# United States Patent [19]

**Tarnoff**

[11] **3,793,932**

[45] **Feb. 26, 1974**


[54] **AIR DAMPER**


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[73] Assignee: **Air Balance, Inc.,** Chicago, Ill.



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[52] **U.S. Cl.** ..... **98/110,** 98/121

[51] **Int. Cl.** ..... **F24f 13/00**

[58] **Field of Search** ..... 98/110, 121



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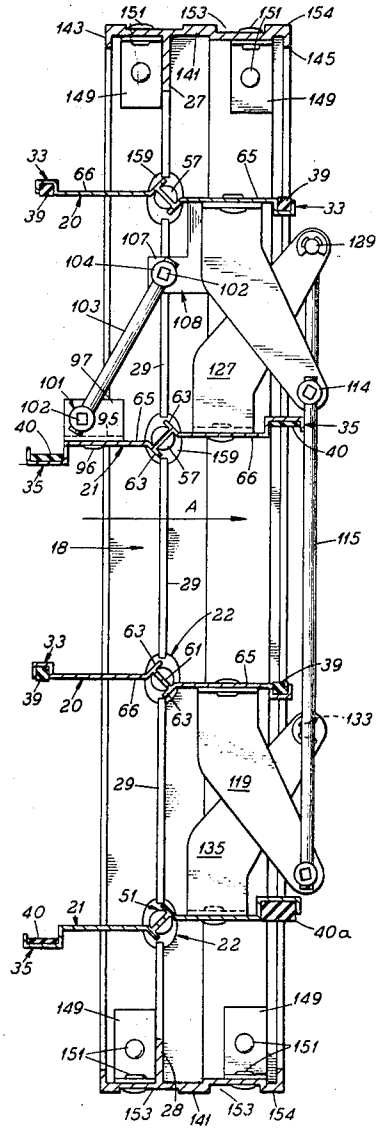
*Attorney, Agent, or Firm*—Fitch, Even, Tabin & Luedeka



[57] **ABSTRACT**

An air damper is formed with first and second sets of extruded aluminum blades pivotally mounted in a frame formed of extruded aluminum frame members with longitudinally extending channel means of different widths along the longitudinal edges of the respective blades. The different width channel means nest in a sealing relationship with one another and seal with the frame when the blades pivot to a closed position from an open position. The method of manufacture of the air damper includes the steps of severing predetermined lengths of blades and frame members from long aluminum extrusions preshaped for the blades and frame members, partially erecting a frame from frame members, alternating and pivotally mounting the first and second blades in the partial frame, completing the frame, and interconnecting the first and second blades with a linkage means to close the narrower width channel means first with the frame and then to follow and close thereon the wider width channel means to provide the nested sealing relationship between the blades of the first and second sets.


**10 Claims, 8 Drawing Figures**



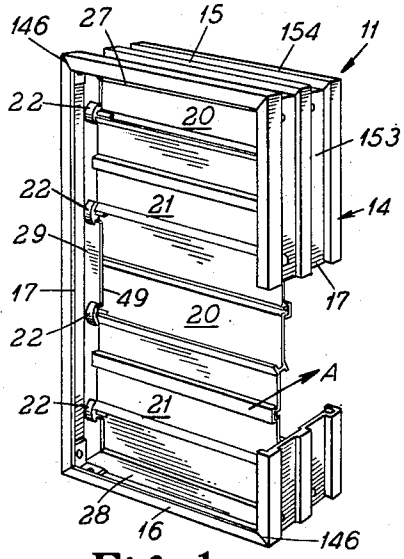



Fig. 1

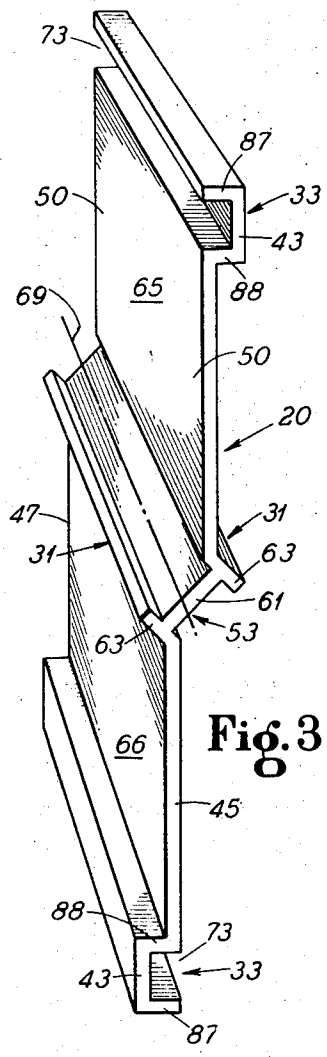



Fig. 3

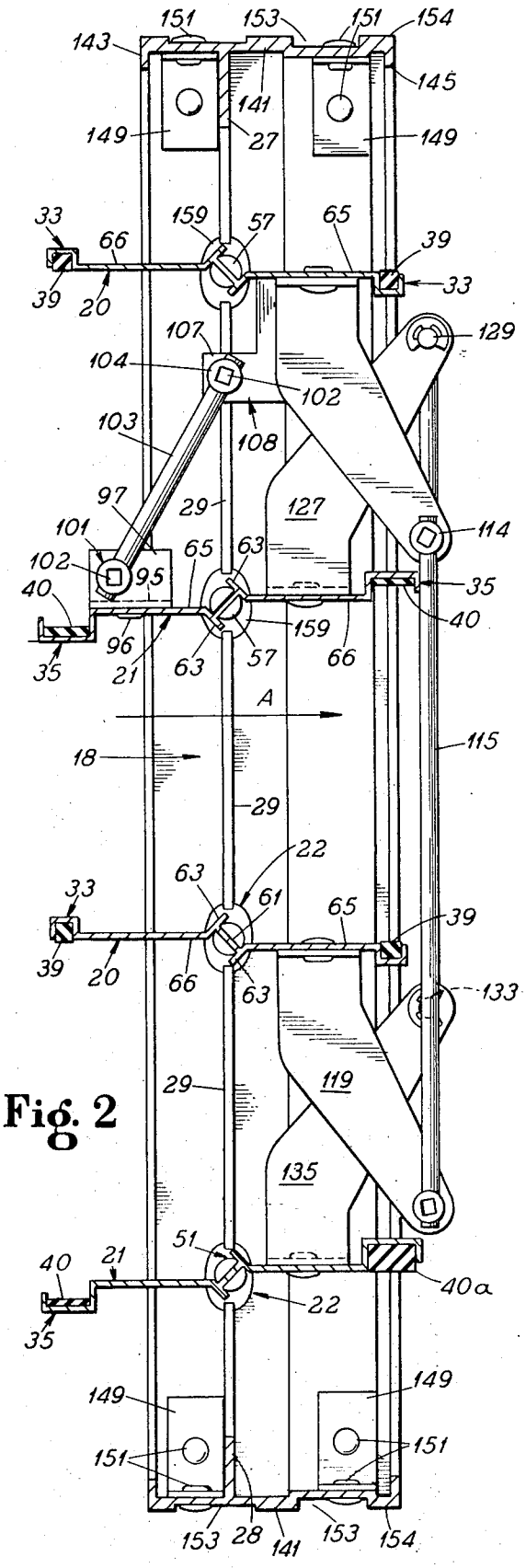



Fig. 2

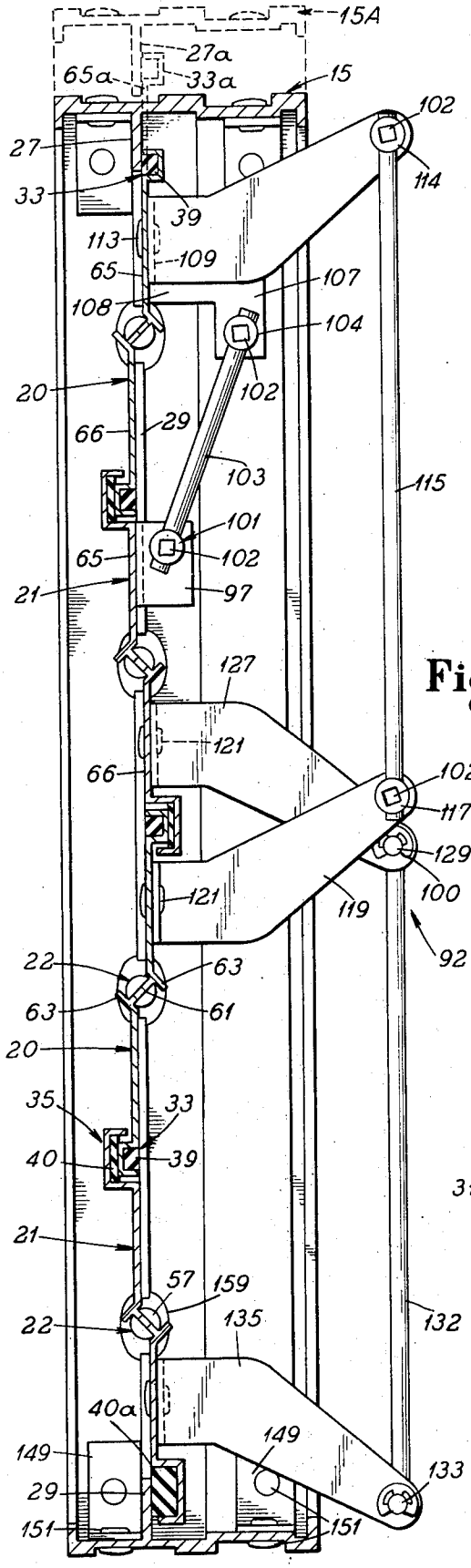



Fig. 4

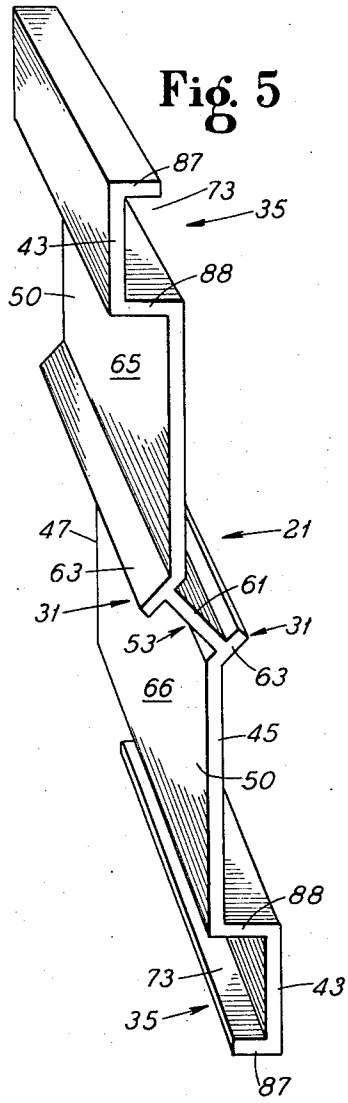



Fig. 5

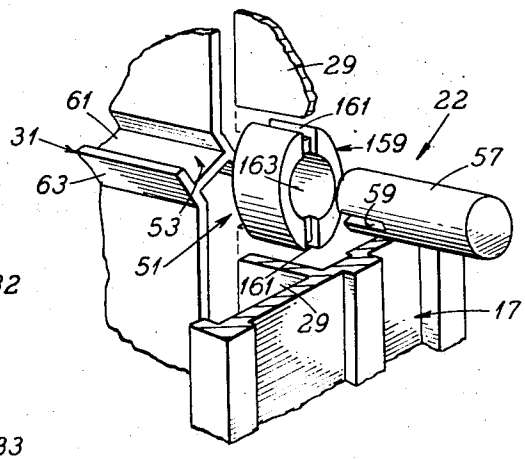



Fig. 6

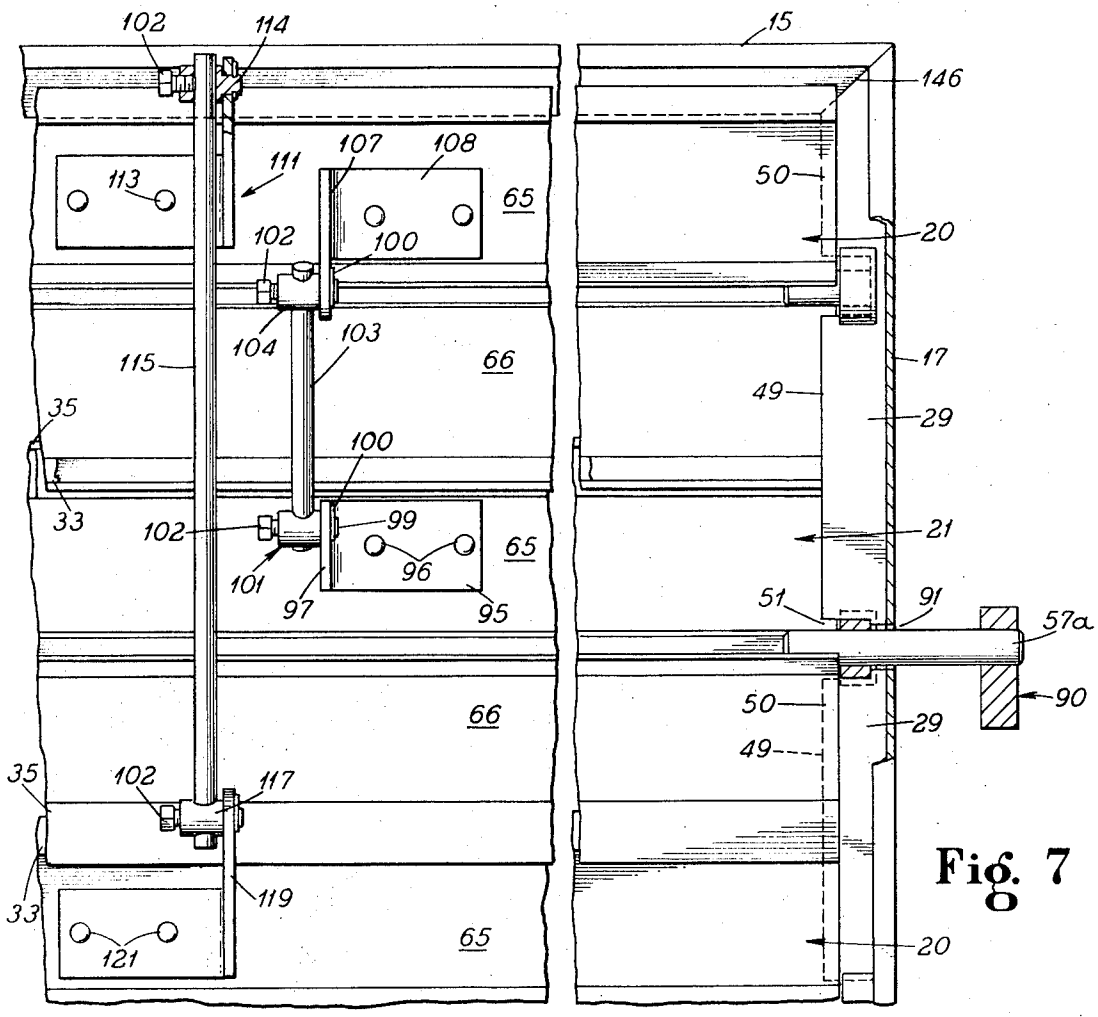

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Fig. 7

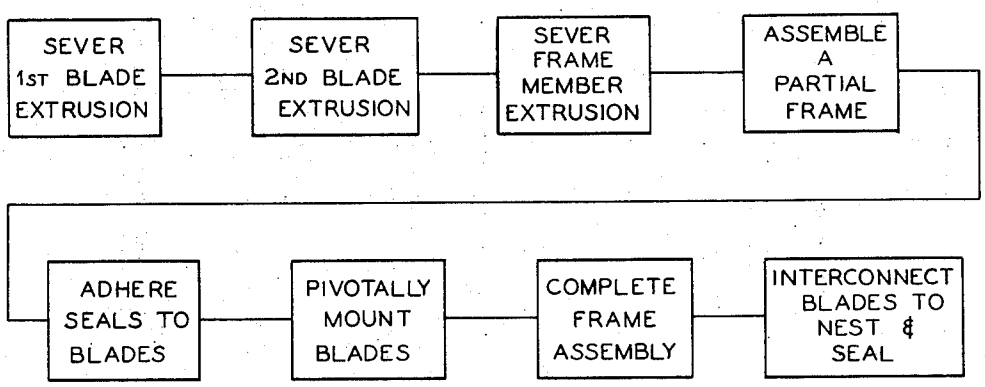
SEVER 1ST BLADE EXTRUSION
SEVER 2ND BLADE EXTRUSION
SEVER FRAME MEMBER EXTRUSION
ASSEMBLE A PARTIAL FRAME
ADHERE SEALS TO BLADES
PIVOTALLY MOUNT BLADES
COMPLETE FRAME ASSEMBLY
INTERCONNECT BLADES TO NEST & SEAL

Fig. 8

# AIR DAMPER

This invention relates to an air damper having a series of pivotally mounted blades which are movable between an open position in which the air may flow through the damper and a closed position in which air is substantially blocked from flow through the air damper.

Air dampers used in air modulating systems are often placed in an air duct with the blades being pivoted to control the flow rate of cool or hot air through the damper and with the damper blades adapted to be pivoted to a closed position to substantially block air flow through the duct. In U.S. Pat. No. 3,381,601, an air damper of this general kind is disclosed with a set of air damper blades pivotally mounted at their opposite ends to side members of a frame for turning to a closed position in which side edge portions of the damper blades overlap shelves on the side frame members to provide side seals with the frame upon operation of a blade actuator. The damper blades carry flexible resilient seals along their longitudinally extending edges for providing a seal between blades and with shelves on the top and bottom frame members. Thus, in a closed position the air flow opening for the air through the damper may be substantially blocked by the blades and their cooperation with the encircling frame.

The amount of air leakage through an air damper of this kind when the blades are in a closed position is an important criterion. For example, some specifications for air dampers of this kind require that the leakage be less than 0.75 percent of the maximum air flow through the damper when it is in a fully open position. Such air tight sealing is difficult to achieve and maintain for dampers mass-produced on a large commercial scale without the use of expensive resilient seals all around the frame. Even with such frame carried seals, leakage may still occur due to warped or bent damper blades which provide an imperfect seal between adjacent edges thereof. More specifically, damper blades formed of sheet metal of the usual thickness for damper blades are relatively flexible and when exposed to high static pressure on the blades over the wide area of the blades will bend and deflect at the center thereof from a sealed position particularly with the top or bottom of the frame. For example, two inches of static pressure for a 48 inch long blade, may result in as much as 600 pounds of force over the entire area of the damper with the result that the sheet metal damper blades often bend substantially in the center portion of the length of the blades.

Additionally, it is difficult to fabricate straight, unwarped damper blades from sheet metal stock which is roll formed while in a long strip and subsequently severed to form a number of blades. These long strips of sheet metal are prestressed when rolled to complex blade shapes. Then when a blade length is severed from the strip, the blade length bends or warps as the stresses are free of restraint. Moreover, such blade bending operations result in rather expensive blade to manufacture.

Another problem with prior art damper constructions was that assembly of the blades and dampers was too difficult and complex for unskilled labor with the result that the blades and seals were not always properly oriented and in the proper sequence. Also, resilient seals of complex shapes were expensive and had to be correctly correlated relative to each blade and to the frame during assembly. Moreover, the various kinds of blades, the different kinds of seals as well as different blades for various widths and heights of dampers often required a complex and expensive inventory of frame members and damper blades.



Accordingly, a general object of the present invention is to provide a new and improved air damper. Another object of the invention is to provide an air damper formed with extruded aluminum damper blades, which have a unique shape to resist bending and which seal readily with an extruded aluminum frame and with one another, and formed with extruded aluminum frame members for manufacture and assembly at a competitive and low cost.

Other objects and advantages of the invention will become apparent in the following detailed description taken in connection with the accompanying drawings in which:

FIG. 1 is a perspective view of an air damper with one side frame member partially broken away and embodying the novel features of the invention;

FIG. 2 is an enlarged vertical cross-sectional view of the air damper of FIG. 1 but with the damper blades in an open position;

FIG. 3 is a perspective view of a damper blade of a first kind used in the air damper of FIG. 1;

FIG. 4 is a sectional view generally similar to the view of FIG. 2 but with the blades in a closed position;

FIG. 5 is a perspective view of a damper blade of a second kind used in the air damper shown in FIG. 1;

FIG. 6 is an enlarged fragmentary perspective view of a means for pivotally mounting the blades to a side frame member;

FIG. 7 is a rear view of the air damper partially in section and showing the damper blades in a closed position; and

FIG. 8 is a block diagram of a method of constructing the air damper illustrated in FIG. 1.

As shown in the drawings for purpose of illustration, the invention is embodied in an air damper unit **11** of the kind which may be used in an air modulating system and which may be inserted into an air duct (not shown). Very generally, the air damper **11** comprises a frame **14** having a top frame member **15** and a bottom frame member **16** which are disposed parallel to one another and spaced from each other by a pair of side frame members **17**. The frame members **14, 15, 16** and **17** are joined to one another to form the enclosed frame **14**. The frame **14** encloses a central opening **18** through which air may flow in the direction shown by the arrow A. Air flow through the damper is controlled by a series of first and second air damper blades **20** and **21** which are pivotally mounted at the opposite ends thereof by pivot means **22** to the opposite side memebers **17** for turning substantially simultaneously between a fully open position, such as shown in FIG. **2**, in which the damper blades **20** are substantially parallel to the direction of air flow through the central opening **18** in the frame **14** and a closed position in which the blades **20** and **21** block air flow through the central opening **18**. In the closed position, the blades **20** and **21** are generally aligned with longitudinally extending edges thereof in sealed engagement with one another and with the remote longitudinal edges of the top and bottom blades in sealed engagement with shelves **27** and **28** projecting inwardly from the top and bottom frame

members 15 and 16. Side edges of the blades 20 and 21 also abut shelves 29 projecting inwardly from the respective vertical frame side members 17 to provide side seals between the blades and the frame.

Air damper constructions of a kind similar to that described above are disclosed in U.S. Pat. No. 3,381,601 with damper blades made of sheet metal, which dampers are generally satisfactory, but have the shortcoming that the sheet metal damper blades may be warped and bent and,without corrective measures, unable to provide a good tight seal with the frame and with one another to meet rigid specification requirements, e. g., a leakage of less than 0.75 percent of the maximum air flow through the damper. These prior art sheet metal blades are generally formed by rolling long lengths, e.g., 18 foot lengths, to the blade shape and then cutting lengths of blades therefrom. Upon cutting the rolled formed strip into blade lengths, the blades often warp or twist due to prestresses in the steel strip caused during the roll forming and released by the severing operation. Further, the blade shaping operations are relatively expensive. Moreover, sheet metal blades of the thickness used are relatively flexible under large static load conditions and they tend to bend and deflect relative to the frame particularly at the top and bottom shelves 27 and 28 allowing air leakage beyond that permissible. Also, such damper blades of the prior art employ relatively complex resilient seals which are expensive and require a definite and complicated assembly relationship to assure proper sealing.

In accordance with one aspect of the present invention, air leakage experienced heretofore may be reduced substantially by the use of uniquely shaped damper blades 20 and 21 formed of extruded aluminum having reinforcing rib means 31 thereon which provide rigidity to resist bending and having longitudinally extending channel means 33 and 35 for nesting in a sealing relationship with one another when the damper blades 20 and 21 are in the closed position. The extruded aluminum blades 20 and 21 may be cut from long lengths of extrusions, but the extruded aluminum strips and damper blades are free of the prestresses which warp and bend the blades when they are separated from the stock as experienced when cutting prestressed steel blades from a roll formed strip of steel. Also, the roll forming operations used to shape the sheet metal blades are eliminated. The aluminum damper blades 20 and 21 also are made of a dead metal, i.e., less resonant, and hence make less noise when hit by a metal object carried by the air stream; and the aluminum damper blades have less tendency to flutter or vibrate under certain air flow conditions which tend to vibrate or flutter the more resonant sheet metal blades.

To achieve an overlapping and nesting relationship for the channel means 33 and 35, the illustrated channel means 33 is formed with a narrower width than the channel means 35 and the blades are positioned in the frame to overlap and nest the narrow channels means 33 in the wider channel means 35. Preferably, flat strip resilient seals 39 and 40 are carried in each of the respective channel means 33 and 35 for sealing engagement with the top and bottom shelves 27 and 28 and also with the channel means of an adjacent blade in a nested relationship therewith. The flat strip seals 39 and 40 are less expensive than the complex seals of the prior art, and are preferably adhesive-backed for ready adhesion to the channel means. The nested channel means 33 and 35 provide a sufficient seal between blades for many uses of an air damper without having the resilient seals 39 and 40, as only a small tortuous passage exists between the channel means 33 and 35 when the blades 20 and 21 are in the closed position. Preferably, each of the narrow channel means 33 has a resilient seal 39 even though it is only the uppermost blade in which the seal 39 actually seals against the shelf 27, and even though the other seals 39 seal only at their ends against the shelves 29. This allows the assembly of the blades to be made fast without concern as to the blade being a top or bottom or right- or left-hand blade.

Also, in accordance with an important aspect of the invention, air dampers 11 of various dimensions may be constructed by severing different lengths from the frame extrusions for the frame members 15, 16 and 17 and from the damper blade extrusions for the damper blades 20 and 21 with the result that only a small inventory of blades or frame members need be maintained irrespective of the height or the length of the damper. For instance, the illustrated air dampers have been made with 7 to 48 inch blade lengths and with two to nine damper blades in the damper. As will be explained in greater detail, the aluminum extrusions for the damper blades are made in relatively long lengths, for example, 20-foot lengths, with the individual blades being severed for the desired blade length from the 20-foot extrusions.

Preferably, the channel means 33 and 35 have a rectangular cross section to allow nesting and to permit ease of insertion of and fastening of the seals 39 and 40 to a bottom wall in the channel means. The illustrated resilient seals 39 and 40 have an adhesive coating covered by a backing strip (not shown) which is peeled from the adhesive coating prior to inserting the seals to adhere to the bottom channel walls 43. In this manner, the seals may be readily applied to the damper blades in a quick and economical fashion.

Because unskilled labor is often used, the assembly of the damper is made simple and relatively error free by the use of damper blades which are symmetrical about their pivot axis with identical channel means 33 or 35 on opposite edges of the same blade so that each blade may be used either as a top, bottom or intermediate blade. The manufacture of the damper is economical in that the number of operations is few and comprises the following steps: severing the long extrusion to form blades 20 of a predetermined length; severing another long extrusion to form blades 21 of a predetermined length; severing a long frame extrusion to form the desired lengths for the frame members 16, 17 and 18; joining the top and bottom frame members to a side frame member to form a partial frame; alternating and pivotally mounting the blades 20 and 21 in the frame and completing the frame; and adjustably interconnecting the blades with the channel means 33 of the blades 20 nesting in the channel means 35 of the blades 21 and with the top and lower blades sealing with the top and bottom shelves 27 and 28 and the side edge margins of the blades sealing with the side frame members 29. In the preferred embodiment, the seals 39 and 40 are adhered to the blades after the blades are severed from the extrusions.

Referring now in greater detail to the damper blades 20 and 21, they are severed from a long blade extrusion

at transversely extending blade ends **45** and **47** with a length greater than the distance between inwardly facing vertical edges **49** of the respective side frame shelves **29** so that marginal edge portions **50** of the blades may abut the shelves **29** to provide vertical side seals when the damper blades are in a closed position. To allow pivoting of these long blades, the side frame shelves **29** are provided with cut outs or openings **51** to receive central offset sections **53** of the damper blades, the offset sections **53** cooperating with pivot means **22** including a slotted stub shaft or pin **57** for pivotally mounting the blades to the side frame members **17.**

Reinforcing rib means **31** reinforce the offset blade sections **53** against a tearing of the metal due to torques applied through the slotted pin **57** (FIG. **6**). More specifically, the slotted pin **57** has a slot **59** for receiving a central web **61** of the blade offset section **53.** With the slotted pin **57** mounted on the blade web **61,** the pin is centered between a pair of oppositely directing and outwardly projecting ribs **63** of the rib means **31.** Preferably, the ribs **63** are rectangular in cross section, extend longitudinally of the blade, and have a height less than the heights of the respective channel means **33** or **35** so that the reinforcing ribs **63** will not substantially interfere with air flow across the blades. The reinforcing ribs **63** are disposed at an angle to the planes of the respective wide planar section or halves **65** and **66** of the blades.

It can be appreciated from the examination of the damper blades **20** and **21** that opposite planar sections **65** and **66** of the blades are offset relative to a vertical plane taken through the longitudinal pivotal axis **69** (FIG. **3**) so that each damper blade may seal on the respective forward and rearward sides of the shelves **29** as clearly shown in FIG. **4.** As illustrated in FIG. **4,** the upper planar section **65** may seal the downstream (hereinafter called rearward) side of the shelves **29** while the lower planar section **66** may seal with the upstream (forward) side of the shelves **29.** Thus, it will be seen that the offset blade section **53** allows the pivotal axis **69** of the blades to intersect the shelves **29** and the planar sections **65** and **66** to overlap their marginal edge portions **50** with the forward and reverse sides of the shelves **29.**

The channel means **33** and **35** are formed along the longitudinal edges of the planar sections **65** and **66** to nest with one another and to seal with the top shelf **27** and the bottom shelf **28.** The nested relationship between the channel means **33** and **35** is achieved by a formation of the narrow channel means **33** with a width less than the width dimension of groove **73,** as best seen in FIG. **5,** defined between parallel side walls **87** and **88** for the channel means **35** of the damper blades **21.** The blades are positioned in the side frames and the dimension of the blades **20** and **21** are such that the channel means **38** will be centered and be disposed within the groove **73** of the channel means **35.** For instance, the blades may have about 5½ inch widths with the blades being pivoted at 5-inch centers to provide the overlap and centering of the respective channel means. The general rectangular cross section for the grooves **73,** as defined by the side walls **87** and **88** and the bottom wall **43,** facilitates the installation of the inexpensive flat strip resilient seals **39** and **40.** While the illustrated embodiment of the invention uses resilient seals **39** and **40** such as of a closed cell neoprene, the seals **39** and **40** may be eliminated where the leakage requirements are not a controlling consideration. Thus, it is within the purview of the present invention that the nested channel means **33** and **35** provide a sealing relationship between longitudinally extending blade edges with or without the seals **39** and **40.**

In the illustrated embodiment of the invention, the wide seals **40** in the wide channel means **35** are formed with a thickness considerably less than the depth of the receiving groove **73** to allow the bottom wall **43** of the channel means **33** to enter into the groove **73** before abutting the wide seal **40.** When the bottom damper blade has a wide seal, it is preferred to make the lowermost seal **40***a* (FIG. **4**) of a thickness greater than the depth of the groove **73** so that the seal will project outwardly of the groove **73** to abut the lower shelf **29** and be compressed when in sealing engagement therewith. This thick lower seal **40***a* may be constructed as one integral layer or by superposing two layers of the wide seal **40** in the groove.

On the other hand, the narrow seals **39** all are sufficiently thick to project from the bottom wall **43** outwardly of the groove **73** to abut the top shelf **27** (or a bottom shelf **28**) and to be compressed slightly when in sealing engagement with one or the other of the shelves **27** or **28.** It is to be understood that, when there are an odd number of damper blades, the lowermost blade will carry a narrow seal **39** for abutting the lower shelf **28.** In the illustrated four blade construction, as shown in FIG. **4,** a wide seal **40***a* abuts the bottom shelf **28.** A narrow seal **39** is preferably inserted into the channel grooves **73** for each of the damper blades **20** so that they may be assembled without regard to whether or not the blade will actually be a top, an intermediate or a bottom blade in the series of blades **20** in the damper. Also, the narrow seals **39** in the marginal edge portions of the blades abut the overlapped portion of the side frame shelves **29** and prevent air from flowing into the end of the groove **73** and past the corner of the shelf **29.** The symmetry of the blades allows them to be used either as right-hand or left-hand blades as narrow channel means **33** are the same size, located equidistantly from the pivot axis, and spaced the same distance from a plane through the pivot axis **69** and parallel to the planar sections **65** and **66.** The same is also true of the symmetry for damper blades **21.** The symmetry of the blades also provides a balanced blade which allows a balanced flow of air between blades and affords a less turbulent flow of air through the damper and duct. The balancing of the blades also reduces the net torque exerted by the air stream on the blades resisting opening or closing of the blades.

The illustrated damper has been built in various sizes from a unit only 7 inches wide to a damper measuring 48 inches by 48 inches. The illustrated blades **20** and **21** are usually about 5½ inches wide with the pivot axes **69** spaced at about five inch centers. When the height of the duct is different from that of a multiple of blades, then the upper planar section **65***a* (FIG. **4**) is made wider than its lower planar section **66** so that its channel means **33***a* will seal with the shelf **27***a* (as is shown by the phantom line) in FIG. **4.** Thus, the top blade will not be symmetrical about the pivot axis in some instances. However, the balancing of the top blade is not as critical as less air flows along the top of the damper.

To assure ease of opening from and closing of the channel means **33** and **35** into the nested relationship and sealing of all blades with the frame shelves **27, 28**

and 29, the damper blades 20 and 21 are interconnected by a linkage means 92 and adjusted to be timed in their rotation. In this connection, each second blade having the wide channel means 35 is swung away from its associated nesting small channel means 33 slightly before the latter pivots from its closed to its open position. It is preferred that the second blade 21 from the top always be the "power blade," that is, the blade which is driven by a suitable power or actuating means 90 such as manual crank, a chain operator, a pneumatic operator, an electric solenoid, or an electric motor. Usually the actuating means is connected to an elongated slotted pin or operating shaft 57*a* (FIG. 7) which extends outwardly through an opening 91 in the side frame member 17 and also through the air duct wall (not shown) to where the actuating means 90 is usually located. Thus, the actuating means 90 may turn the pin 57*a* to exert a turning torque on the power blade 21.

The preferred interconnection between the power blade 21 and the remaining damper blades 20 and 21 includes an adjustable linkage means 92 which is readily adjustable to assure that the side edge marginal portions 50 of all the blades will simultaneously be abutting or closely adjacent the side frame members when the power blade is turned by the actuating means 90 to a sealing position with the side frame shelves 29. In this instance, the power blade 21 and the other blades 21 turn through approximately 90° between their open and closed positions whereas the blades 20 move through approximately 87° between open and closed positions. The opening and closing of all the blades appears to be substantially simultaneous to an observer of the operation. A stop means for limiting the pivotal movement of the blades at the full open position may be provided on the exterior of the damper for abutment to limit the turning of the actuating means 90. Of course, the blades may be opened to any lesser extent and this will proportionally reduce the flow rate of air through the damper from the maximum flow rate.

With the illustrated linkage means 92, the second or power blade 21 drives the top or first damper blade 20 which in turn is connected to the third blade 20 having a narrow channel means 33. The third blade would then be connected to a fifth blade when one is present. The first, third and fifth blades all belong to one set of blades 20 while the even blades belong to the other set of blades 21. Thus, the second blade is also connected to the fourth blade to pivot it; and the fourth blade would be connected to the sixth blade by similar means when a sixth blade is present. In this instance, the first set of blades 20 pivot in a direction (counterclockwise in FIG. 2) opposite to the direction (clockwise) the second set of blades 21 pivot when swinging to the closed position.

The portion of the linkage means 92 extending between the power blade 21 and first blade 20 comprises a bracket 95 preferably made of aluminum and fastened by aluminum rivets 96 to the rear side of the upper planar blade section 65. The bracket 95 includes an outwardly projecting flange 97 which is apertured to receive one end of a swivel 101 which is freely turnable in the aperture in the bracket flange 97. The swivel has a large diameter body 98, as best seen in FIGS. 4 and 7, joined at a shoulder to a small diameter end 99 and a snap retainer ring 100 is fastened to the small diameter end. The swivel 101 is provided with a diametrically extending bore to receive a lower end of a connecting shaft 103 which is secured against sliding through the bore by a set screw 102 threaded in an axially extending bore in the swivel. The inner end of the set screw 102 may abut against the shaft 103 when the set screw is turned sufficiently into the threaded bore in the swivel. In a similar manner, the upper end of the shaft 103 is connected to a swivel 104 which is identical to the swivel 101. The upper swivel 104 for the first blade 20 is journalled to turn in an aperture of an L-shaped flange 107 of a bracket 108 which has another flange 109, as best seen in FIG. 4, fastened by suitable rivets to the upper planar section 65 of the first blade.

To assure that both the upper and power damper blades have their edge marginal portions 50 in contact with the shelves 29 when the power blade is in the closed position, both of the damper blades may be pivoted to their closed position with the marginal edge portions 50 abutting the shelf 29 and then the set screws 102 are tightened in the swivels 101 and 104 to lock the shaft 103 at a predetermined angle and at a predetermined effective length for the shaft 103 between the set screws. The shaft 103 will thus maintain given angular relationship and positional relationship between the first and second blades to assure they both are synchronized in movement and will both close together.

To prevent interference between channel means 33 and the channel means 35, the blades 20 carrying the narrow channel means and having the narrow outward projecting portion (bottom wall 43), as best seen in FIG. 4, projecting from the side shelf 29 are swung through their final few degrees of closing and into the closed position abutting the shelves 29 before the wide channel means 33 swings through its final degrees of closing and into the nested relationship with the closed narrow channel means 33 and against the shelves 29. If both channel means 33 and 35 were simultaneously closing at the same time and at the same rate toward the shelves 29, they would strike each other and interfere with the nesting.

The relationship of shaft 103 and the pivot axes of the swivels 101 and 104 in their respective brackets 95 and 107 relative to pivot axes 69 for the power blade 21 and the top blade 20 is such that the blade 20 may first abut the side shelves 29 and fix the location of the axis for the swivel 104 while the swivel 101 is traveling through a few more degrees in a path substantially tangential to an arc having its center at the axis of the swivel 104 and a radius equal to the effective length of the shaft 103. The play and looseness in the mountings of the swivels 101 and 104 in their respective brackets and the play and looseness in the mountings for the damper blades 20 and 21 allow these movements without any binding.

Conversely, when pivoting to the open position, the pivot pin 57*a* will turn the power blade 21 through a short arc, e.g., 3° with the swivel 101 again moving along a path substantially tangential to the arc being swung by the lower end of the shaft 103 at the axis for the swivel 101 about its upper end at the pivot axis of the swivel 104. After the wide channel means 35 travels through several degrees and uncovers the narrow projection formed by the bottom wall 43 of the narrow channel means 33, the swivel 101 moves from the tangential path and begins to pull the shaft 103 down and toward the shelf 29 thereby pivoting the narrow seals

39 from shelves 29. As will be explained, the power blade 21 is connected to the other blades 21, so that they also move in a similar manner relative to the blades 20, that is to open before the blades 20 and to follow and close behind the narrow channel means on the blades 20.

To assure simultaneous opening and closing of the third damper blade 20 with the first damper blade 20, a means similar to that above described is provided. Briefly, an angle-shaped bracket 111 projects outwardly from a blade section 65 of the first blade 20 and has a flange fastened thereto by rivets 113. The angle-shaped brackets extend downstream and carry a swivel 114 similar to the swivel 100 described above. A shaft 115 extends between the upper swivel 114 and a similar swivel 117 mounted in an aperture on a bracket arm 119 fastened to the upper planar section 65 of the third blade by rivets 121. The effective length of the shaft 115 and its angular relationship to the blades may be adjusted and the set screws 102 tightened in the swivels 114 and 117 to assure that in the closed position the overlapping marginal portions 50 of the third damper blade 20 abut the shelves 29.

The power blade 21 is connected to the fourth damper blade 21 in a manner generally similar to that described for the first and third blades 20. More specifically, as best seen in FIGS. 2 and 4, angle-shaped brackets 127 are riveted to the lower planar section 66 of the power blade and carry a swivel 129. A shaft 132 extends downwardly from the swivel 129 to another swivel 133 carried on an angle-shaped bracket 135 riveted to the planar section 66 of the fourth damper blade. Thus, the effective length of the shaft 132 and its angular relationships with the second and fourth blades between swivels 129 and 133 can be adjusted with tightening of the set screws 102 to assure closing of the fourth damper blade. These adjustments also assure proper positioning of the swivels, brackets and connecting shafts for the blades when in the blade open position illustrated in FIG. 2.

As stated above, the illustrated frame means 14 may be made in various lengths such as, for example, 7 to 48 inches. Also, it is preferred that the frame side members 15, 16 and 17 be identical in cross section and be severed from a long aluminum extrusion thereby reducing the required inventory for producing frames of various sizes. By way of example only, illustrated frame members 15, 16 and 17 are formed of a 12-gauge thick (.081 inch) wall thickness for extrusion body 141 which has a width of about 3¾ inches. Preferably, the extruded frame body 141 is formed with a front inturned flange 143 and a rear inturned flange 145 providing additional strength for the frame. Each of the frame members has an identical size and shape for its respective shelf 27, 28 or 29 which is integral with the extruded frame body 141. The frame members 17 used for the sides have their shelves 29 suitably notched to provide the openings 51 to receive the pivot means 22 and offset portions 53 of the damper blades. The frame members are also pierced for the opening 91 and to receive rivets, as will be explained.

Each of the frame members 15, 16 and 17 is provided with a mitered end 146, as best seen in FIGS. 1 and 7, for abutment with another mitered end to form the generally rectangularly-shaped frame. The frame members may be bent to form integral corners; but are preferably joined together in the corners by a means such as interiorly disposed angles 149 preferably made of aluminum and joined by aluminum rivets 151 to the side members at the corners. Also, the frame members may be butt welded rather than joined by the illustrated angles 149. In this instance, two angles 149 are provided at each of the four corners of the frame and longitudinally extending grooves 153 are formed in the outer sides of the extrusion body 141 to receive the rivet heads so that the rivet heads will not project beyond outer flat surfaces 154 of the damper frame and interfere with sliding the damper into a close fitting air duct.

Referring now in greater detail to the pivot means 22, the slotted pin 57 is preferably journaled in a stationary, sintered, oil-impregnated bearing 159, as best seen in FIG. 6. The bearing is generally elliptical in shape with upper and lower slots 161 for receiving in sliding engagement portions of the shelves 29 at the notches 51. The bearings are provided with cylindrical bores 163 to receive the pivot pins 57 which are thereby journaled for rotation.

In this preferred embodiment of the invention, the entire air damper is made of aluminum except for the swivels 101, 104, etc., which are made of brass, and also except for the sintered bearings 159. This avoids any electrolytic action as may occur when steel and aluminum are used together. The swivels and bearings may, on the other hand, also be made of aluminum metal.

Referring now to FIG. 8, the preferred method of manufacture and assembly is outlined in block diagram form. The first steps of the method are to sever predetermined lengths from a long aluminum extrusion to provide the desired number of blades 20. Also, in a like manner a second long extrusion of aluminum of the cross-sectional shape of the second blades 21 is severed to form blades 21 of the predetermined length. The frame members 15, 16 and 17 are each severed from a common long extrusion of aluminum at predetermined lengths for the height and width of the damper to be made. After severing, the damper blades are pierced to provide the apertures for reception of the rivets such as rivets 96 or 113 to attach brackets such as brackets 95, 111, 108, etc. The brackets are riveted to the blades. The slotted pivot pins 57 are positioned on the ends of the blades with the web 61 inserted into the slots 59 in the pins. The power blade will receive the elongated pivot pin 57A.

Prior to pivotally mounting the blades in the damper frame 14, seals 39 and 40 cut to the desired length are inserted into the respective grooves 73 of the channel means 33 and 35. A backing strip for the adhesive coating is peeled from the strips, and the adhesive coating is forced against the bottom wall 43 of the respective grooves 73. Where the wide channel means 35 cooperates with the bottom shelf 29, a wide seal 40A is adhered to the bottom channel wall 43 for the bottom blade.

The side frame members 17 are notched to provide the openings 51 for receiving the bearings 159. One of the side frame members 17 is also pierced to provide the opening 91 for the elongated pivot pin 51A. The frame members 15, 16 and 17 are pierced near the corners to receive rivets 51. Three of the four frame members are then joined together to form a partial frame, preferably the top and bottom members 15 and 16 being joined to one side member 17. With the angles 149 then being riveted by rivets 151 to form the partial

frame, the bearings **159** may then be slid into place within the openings **51** with slots **161** in the bearings receiving portions of the side shelves **29.** Then the respective blades may be mounted with their pivot pins **57** inserted into the openings **163** in the bearings **159.** The remaining side frame **17** is then positioned with its bearings **159** on the pivot pins **57** and it is joined to the top and bottom frame by angles **149** and rivets **151.**

The shafts **103, 115** and **132** are then connected to the respective swivels **101, 104, 117,** etc., carried by the various brackets to interconnect the blades **20** and **21** and complete the linkage means **92.** With the blades swung to a closed and nested relationship with one another, the set screws **102** may be tightened in the swivels to provide the effective length for the respective shafts and the angular relationships which will cause the wide grooves **73** on the power blade **21** and the other blades **21** to move to the open position slightly before movement of the blades **20** from the closed position. Conversely, the linkage means **92** causes the blades **20** to swing to a closed position and into engagement with the side shelves **29** before the wide channel means **35** follow to the closed nested relationship and into engagement with the side shelves as shown in FIG. **4.**

From the foregoing it will be seen that air dampers may be provided with metal blades of unique shape for assuring a nested sealing relationship with one another when in a closed position. The air damper may be readily assembled from a small inventory of metal blades and frame members for various widths and lengths of air dampers and at a low cost. The blades may be readily positioned in the frame and adjustably interconnected to assure the blades will seal with side, top and bottom shelves on the frame and will nest with one another along longitudinally extending edges thereof when the blades are in a closed position. While the preferred and described embodiment of the invention is made with extruded aluminum blades and frame members, the invention is not to be so construed as limited to the use of only aluminum metal or to the use of only extruded metal blades. Indeed, the air damper blades may be made of steel and the frame members made of steel or other metals and still fall within the purview of the invention as set forth in the appended claims.

While a preferred embodiment has been shown and described, it will be understood that there is no intent to limit the invention by such disclosure but, rather, it is intended to cover all modifications and alternate constructions falling within the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

**1.** An air damper comprising a frame formed of metal frame members, said frame having a top and bottom frame member extending parallel to one another and a pair of parallel side frame members extending between and joined to said top and bottom frame members and defining therewith a central air flow opening, a shelf on each of said frame members projecting inwardly from said frame members and extending longitudinally thereof, a first set of metal damper blades each supported at opposite ends on said side frame members and extending longitudinally across the air flow opening and mounted for turning about a pivot axis through a central portion thereof, a second set of metal blades cooperable with said first set of blades with each of said second set of blades extending longitudinally across the air flow opening and mounted for turning about a pivot axis through a central portion thereof, each of said blades of said first and second sets of blades having side edge portions for overlapping said shelves on said side frame members when the damper blades are in a closed position blocking air flow through said opening, said damper blades mounted in said frame for sealing cooperation with respective shelves of said top and bottom frame members, means interconnecting said blades of said first and second sets to turn the same in opposite directions between the closed position and open positions in which said blades of said sets are spaced from each other to allow air flow through said damper, each of said first set of blades having longitudinally extending channel means of a predetermined width along each of its longitudinally extending edges, and each of second set of blades having longitudinally extending channel means of a width wider than the width of said channel means of said first set of damper blades, said blades being positioned in said frame to overlap the channel means of respectively adjacent blades of said first and second sets to provide a sealing relationship therebetween when said blades are in the closed position, and interconnecting means pivoting said blades with narrow channel means to a closed position with said frame and then pivoting said wider channel means to close on said narrow channel means to provide a nested sealing relationship between the longitudinal edges of adjacent blades of said first and second sets of damper blades.

**2.** An air damper in accordance with claim **1** in which said narrow and wide channels means comprise a groove and a projecting wall defining the bottom of said groove and in which resilient seals are carried in the respective narrow and wide grooves, said wider channel means having wide seals and said narrower channels having narrower seals, said projecting walls of said narrow channel means nesting in said wide grooves and abutting said wide seals when said blades of said first and second sets are in sealing engagement.

**3.** An air damper in accordance with claim **2** in which said wide and narrow seals are flat rectangular strips and are adhesively secured in their respective channel means.

**4.** An air damper in accordance with claim **3** in which each of said narrow channel means has a groove of a predetermined depth therein, and said narrow seals have a thickness greater than said groove depth to project therefrom for compression against said shelf on said top frame member.

**5.** An air damper in accordance with claim **1** in which pivot means includes slotted pivot pins pivotally mounting said blades on said side frames, a pair of oppositely directed and longitudinally extending rib means are formed on each of said blades for strengthening said blades against bowing, said rib means centering said slotted pins on said damper blades and reinforcing the same against tearing by said slotted pins.

**6.** An air damper in accordance with claim **1** in which each of said blades except the uppermost blade is symmetrical about its pivot axis, said uppermost blade having an upper portion thereof of a width different than the width of a lower portion thereof, said upper portion of said uppermost blade extending to said upper shelf when the blades are in the closed position.

**7.** An air damper in accordance with claim **1** in which said side, top and bottom frame members have identi-

cal cross sections and in which bracket means are provided at the spaced corners of said frame to interconnect said side frame members with said top and bottom frame members and in which outer portions of said fasteners are accommodated with grooves in the exterior walls of said frame members to fasten said bracket means to said frame members.

**8.** An extruded aluminum damper blade for use in an air damper comprising a central section at a central axis about which the blade will be pivoted, oppositely directed rib means projecting outwardly from said blades and spaced from said axis to reinforce the central section of the blade against bending, said central section and said rib means defining a cross-section of substantially I beam shape, longitudinally extending channel means formed on each of the longitudinally extending edges of said blade, said channel means being identical in size and shape, said blade having a first wide planar portion extending from one side of said section in a plane parallel to and spaced from the central pivot axis, and a second wide planar portion extending from the other side of said central section and in a plane parallel to and spaced from the plane of said first wide planar portion, said channel means being joined to the outer edges of said wide planar portions.

**9.** An air damper blade in accordance with claim **8** in which each of said channel means is substantially rectangular in cross section and comprises a pair of spaced, parallel longitudinally extending side walls defining the sides of the channel means, and a flat bottom wall substantially normal to and spanning said side walls and defining the bottom of said channel means.

**10.** An air damper comprising a metal frame and metal damper blades, said frame having parallel top and bottom frame members, parallel side frame members spacing said top and bottom members and extending therebetween and defining therewith a central air flow opening, said frame members each having a longitudinally extending shelf projecting inwardly therefrom, said damper blades including first and second sets of blades pivotally mounted in said air damper, each of said damper blades having a length longer than the distance between inner edges of said shelves on said side members, pivot means for said blades mounted in openings in said side member shelves, an offset portion at each end of said blade projecting through shelf openings, each of said blades having marginal side edges thereof in sealing engagement with opposite sides of said shelves of said side members, said first set of blades having longitudinally extending channel means therein of a predetermined width, a resilient seal carried in each of said channel means, said second set of damper blades alternating with damper blades of said first set of damper blades and pivotally mounted to said side frame members for turning in a direction opposite to direction of turning of said first set of blades, said second blades having longitudinally extending channel means of a width wider than said predetermined width for receiving in nesting relationship the channel means of the first set of blades when the blades are in a closed position blocking air flow through the opening, said narrow channel means having a projecting portion formed along one side thereof, resilient seals carried by said wide channel means for sealing engagement with a projecting portion of the narrow channel means of the first set of blades, and means interconnecting said first and second set of blades to pivot said narrow seals against said shelves on said side members and subsequently to pivot said wide seals against said projecting portions of said narrow channel means to nest said narrow and wide channel means when said blades of said first and second sets are in the closed position.

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