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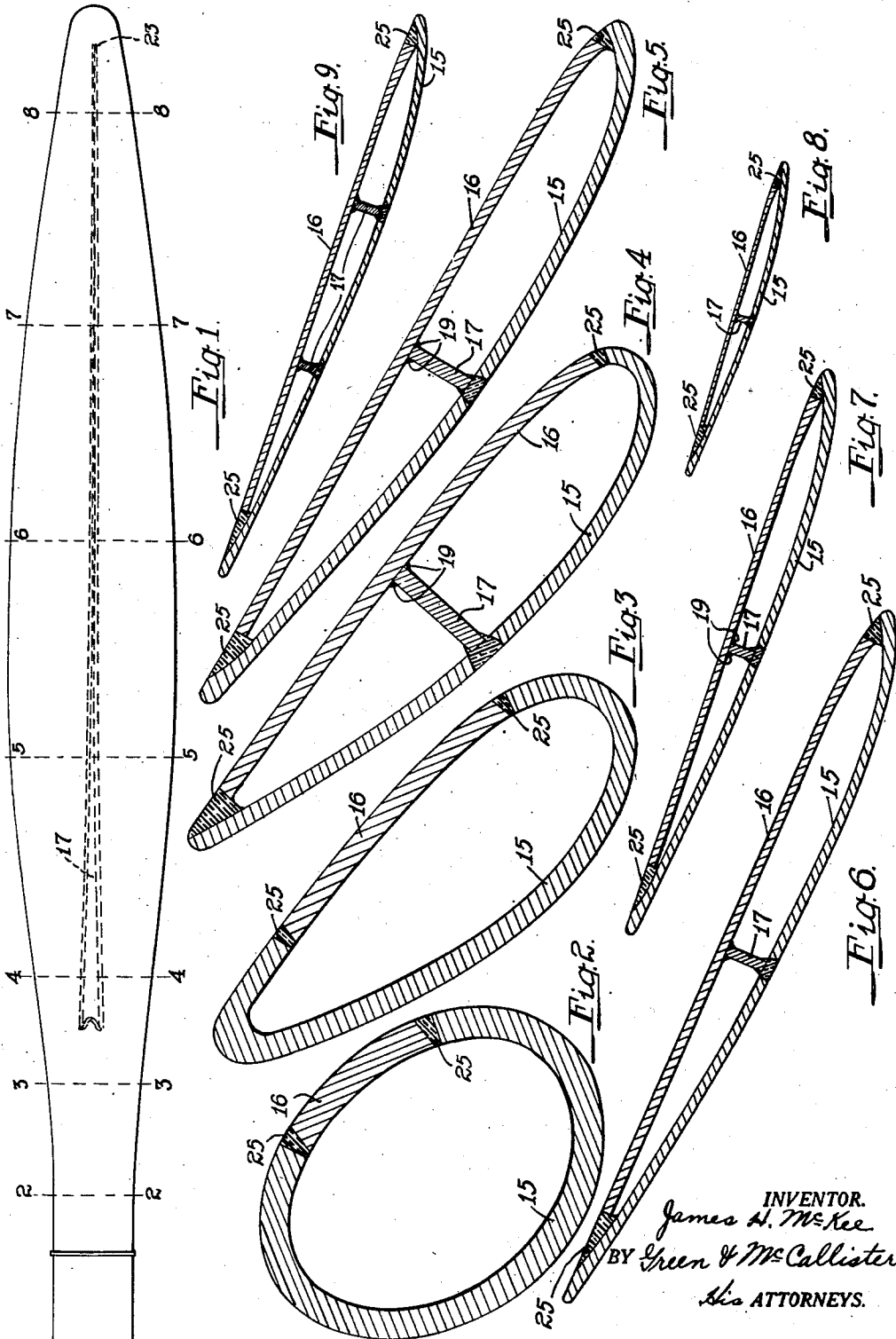
J. H. McKEE

2,214,339

METHOD OF MAKING HOLLOW RIBBED PROPELLER BLADES

Filed Nov. 23, 1937

3 Sheets-Sheet 1



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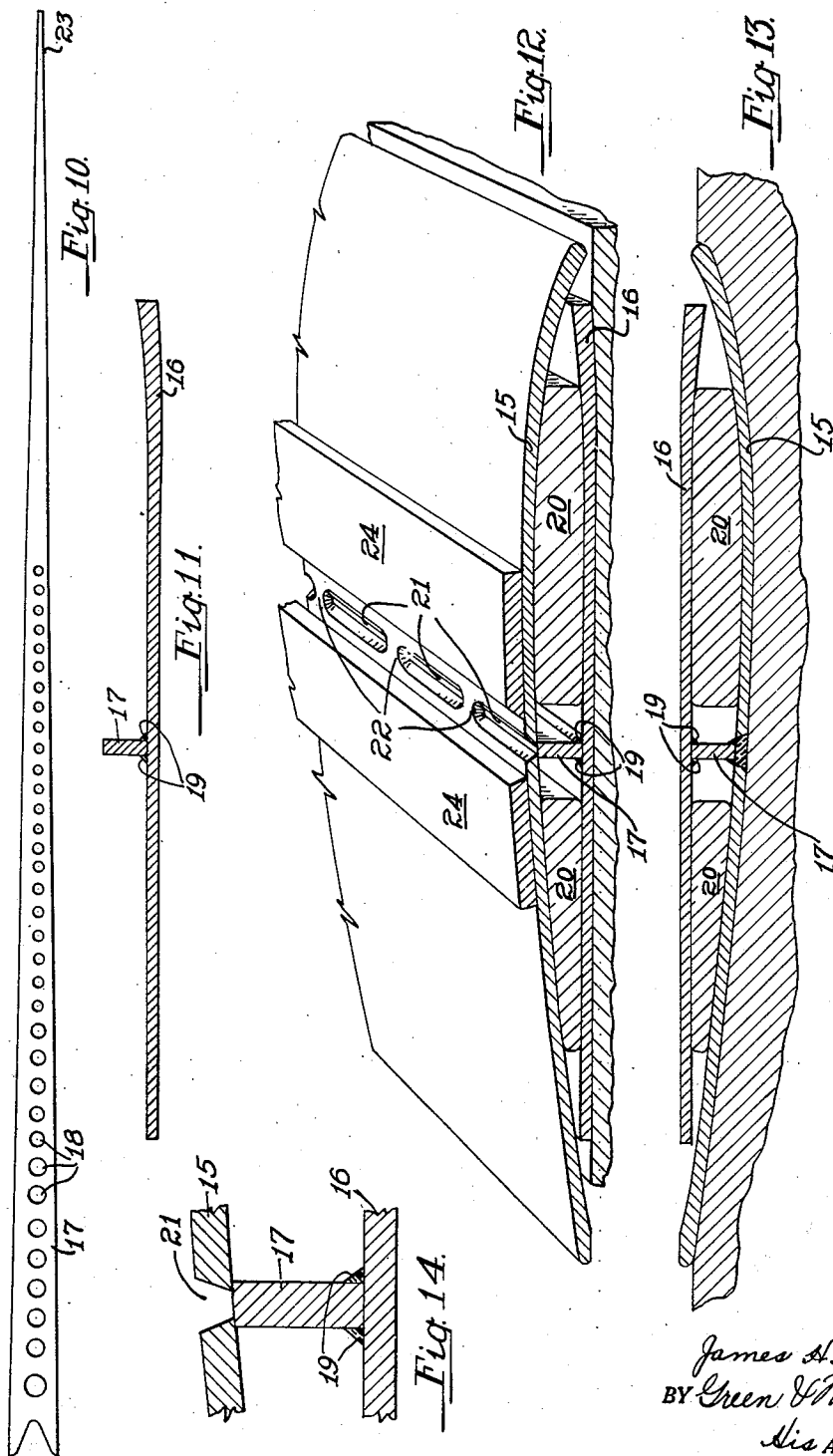
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METHOD OF MAKING HOLLOW RIBBED PROPELLER BLADES

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3 Sheets-Sheet 2



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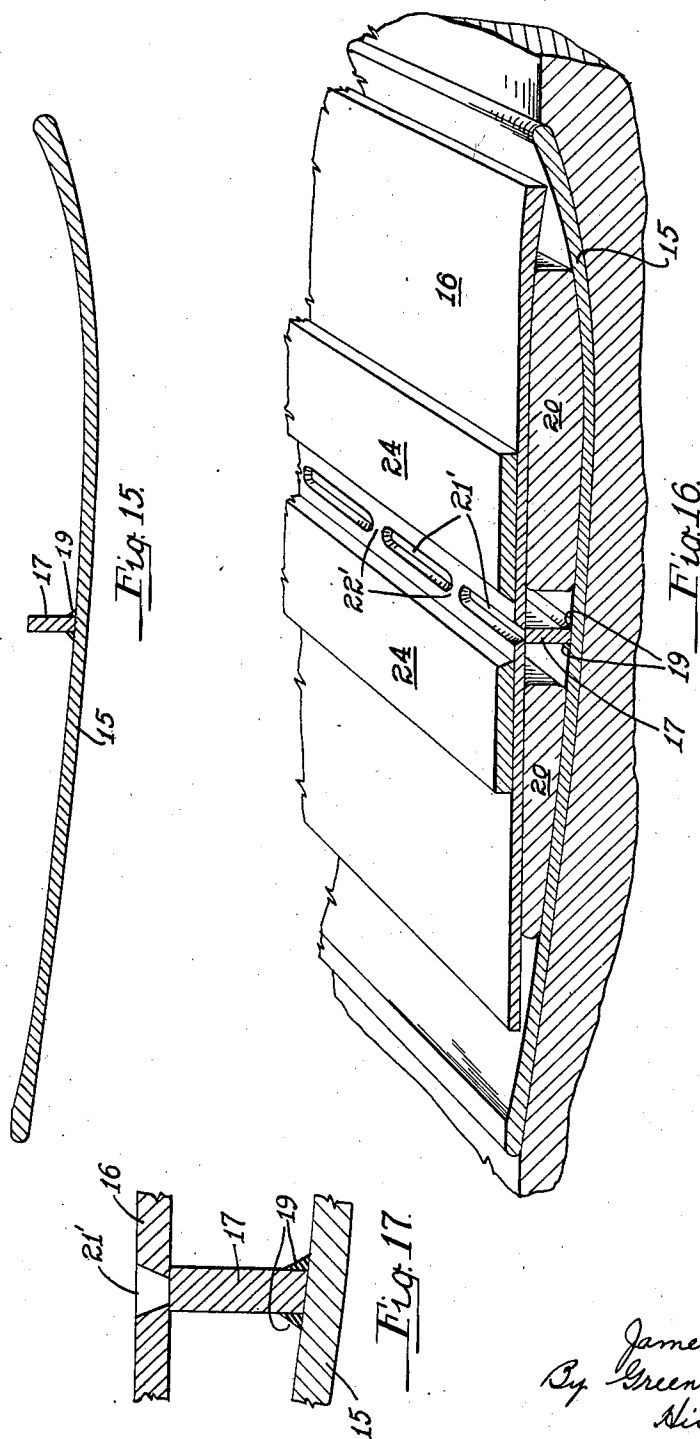
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METHOD OF MAKING HOLLOW RIBBED PROPELLER BLADES

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,214,339

METHOD OF MAKING HOLLOW RIBBED
PROPELLER BLADES

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mesne assignments, to Curtiss-Wright Cor-
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Application November 23, 1937, Serial No. 176,044

5 Claims. (Cl. 29—156.8)

This invention relates to hollow metal ribbed blades for aircraft propellers and to a method of making such blades.

There are examples in the art of hollow metal blades constructed from camber and thrust plate members joined together adjacent the blade edges into a hollow structure and having a stiffening rib extending longitudinally of the blade near the maximum ordinate of the blade sections and secured to the camber and thrust plate members.

T. A. Dicks Patent No. 1,713,500 of May 14, 1929, discloses such a blade and one object of this invention is the provision of an improved and simplified method of making a ribbed blade of the type disclosed in said patent.

Another object is the provision of a method which is applicable to the securing of one or more stiffening ribs to the camber and thrust plate members of a hollow metal blade no matter how such members are bonded together adjacent their edges.

A further object is the production of a blade of the type disclosed in said patent which is provided with a stiffening rib extending throughout the major part of the effective length of the blade adjacent the maximum ordinate of the blade sections and which is bonded to both the camber member and thrust plate by continuous welds extending throughout the entire length of the rib.

These as well as other objects which will be apparent to those skilled in the aircraft propeller blade art, I attain by means of the blade and method disclosed in the specification and illustrated in the drawings accompanying and forming part of this application.

In the drawings:

Figure 1 is a plan view of a blade made in accordance with this invention; the stiffening rib being shown by dotted lines;

Figs. 2, 3, 4, 5, 6, 7 and 8 are transverse sections of said blade and are taken at stations 2—2, 3—3, 4—4, 5—5, 6—6, 7—7 and 8—8, respectively;

Fig. 9 is a view corresponding to Fig. 7, but of a blade having two longitudinally extending stiffening ribs;

Fig. 10 is a side elevational view of one of the stiffening ribs;

Fig. 11 is a transverse section of the thrust plate and the stiffening rib and shows the rib fillet welded to the thrust plate;

Fig. 12 is a more or less diagrammatic view and is intended to illustrate the arrangement of the

members preparatory to butt welding the camber member to the rib;

Fig. 13 illustrates the arrangement of the members when in condition to have the edges of the thrust plate and camber member joined by in-laid weld metal;

Fig. 14 is an enlarged transverse sectional view and illustrates the relation of one of the slots of the camber member to the rib;

Fig. 15 is a transverse section of the camber member and the stiffening rib and shows the rib fillet welded to the camber member;

Fig. 16 is a more or less diagrammatic view and is intended to illustrate the alternative arrangement of the members preparatory to butt welding the thrust plate to the free end of the rib; and

Fig. 17 is an enlarged transverse sectional view and illustrates the relation of one of the slots of the thrust plate member to the rib.

In making a hollow metal propeller blade in accordance with the teachings of said Dicks patent, two blanks sheared from alloy steel plate-like material of uniform thickness are longitudinally tapered. The blank for the camber member is tapered from its shank forming portion to its opposite end and that for the thrust plate is tapered throughout its entire length. These tapered blanks are then trimmed and pressed, one into a hollow camber member and shank portion and the other into a thrust plate.

The camber member is then supported in a cradle with its open side uppermost. The thrust plate is supported in the position it is to occupy in the finished blade within the confines of the edges of the camber member. Supporting of the thrust plate is accomplished by means of a collapsible mandrel which is positioned in the hollow camber member and which is of such construction that it may be withdrawn lengthwise of the blade through its open shank portion.

The cradle, the camber member, the mandrel and the thrust plate are then heated to a relatively high temperature in order to facilitate the bonding together of the camber member and thrust plate by means of the inlaid metal weld as disclosed in said Dicks patent.

The above procedure is also utilized in making the improved Dicks blade disclosed in my applications Serial Nos. 74,007 and 84,698 and the invention of this application is not only applicable to the form of blade disclosed in said Dicks patent, but also to the forms disclosed in my said applications.

In making a blade in accordance with the invention of this application, I first prepare the

camber and thrust plate members in accordance with the teachings of said Dicks patent or the teachings of either of my said applications. The camber member is numbered 15 and the thrust plate member 16. I then prepare a suitable rib 17 preferably from the same kind of material as that from which the camber and thrust plate members are made. This rib is of a length sufficient to reach from near the shank portion of the blade to within a short distance of the tip end thereof and has a height such that it will abut against the inner faces of the camber and thrust plate members adjacent the maximum ordinate of the blade sections. The rib tapers in thickness from its shank end to its tip and the major part of the same is lightened by being provided with through holes which are graduated in size as shown in Fig. 10. I bond the rib to the thrust plate member by fillet welds 19; one on each side of the rib at its base.

After the rib has been fillet welded to the thrust plate member said member is placed in position in its cradle with its ribbed side uppermost. The camber member is then placed in the position it is to occupy in the finished blade as shown in Fig. 12 and is supported in this position by said rib and by two mandrels 20 positioned between the thrust plate and camber member and on opposite sides of the rib.

Prior to thus placing the camber member in position, I mill throughout the major part of its effective length an aligned series of narrow or elongated slots 21. These slots decrease in width from the shank end of the series to the tip end thereof. As shown in Fig. 14, the longitudinal sides of these slots converge inwardly on about a 14° angle with the width of the slots at their bottoms equal to about 60% of the width of that part of the rib located therebeneath. Slots 21 are separated by relatively narrow sections 22 of camber member metal. The end slot of the series adjacent the tip end of the blade is arranged to coincide with the end portion 23 of the rib. The tip end of the rib terminates short of the extreme tip end of the blade as shown in Fig. 1.

In order to butt weld the camber member to the rib, the line of slots is filled with fused weld metal, and as the line of welding progresses throughout the length of the rib, the short sections 22 of camber member plate metal between the slots are fused and merge with the deposited weld metal to form a continuous weld extending throughout the length of the rib.

In order to prevent distortion of the camber member during the welding operation by which said member is joined to the rib, I place relatively heavy copper plates 24 on opposite sides of the series of slots 21. These copper plates extend throughout the length of the series of slots and are preferably clamped in place by suitable clamps not shown in Fig. 12. These copper plates rob the camber member of heat during the welding operation and thus prevent distortion of said member.

After this welding operation is completed and the camber member and thrust plate are joined together by the rib the copper plates are removed and the assembly is inverted so that the thrust plate is on top as shown in Fig. 13.

The outer peripheral edge of the thrust plate is next joined to the edge of the camber member by an inlaid metal weld 25 in accordance with the teachings of said Dicks patent. Before this is done, however, the assembly comprising the cradle, the ribbed camber member, the mandrels

and the thrust plate is heated in order to facilitate the further welding operation.

After this welding procedure is completed the mandrels are withdrawn and the shank forming portion of the camber member blank is formed into a tubular shank and the seam which extends longitudinally of the shank is closed by an inlaid metal weld as described in said patent.

I find that it is preferable to use atomic hydrogen in making all welds and to use weld rod material of substantially the same analysis as that of the camber and thrust plate members and rib.

In order to conserve the heat in the main portion of the blade during formation of the shank, I find it desirable to embed the main blade portion in lime during the shank forming operation.

It will be apparent that the rib may be first welded to the camber member and then to the thrust plate. This alternative scheme is illustrated in the three Figures 15 to 17 inclusive. The thrust plate is provided with a series of elongated slots 21' and the rib is connected to the camber member by continuous welds 19'.

In this alternative procedure, the camber member after having the rib welded thereto is supported with its ribbed side uppermost. The slotted thrust plate is then supported above the camber member in the position it is to occupy in the finished blade with its slots 21' in line with the rib of the camber member. Slots 21' are then filled with fused weld metal and the thrust plate metal between the ends of the slots is fused and merged with the weld material in forming a continuous weld throughout the length of the rib.

In order to form the inlaid metal weld which joins the edges of the thrust plate and camber member, the assembly, consisting of the two members and the rib connecting the same need not be inverted as the camber member is below the thrust plate and the members are in position for the welding operation by which the edges of the members are joined.

After all the welding operations are completed, the excess weld metal projecting beyond the normal surfaces of the camber and thrust plate members is removed, preferably by grinding. The blade is then heat treated and finished in the usual way.

I have found that it is necessary to weld the rib to both thrust plate and camber member before the edges of such members are joined together whether by welding or by brazing, and this procedural sequence forms an important part of this invention.

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

1. In the manufacture of a hollow metal aircraft propeller blade, the steps of forming the camber and thrust plate members from plate-like metal blanks, welding a stiffening rib to the inner face of the thrust plate member, supporting the thrust plate member with its ribbed side uppermost, providing the camber member with an aligned series of elongated slots having a combined length substantially equal to the length of said rib, placing the slotted camber member above the thrust plate member and in the position it is to occupy in the finished blade with said series of slots in line with said rib, filling said slots with weld metal and melting the plate metal between said slots whereby the camber member is bonded to said rib throughout its entire length,

reversing the positions of said members so that the thrust plate member is above the camber member, heating the structure consisting of camber member thrust plate member and rib and then depositing weld metal between the edges of the thrust plate member and camber member until such members are bonded together by an intervening inlaid metal weld.

2. In the manufacture of a hollow metal aircraft propeller blade, the steps of forming the camber and thrust plate members from plate-like metal blanks, welding a stiffening rib to the inner face of the camber member, supporting said member with its ribbed side uppermost, providing the thrust plate member with an aligned series of elongated slots having a combined length substantially equal to the length of said rib, placing the slotted thrust plate member above the camber member and in the position it is to occupy in the finished blade with said series of slots in line with said rib, filling said slots with weld metal and melting the plate metal between said slots whereby the thrust plate member is bonded to said rib throughout its entire length, heating the structure consisting of camber member thrust plate member and rib and then depositing weld metal between the edges of the thrust plate member and camber member until such members are bonded together by an intervening inlaid metal weld.

3. A method of manufacturing a hollow metal aircraft propeller blade which consists in preliminarily forming two air-foil blank members, providing one such blank member with a line of rib-registering slots, welding a reinforcing rib to the other of said blank members, assembling said members in blade-forming relationship with one such member supported by said rib and with the slots thereof in registry therewith, applying heat and welding metal to said rib and through said slots and progressively applying heat to melt the inter-slot portions of the one blank member so as to form a continuous inlaid weld intercepting the rib supported member and extending substantially throughout the length of said rib and

between it and said member supported thereon, and then welding the free edges of said members together.

4. A method of manufacturing a hollow metal aircraft propeller blade which consists in preliminarily forming two air-foil blank members, providing one such blank member with a line of rib-registering slots, welding one edge of a reinforcing rib to the inner surface of the other of said blank members, assembling said blank members in blade-forming relationship with one such member supported by said rib and with the rib-registering slots thereof in registry therewith, applying heat and welding metal to said rib and through said slots and progressively applying heat to melt the inter-slot portions of the one blank member so as to form a continuous inlaid weld between said rib and said member extending substantially throughout the length of said rib and intercepting said blank member, welding the free edges of said blank members together, forming a shank from metal of one such blank member and then welding the edges of such shank together to complete the formation of the blade.

5. A method of manufacturing a hollow aircraft propeller blade, the preliminary steps of forming two air-foil blank members, welding one edge of an intermediate longitudinally extending stiffening rib to the inner face of one such member, assembling the members in blade-forming relationship with one such member supported by the free edge of said rib and with slots formed therein in registry with said rib, and in metal-receiving position, filling such slots with weld metal and melting the blank metal between said slots to form a continuous inlaid weld between said rib and the blank member supported thereby extending throughout the length of said rib and intercepting said member, then depositing weld metal between the edges of said blank members to bond the same together by a substantially continuous inlaid metal weld.

JAMES H. MCKEE.