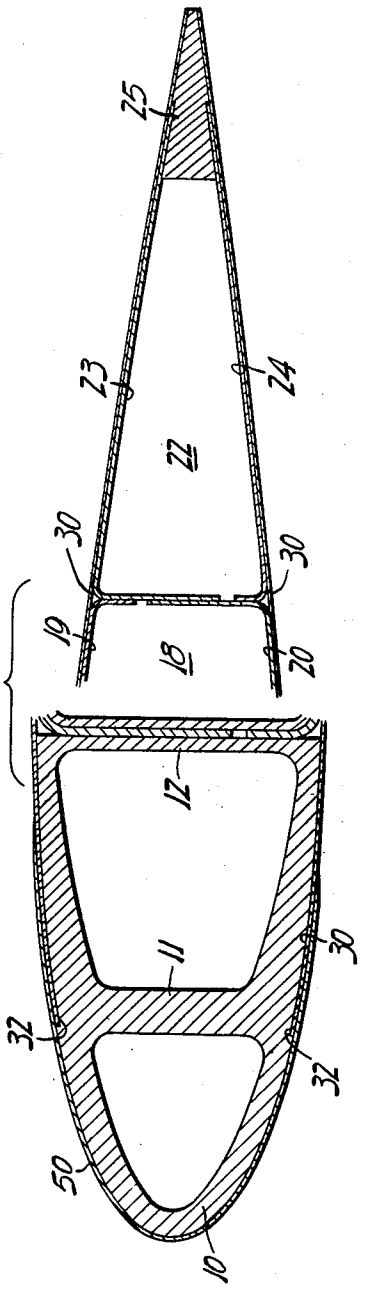


Fig. 4.



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ROTOR BLADE CONSTRUCTION

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5 Claims. (Cl. 170—159)

This invention relates to hollow metal rotor blades, and more particularly to an improved rotor blade construction for use in rotary wing aircraft and the like.

The present invention is especially applicable to relatively large rotor blades wherein the problems of vibration and flexing are more severe; and one of the objects of the invention is to provide a blade of the character aforesaid which is of improved fatigue life and practically impervious to fungi, rot and moisture absorption, as well as being adapted to take gun fire damage to some degree without disastrous results.

Another object of the invention is to provide a blade construction as aforesaid which may be readily and inexpensively fabricated of easily formed standard type component parts.

Another object of the invention is to provide an improved blade as aforesaid which comprises a novel fabrication of structural elements eliminating highly stressed connection areas and providing improved overall structural strength.

Another object of the invention is to provide a blade as aforesaid which is free from welds or unreinforced perforations, or other stress raising arrangements in areas of substantial blade stress.

Another object is to provide an improved blade constituting multi-cell type construction elements which may be individually penetrated by bullets or shell fragments or the like without disastrous results.

Other objects and advantages of the invention will appear from the specification hereinafter.

In the drawing:

Fig. 1 is a fragmentary top plan view of the root end portion of a blade of the invention;

Fig. 2 is a composite fragmentary top plan view of intermediate and tip end portions thereof;

Fig. 3 is a section, on an enlarged scale, taken along line III—III of Fig. 1; and

Fig. 4 is a fragmentary composite section, on a large scale, taken along line IV—IV of Fig. 2.

As shown in the drawing, the blade of the invention is illustrated to comprise a metal nose element **10** in the form of a metal extrusion member sectioned as illustrated in Figs. 3–4 to comprise a typical airfoil nose contour and consisting generally of top and bottom surfaces interconnected by chordwise spaced web portions **11—12**. The element **10** runs lengthwise of the leading edge of the blade, and is preferably uniformly dimensioned throughout its length and designed and selected as to weight so as to assist in bringing the overall center of gravity of the blade forwardly to the desired chordwise position. Abutting the rear web **12** of the nose section **10** is a box section structure **14** comprising a pair of positionally opposed channel section metal members **15—16**. Similar box section structures **18** and **22** comprising positionally opposed channel section elements **19—20** and **23—24**, respectively, are arranged alongside and successively to the rear of the box section **14** and the box section **18**; the members **23—24** in turn mounting in lapped relation at their trailing edge portions upon a trailing edge strip **25** (Fig. 3) which may also be conveniently fabricated in the form of a metal extrusion strip.

The channel section elements **15—16—19—20—23—24** are connected at their positions of abutting continuity by means of suitable metal-to-metal cement, and the members **15—16** are similarly connected to the extrusion **10** where they abut the web portion **12** thereof,

and the members **23—24** are similarly connected to the trailing edge strip **25** at positions of overlapping thereof. Thus, the box sections **14—18—22** combine with the nose section **10** to provide a multi-cell base structure which may be readily fabricated to the desired airfoil sectional contour simply by suitable shaping of the element **10** and selection of suitably dimensioned channel members forming the box sections of the unit. Skin elements such as are indicated at **30—30** are then applied over the top and bottom surfaces of the framing cell structure and integrally connected thereto as by any suitable metal-to-metal adhesive; the nose element **10** being illustrated at **32—32** as being recessed at its top and bottom surfaces so as to receive the skin plates **30—30** in flush relation thereon. Similarly, the skin plates **30—30** overlap and are cemented to the trailing edge strip **25**; thus firmly bonding the structure together.

As illustrated in Figs. 1 and 3, the root end portion of the blade may be effectively reinforced if required in the neighborhood of the rotor hub attachment connection by means of "root doubler" metal sheets **34, 36, 38, 39**, which are shaped to lap over the skin and to build up a laminar structure the sheets of which are cemented together by suitable metal-to-metal adhesive. Thus, as shown in Figs. 1–3, the laminar structure may be provided of progressively increased thickness at the root end of the blade and of maximum thickness in the region of the clevis bolt connection of the blade to the rotor hub. For this purpose the nose element **10** and the skin and reinforcing sheet elements are apertured to receive a sleeve **40** which also extends at its opposite ends through apertured portions of a clevis bracket **42** constituting the hub-to-root connection device. A bolt (not shown) slip-fits through the sleeve **40** to take the connection loads during service.

Thus, it will be appreciated that the channel section elements **15, 16, 19, 20, 23, 24** are fabricated in conjunction with the nose element **10** and trailing edge strip **25** to provide a novel airfoil base fabrication; the flange portions of the channel members being arranged so that each line of junction between oppositely paired channel flanges as indicated for example at **46** (Fig. 3) registers against a solid flange portion of the adjacent abutting channel flange. Consequently, the channel elements of one box section cooperate in novel manner to reinforce the lines of junction between the channel elements of the next adjacent box section, and the completed structure is therefore of improved strength while being of utmost simplicity. An abrasion-resistant leading edge cover sheet of steel or the like is preferably cemented over the leading edge of the blade as indicated at **50** to guard the blade against impact damage during service. Supplemental reinforcement elements such as indicated at **52** may be cemented in place as shown in Fig. 3 to further brace the blade against loads, as may be required.

Thus, it will be appreciated that by simple constructional processes the channel sectioned elements are relatively assembled so as to provide box sectioned structural cells interiorly of the blade, such as provide maximum strength against failure due to damage for example as by gun fire penetration of the individual cells. In such event due to the construction of the cells they are not materially reduced in strength, and in most cases the blade would be suited to continued operation until opportunity may be found for repair of the blades. Whereas, only one specific form of the construction has been shown and illustrated herein it will be understood that the invention is not so limited but that various changes may be made therein without departing from the spirit of the invention or the scope of the appended claims.

I claim:

1. A hollow rotor blade comprising a multi-cell base structure shaped externally to airfoil contour form, said base structure comprising a plurality of cells extending longitudinally of the blade in side-by-side relation, one of said cells comprising an integral hollow metal extrusion having a surface portion forming the shape for the leading edge portion of the blade and terminating rearwardly thereof in a transverse web portion, a second cell adjacent said one cell web portion comprising op-

positely paired channel sectioned metal members disposed in oppositely faced relation to define a box-sectioned shaped cell, the remaining of said cells similarly comprising oppositely faced channel sectioned members disposed to define corresponding box sectioned cell formations terminating in a trailing edge strip portion, said extrusion and said channel members being cemented together at positions of abutting continuity, and said base structure being covered by sheet metal skin elements cemented thereto so as to overlap the junctions between said cells.

2. A hollow rotor blade comprising a multi-cell base structure shaped externally to airfoil contour form, said base structure comprising a plurality of cells extending longitudinally of the blade in side-by-side relation, one of said cells comprising a generally tubular member having a surface portion forming the shape for the leading edge portion of the blade and terminating in a rear wall portion extending spanwise of the blade, the cell adjacent said one cell comprising oppositely paired channel sectioned metal members disposed in oppositely faced relation to define a box-sectioned shaped cell, the remaining cells similarly comprising oppositely faced channel sectioned members disposed to define corresponding box-sectioned cell formations terminating in a trailing edge strip portion, said tubular member rear wall portion and said channel members being cemented together at positions of abutting continuity with the channel members of each cell bearing against a channel member of both adjacent cells, and said base structure being covered by sheet metal skin elements cemented thereto so as to overlap the junctions between said cells.

3. A hollow rotor blade comprising a multi-cell base structure, said base structure comprising a plurality of cells extending longitudinally of the blade in side-by-side relation, one of said cells comprising a generally tubular shaped extrusion member having a surface portion forming the base for the leading edge portion of the blade and terminating in a rear flat wall portion, the cell next adjacent said one cell comprising oppositely paired channel sectioned metal members disposed in oppositely faced relation to define a box sectioned shaped cell, the remaining of said cells each similarly comprising oppositely faced channel sectioned members disposed to define corresponding box sectioned cell formations, said tubular member and said channel members being cemented together at positions of abutting continuity with a channel member in each cell overlapping both channel members of an adjacent cell, and said base structure being covered by sheet metal skin elements cemented thereto so as to overlap the junctions between said cells.

4. A hollow rotor blade comprising a multi-cell base structure shaped externally to airfoil contour form, said base structure comprising a plurality of cells extending longitudinally of the blade in side-by-side relation, said cells each comprising oppositely paired channel sectioned metal members disposed in oppositely faced relation to define a box sectioned shaped cell, the channel members

of adjacent cells being arranged in abutting continuity with the junction between channel members of the same cell registering with a solid flange portion of an adjacent cell channel member, said channel members being cemented together at positions of abutting continuity, and said base structure being covered by sheet metal skin elements cemented thereto so as to overlap the junctions between said cells.

5. A hollow rotor blade comprising a multi-cell base structure shaped externally to airfoil contour form, said base structure comprising a plurality of cells extending longitudinally of the blade in side-by-side relation, one of said cells comprising an integral hollow metal extrusion having a surface portion forming the shape for the leading edge portion of the blade and terminating rearwardly thereof in a transverse web portion, a second cell adjacent said one cell web portion comprising oppositely paired channel sectioned metal members disposed in oppositely faced relation to define a box sectioned shaped cell, the remaining of said cells similarly comprising oppositely faced channel sectioned members disposed to define corresponding box sectioned cell formations terminating in a trailing edge strip portion, said extrusion and said channel members being cemented together at positions of abutting continuity, said base structure being covered by sheet metal skin elements cemented thereto so as to overlap the junctions between said cells, a clevis bracket provided adjacent the root end of said blade, said extrusion being apertured adjacent the root end thereof, a sleeve extending through said bracket and said aperture, and a sheet metal laminar reinforcing structure over said skin elements, said reinforcing structure being of maximum thickness in the region of said clevis bracket and of progressively decreased thickness from the root end to the tip end and the leading edge to the trailing edge of the blade.

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