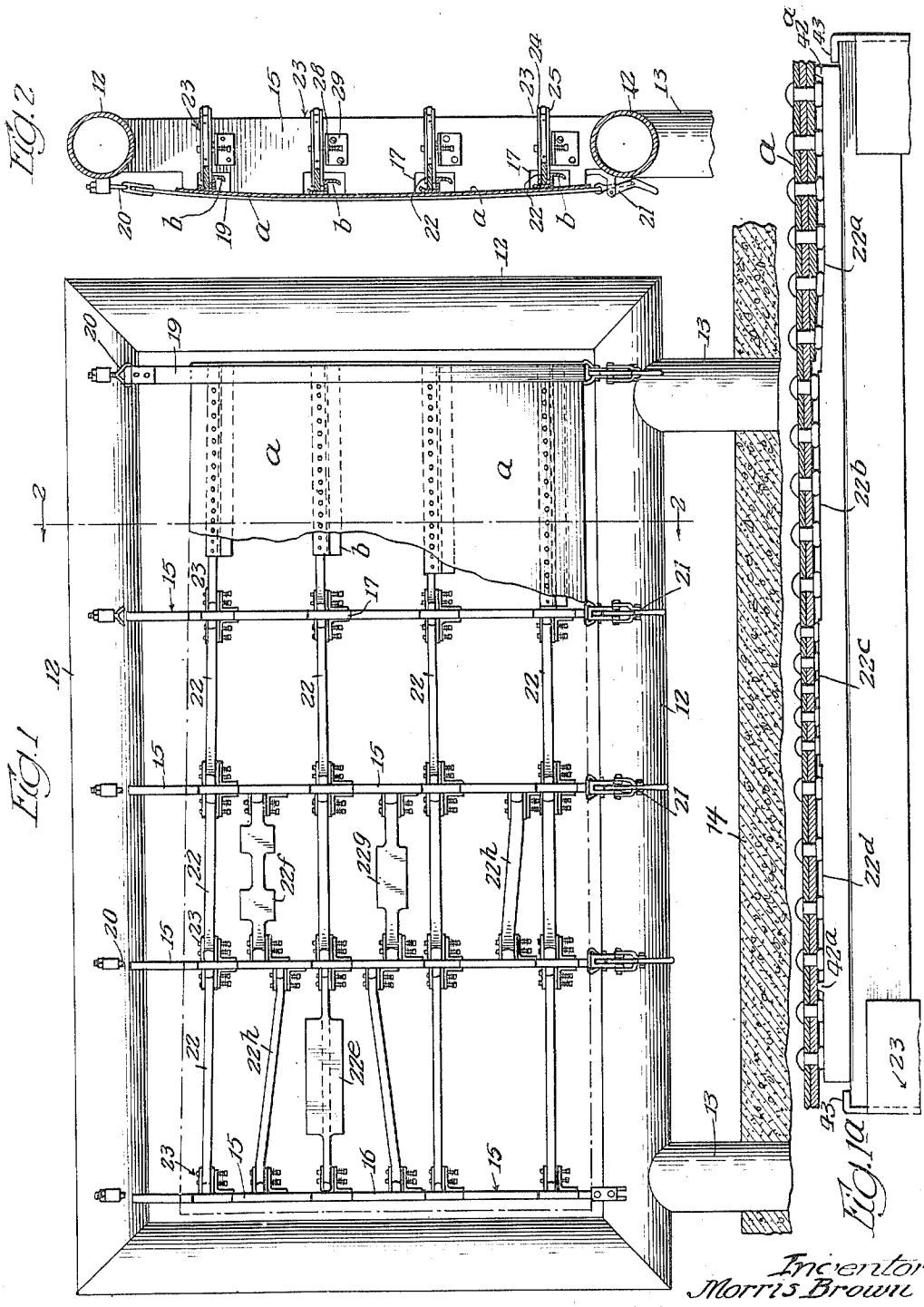
Feb. 7, 1950 M. BROWN 2,496,330

RIVETING EQUIPMENT

Filed June 2, 1944 3 Sheets-Sheet 1



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RIVETING EQUIPMENT

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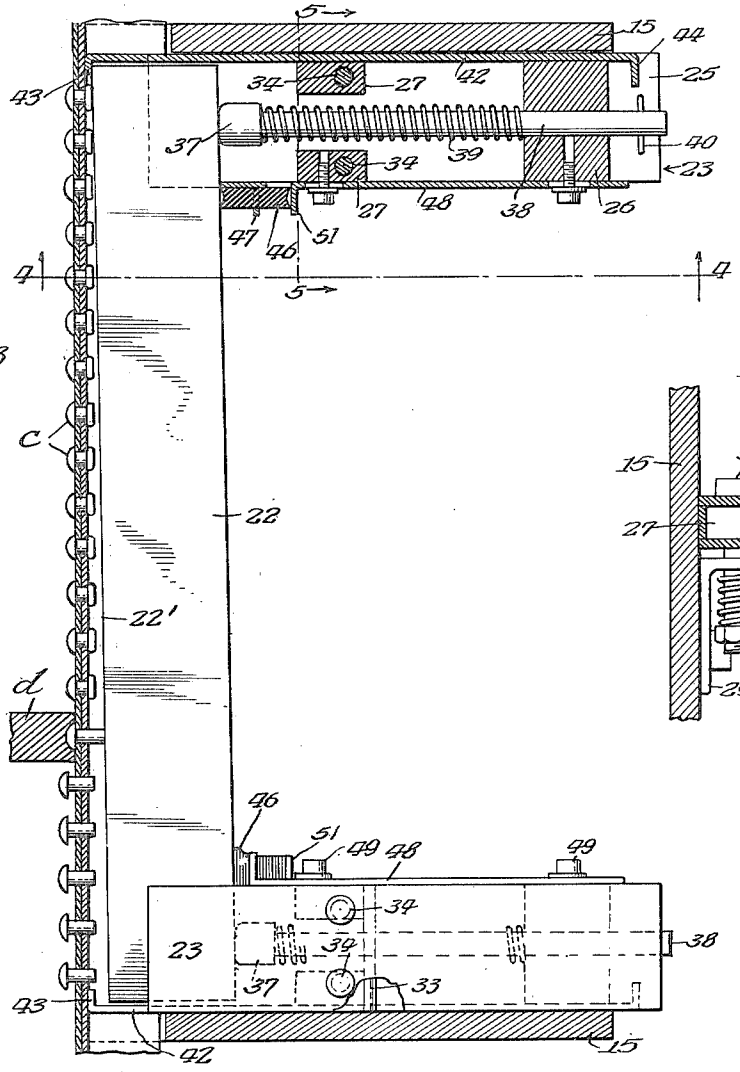


Fig. 3

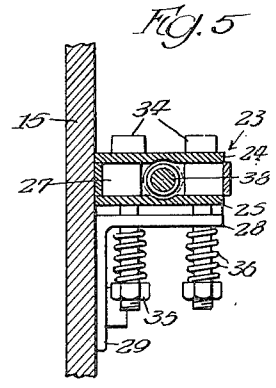


Fig. 5

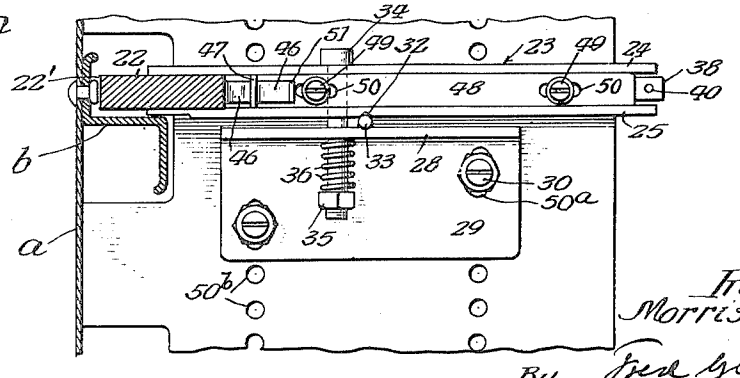


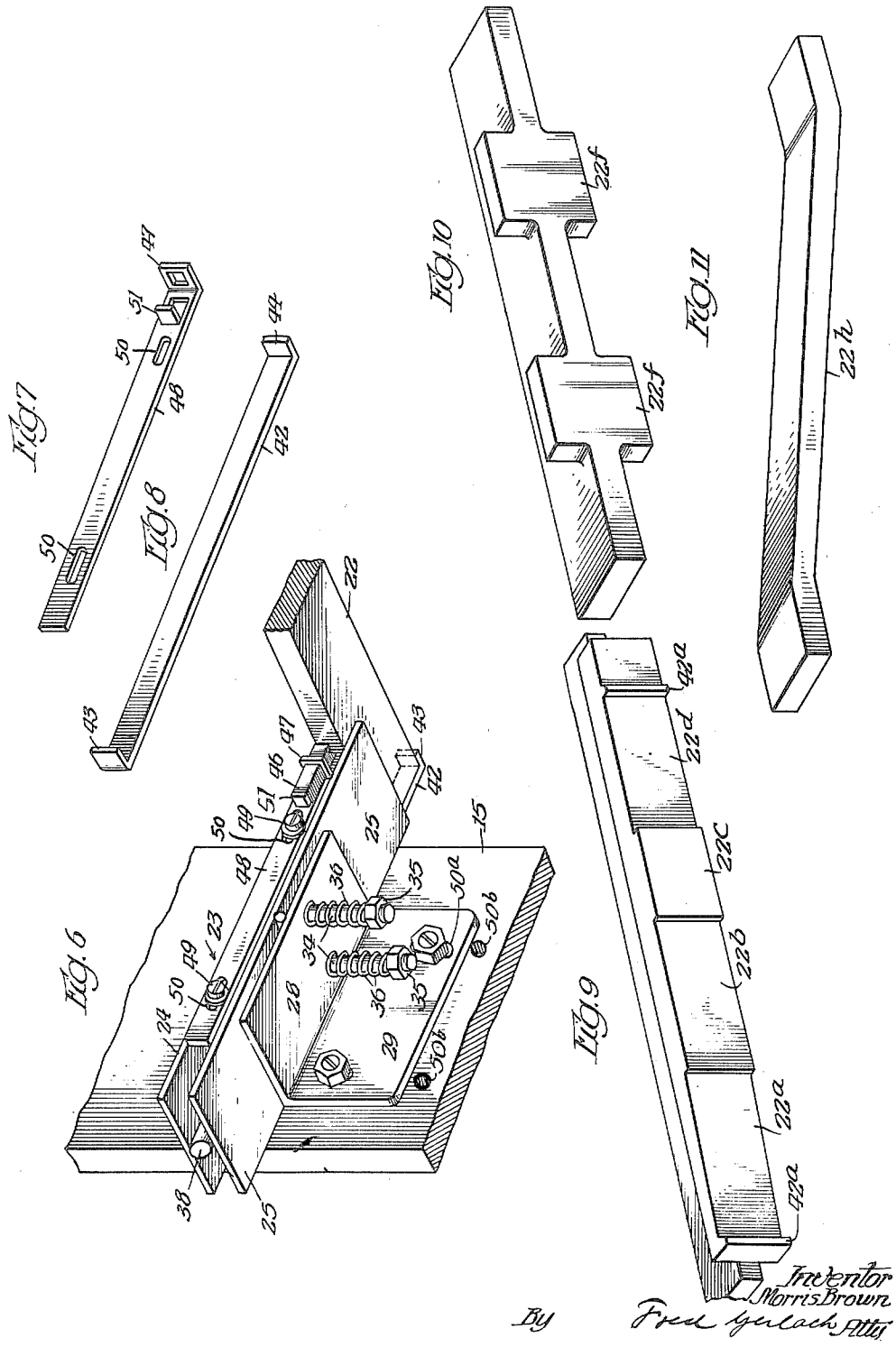
Fig. 4

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RIVETING EQUIPMENT

Morris Brown, San Diego, Calif.

Application June 2, 1944, Serial No. 538,355

5 Claims. (Cl. 78—53.5)

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The invention relates to improvements in equipment for riveting.

In riveting together parts, such as sheets, or sheets and structural members such as stringers and sheets, for aircraft panels, a great multiplicity of rivets is necessary. In many instances the rivets must be fixed in non-symmetrical rows, rivets of different sizes must be used, and clusters of rivets are required in certain areas of a panel or structure, depending upon the stress concentrations or location of the stringers in different areas of the panels. The panels in many instances are differently shaped or of different contours and the stringers are non-symmetrically located on the panels. Heretofore, so far as I am aware, it has been necessary in structures embodying such variables or variations to use a power-operated hammer handled by an operator on one side of the panel and a bucking tool handled by another operator on the opposite side of the panel. In some structures there is little space available for the manipulation of the bucking tool, which slows down the riveting operation. If the hammer is erroneously applied to rivets in the absence of a bucking tool, the work may be objectionably deformed.

One object of the invention is to provide equipment which comprises an elongated bucking-bar for automatically upsetting the rivets in a row or series and dispensing with the necessity of an operator for handling the bucking tool during the riveting of the row or series of rivets.

Another object of the invention is to expedite the riveting operation by a bucking element to which counter blows are imparted reactively to blows received through the rivets from a power-operated hammer, by damping the vibrations of the bucking element or restraining its movement with the anvil.

A still further object of the invention is to provide equipment which, by variations of the face of the bucking-bar engaged by the rivets, can be adapted for automatically bucking rivets of different sizes or clusters.

Another object of the invention is to provide an automatic bucking device which is simple in construction and efficient in operation.

Other objects of the invention will appear from the detailed description.

The invention consists in the several novel features hereinafter set forth and more particularly defined by claims at the conclusion hereof.

In the drawings:

Fig. 1 is a side elevation of an apparatus equipped with a series of bucking devices embodying the invention, parts being broken away for illustrative purposes.

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Fig. 1ª is a horizontal section through the fixture illustrating one of the bars for bucking a row of rivets of different sizes or lengths.

Fig. 2 is a section taken on line 2—2 of Fig. 1.

Fig. 3 is a horizontal section illustrating one of the bucking devices for a row of rivets of the same length.

Fig. 4 is a section taken on line 4—4 of Fig. 3.

Fig. 5 is a section taken on line 5—5 of Fig. 3.

Fig. 6 is a perspective of one of the carriers which are mounted on the vertical members of the fixture, for slidably supporting one end of the bucking-bar, and means for damping the vibrations of the bucking-bar.

Fig. 7 is a perspective of one of the adjustable bars for supporting one of the damping elements.

Fig. 8 is a perspective of one of the gauge-bars.

Fig. 9 is a perspective of the bucking-bar illustrated in Fig. 1ª.

Figs. 10 and 11 are perspectives of different forms of bucking-bars.

The bucking devices are adapted to be mounted in a rigid fixture which is provided for supporting the components of a panel for use in aircraft which are to be riveted together. This fixture may comprise a heavy rigid rectangular frame 12 which may be formed of tubing and is fixed to columns 13 which are usually embedded in a concrete floor 14 for rigidly securing the frame. A series of rigid vertical bars 15 extend between and have their ends welded to the top and bottom members of frame 12. Bars 15 are utilized to support the automatic bucking devices in the frame and also for supporting the work in cooperative relation with said devices. The front faces 16 of the vertical bars 15 are shaped to engage the sheets *a* of the panel which are usually curved, and notches 17 are formed in said bars for receiving the structural members, such as stringers *b* which are to be riveted to the sheets *a* of the skin-forming aircraft panel. The assembled sheets and stringers for a panel are secured and positioned on the frame 12 by metallic straps 19, the upper ends of which are adjustably secured at 20 to the top member of the frame 12 and the lower ends of which are secured to the lower member of frame 12 by suitable lever operated clamps 21 whereby the straps may be tensioned to clamp the sheets of the panel against the front faces of the bars 15. This frame exemplifies a rigid fixture whereby an assembly of sheets and stringers can be rigidly supported while all of the riveting operations necessary for

the panel are performed by one or more power operable hammers, in coaction with bucking devices which are supported in the fixture.

A series of bucking devices are supported on the vertical members **15** of the frame **12** at the back of the panel-assembly and each of these devices comprises a bucking-bar, generally designated **22**. Each bucking-bar is adapted for upsetting all of a row or group of rivets, and collectively these devices are adapted for upsetting substantially all of the rivets for securing together the components of the panel. Each bucking-bar is positioned conformably to a row or group of rivets. These bars may be non-symmetrically arranged according to the areas in the panel to be riveted, may be provided with extensions for riveting clusters of rivets, may be formed of masses of different weight for rivets of different sizes, and may be arranged angularly relatively to one another, all according to the structural requirements of a panel used in aircraft, so that substantially all of the rivets for the panel can be upset in one setting of the panel-assembly on the fixture. The bucking-bar shown in Figs. 3, 4 and 6 is provided with an elongated straight face **22'** which is adapted to be engaged by the inner ends of the shanks of a row of rivets *c* (Fig. 3) which are inserted through the work. The pre-formed rivet heads are engaged by a power operable hammer *d* to cause the bucking-bars to upset a head on the inner ends of the rivets.

Each bucking-bar is slidably supported by a pair of carriers, one at each end of the bar, which permit the bar to slide angularly when either end portion of the bar is engaged by a rivet, or rectilinearly when engaged by a rivet along the longitudinal center of the bar. These carriers are alike in construction. These carriers, generally designated **23**, are each supported from a vertical frame member **15**. Each carrier **23** is supported from one of the vertical frame bars **15** by an angular bracket **28**, the vertical flange **29** of which is secured by bolts **30** to one of the vertical frame bars **15**. The lower plate **25** of each carrier **23** is transversely notched as at **32** to fit on a pin **33** which is welded to the top of the bracket **28** and the carrier is held in engaged relation with said pin by a pair of studs **34** which extend vertically through the carrier and are provided with nuts **35** which engage springs **36** to hold the carrier seated on the bracket **28**. The studs **34** and springs **36** provide a pivotal connection between the carrier and the fixed supporting bracket **28** which permits the slidable bucking-bar to be slightly tilted vertically. In practice, this connection between the carrier and bracket **28** permits the bucking-bar **22** to be deflected to position it to compensate for slight deformations in the stringers *b* or tolerances in the location of the rivet-holes.

Each carrier **23** is equipped with spring-pressed means for imparting counter blows to the bucking-bar reactively to the blows of the hammer. This means is exemplified by an anvil **37** on a stem **38** which is slidably mounted in the block **26** and a spring **39** between block **26** and the anvil **37**. A pin **40** in the inner end of stem **38** retains the anvil **37** and spring **39** in the carrier when the bucking-bar is removed. Each carrier **23** is provided with a gauge-bar **42**, with an inwardly extending lip **43** which laps the face **22'** of one end of the bucking-bar, and limits the movement of the bucking-bar toward the work for limiting the thickness of the upset heads by rendering the bucking-bar ineffective when it engages the lip **43** which limits the movement of

the bucking-bar toward the work and determines the thickness of the upset on the rivets. The gauge-bar **42** is confined vertically between the plates **24** and **25** and laterally slidable between the blocks **26** and **27** and the contiguous face of the frame bar **15**. A lip **44** on the inner end of the gauge-bar **42** retains the gauge-bar in the carrier. During the operation the bucking-bar is pressed inwardly by a rivet when it is engaged by the riveting hammer, and the blows imparted to the outer end of the rivet will be transmitted through the rivets to the bucking-bar. The spring-pressed anvil **37** will receive impact blows from the bucking-bar which will move the anvil against the force of spring **39** away from the bucking-bar until the rivet has been upset within the limits permitted by the lip **43** of gauge-bar **42**. The mass in the bucking-bar and in the anvil and the force of the spring **39** are co-related to produce these counter blows.

In practice, it has been found that undamped vibrations of the bucking-bar reduce the effectiveness of the anvil in imparting counter blows to the bucking-bar and slow down the upsetting of the rivet, and the invention contemplates damping these vibrations. For this purpose, each carrier **23** is provided with a damping element which is exemplified by an elastic block or mass **46** formed of rubber. This block or mass is held in an outstruck tongue **47** on a bar **48** which is adjustably secured to the carrier by screws **49** which extend through slots **50** in bar **48** and are threaded into a block. One end of the element **46** abuts against an outstruck shoulder **51** on bar **48** and its outer end is engaged by the bucking-bar. When the bucking-bar is forced away from the work by a rivet, as illustrated in the lower portion of Fig. 3, the elastic mass **46** will be compressed between the bucking-bar and shoulder **51**. This elastic mass, when compressed, exerts pressure against the bucking-bar and toward the rivets independently of the force of spring **39** and damps the vibration of the bucking-bar. The anvil **37**, when struck by the bar, compresses the spring **39** and rebounds from the bucking-bar and the spring **39** operates the anvil to impart the counter blows with substantially the same effect as if hammer blows were imparted to the anvil by a riveting hammer. The elastic mass **46** damps the vibration and also restrains the bucking-bar so that the latter will not follow the strokes of the anvil against its spring **39** and permits the full force of the spring-imparted strokes of the anvil to be utilized with counter blows reactively to blows imparted through the rivets by the hammer *d* to the bucking-bar. In practice, it has been found that this damping and restraining of the bucking-bar causes it to more expeditiously upset a rivet than when a hand manipulated bucking tool is used. When the bucking-bar is initially moved inwardly by a rivet to which the hammer *d* is applied, the spring **39** and the damping mass **46** will be compressed. The spring will cause the bucking-bar to follow up the rivet as the upset head is formed thereon and the damping element **46** will remain effective until the upset is completed. During each riveting operation, the gauge-bar **42** determines the thickness of the head which will be upset on the rivet shank. When the head is formed, the gauge-lip **43** will hold the bucking-bar spaced from the work a distance equal to the thickness of the upset head on the rivet. A distinct change in sound occurs when the bar strikes the gauge-bar engaging the work,

and this indicates to the operator that the upset head is completed.

Each bucking-bar is adapted for upsetting a series or row of rivets. When all of the rivets in a row are of the same size and length, the bucking-bars are provided with straight faces 22′ as illustrated in Figs. 3, 4 and 6. The work to be riveted may be of different thickness. Rivets of different lengths may be necessary, as illustrated in Fig. 1[a], where three sheets are riveted together in one portion of the panel, or two sheets may be riveted together in a portion of the panel, or one of the sheets of metal may be tapered in thickness. These varying requirements are met by modifications in the rivet-engaging faces on the bucking-bars. Where a group of rivets is extended through a portion of the work having an inclined thickness, as illustrated in Figs. 1[a] and 9, the bucking-bar is provided with an inclined face 22[a]. Where rivets of different thickness with heads of different thickness are necessary, the rivet-engaging face of the bar is longitudinally stepped as at 22[b], 22[c] and 22[d], as illustrated in Figs. 1[a] and 9. The face portion 22[b] is spaced from the work to form the head on a thick rivet; the face portion 22[c] is spaced from the work to form thin heads on the rivets; and the face portion 22[d] is spaced from the work to form heads of intermediate thickness. In some instances a cluster of closely arranged small rivets is necessary in an area of the panel. The face of the bar may be of sufficient width for this purpose or the face may be extended by pads 22[e], 22[f] and 22[g], as illustrated in Figs. 1 and 10. In constructions where the rivet-engaging faces of the bar are stepped or inclined, gauge ribs 42[a] are provided which determine the thickness of the heads which are upset by that bar. In some instances the rows of rivets must be angled relatively to one another, and for riveting such rows the portions of the bucking-bars between their ends are inclined as illustrated at 22[h] in Figs. 1 and 11.

Each of these different forms of bucking-bars has its ends slidable in a pair of carriers 23 which are supported in the fixture independently of the others. These bars make it possible to meet the requirements in riveting composite panels, such as those used in aircraft, in which the rows of rivets are non-symmetrically arranged in different areas of the panel, rivets of different thickness and length may be upset, for completing substantially all of the riveting necessary during a single setting of the assembled work on the fixture.

In these various bucking devices, bars of different weights may be used according to the thickness of the rivets which are to be bucked. The mass or weight of the bucking-bars is co-related with the weight of the anvil and the force of the springs for shifting them. In some instances, pneumatic hammers with impacting elements of different force are used for upsetting rivets of different thickness. This co-relation has been found to be readily determinable by trial and providing anvils of suitable weights or masses and springs 39 of suitable magnitude to produce effective counter blows against the bucking-bar for different kinds of work when the vibrations of the bar are damped by a resilient mass 46. The vertical frame-bars 15 may be provided with holes 50[b] and the brackets 28 with slots 50[a] for the screws which secure the bracket 28 to bars 15 for mounting the bucking devices in different positions in the frame 12.

The operation of the riveting equipment is as follows: After the bucking devices have been installed in the fixture in accordance with the location of the rivets to be upset, the components of the panel, consisting of sheets or sheets and structural members, such as stringers for the desired panel, will be assembled on the front faces of the vertical frame member 15 with the rivet holes in the components to be riveted together coaxially disposed and so that the bucking-bars will be positioned in back of the rivet holes in the panel and fixedly secured on the frame members 15 by straps 19. The rivets inserted in all of the holes are usually temporarily held therein by a strip of tape (not shown). A power operated hammer *d* is then successively applied to any of the rivets. As the hammer is applied to any rivet, the latter will force the bucking-bar rearwardly against the force of the spring 39 applied to the nearest anvil 37 and the damping element 46 associated with said anvil will be compressed. The ends of the bucking-bar being slidable in the carriers, at least one of the spring-pressed anvils 37 will be shifted against the force of its spring 39 and the associated damper 46 to be compressed while the other end of the bar may remain static. As the hammer is operated, the bucking-bar will upset the head on the inserted end of the rivet. During the continued operation of the hammer, the shifted anvil will impart counter blows to the bucking-bar reactively to the hammer blows while the vibrations in the bucking-bar are damped by the associated damper 46, and said bar will follow the rivet-end as it is upset until the bucking-bar and gauge-lip 43 arrest the movement of said bar toward the rivet, which determines the thickness of the upset head on the rivet. In practice, it has been found that when the vibrations in the bucking-bar are damped or it is resiliently restrained from following the movements of the anvils, the mass in the anvils 37 and the force of springs 39 can be co-related to the bucking-bar to cause the hammer blows and the counter blows to be measurably synchronized and produce an effect similar to that produced when blows in counter directions are simultaneously applied to the rivet, and this results in greatly expediting the upsetting of the rivets. The bars 48 which support the damping elements are adjustable on the carriers, so they can be set to effectively damp the vibrations of the bar and restrain, in desired degree, its movement while transmitting blows to the anvils. As the hammer is applied to successive rivets in a row or group in front of the bucking-bar, one or the other or both of the anvils 37 and damping means 46 will be effective against the bar during the successive operations of the hammer. A characteristic of this apparatus is that a bucking-bar is always present in back of a row of rivets. When a manually held bucking tool is used it frequently occurs that the operator of the hammer on one side of the work will, through error, apply the hammer to a rivet while the bucking tool is not manually held against it, which results in dimpling or deformation of the work when skin-forming panels are fabricated. The presence of the bucking-bars for a row of rivets in the panel effectively reduces the likelihood of this deformation. It is also possible for several operators to simultaneously apply hammers to rivets in different portions of the panel to expedite fabrication. When stringers *b* are being

riveted to sheets, slight deviations or irregularities occur. The pivotal and spring connection between the carriers **23** for the bucking-bars and the brackets **28** permit the bucking-bar to be shifted vertically to compensate for these variations or deviations.

The invention exemplifies riveting equipment which includes an elongated automatic bucking-bar which is supported at its ends in a fixture for quickly upsetting of rows or groups of rivets. The invention also exemplifies a bucking device which is provided with a spring-pressed anvil for imparting counter blows to the bucking element and which is provided with means for damping the vibrations of the bucking element or restraining it from movement with the spring-pressed anvil. The invention also exemplifies bucking equipment which is adapted for the ready substitution of bars having faces for engaging different rivets or rivets in differently arranged groups and rows. The invention also exemplifies a bucking device for expeditiously upsetting rivets in coaction with a power-operated hammer.

The invention is not to be understood as restricted to the details set forth, since these may be modified within the scope of the appended claims without departing from the spirit and scope of the invention.

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

1. Apparatus adapted for use with a power-operated hammer for riveting assembled elements together comprising: a rigid upright frame extending over substantially the entire area of a panel assembly which is to be riveted and includes a sheet, columns rigidly supported in the frame, means for clamping parts of the assembly against the columns, bucking bars extending between the columns for series of rows of the rivets to be upset in substantially the entire sheet, a pair of spaced members on the columns for slidably and separately supporting the ends of each of the bucking bars and on which the ends of each bar are freely supported for angular deflection by impact blows, and devices for each end of each of the bars, carried by said supporting members, for imparting counterblows independently to the ends of each bucking bar reactively to impact blows imparted to the bars.

2. Apparatus adapted for use with a power-operated hammer for riveting assembled elements together comprising: a rigid upright frame extending over substantially the entire area of a panel assembly which is to be riveted and includes a sheet, columns rigidly supported in the frame, means for clamping parts of the assembly against the columns, bucking bars extending between the columns for series of rows of the rivets to be upset in substantially the entire sheet, a pair of spaced members on the columns for slidably and separately supporting the ends of each of the bucking bars and on which the ends of each bar are freely supported for angular deflection by impact blows, said members being mounted on the columns for pivotal movement transversely of the bars, and devices for each end of each of the bars, carried by said supporting members, for imparting counterblows independently to the ends of each bucking bar reactively to impact blows imparted to the bars.

3. Apparatus adapted for use with a power-operated hammer for riveting assembled elements together comprising: a rigid upright frame extending over substantially the entire area of a panel assembly which is to be riveted and includes a sheet, columns rigidly supported in the frame, flexible strips for clamping parts of the sheet against the columns, bucking bars extending between the columns for series of rows of the rivets to be upset in substantially the entire sheet, a pair of spaced members on the columns for slidably and separately supporting the ends of each of the bucking bars and on which the ends of each bar are freely supported for angular deflection by impact blows, and devices for each end of each of the bars carried by said supporting members, for imparting counterblows independently to the ends of each bucking bar reactively to impact blows imparted to the bars.

4. Apparatus adapted for use with a power-operated hammer for riveting assembled elements together comprising: a rigid upright frame extending over substantially the entire area of a panel assembly which is to be riveted and includes a sheet, columns rigidly supported in the frame, means for clamping parts of the sheet against the columns, bucking bars extending between the columns for series of rows of the rivets to be upset in substantially the entire sheet, a pair of spaced members on the columns for slidably and separately supporting the ends of each of the bucking bars and on which the ends of each bar are freely supported for angular deflection by impact blows, spring-pressed anvils for each end of each of the bars carried by said supporting members, for imparting counterblows independently to the ends of each of the bucking bars reactively to impact blows imparted to the bars, and means adjacent the ends of each bucking bar for damping vibrations in the bar.

5. Apparatus adapted for use with a power-operated hammer for riveting assembled elements together comprising: a rigid upright frame extending over substantially the entire area of a panel assembly which is to be riveted and includes a sheet, columns rigidly supported in the frame, bands extending over the columns for clamping parts of the sheet against the columns, bucking bars extending between the columns for series of rows of the rivets to be upset in substantially the entire sheet, a pair of spaced members on the columns for slidably and separately supporting the ends of each of the bucking bars on which the ends of each bar are freely supported for angular deflection by impact blows; and spring-pressed devices for each end of each of the bars carried by said supporting members, for imparting counterblows independently to the ends of each of the bucking bars reactively to impact blows imparted to the bars.

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