# United States Patent [19]

**Burt et al.**

[11] **3,897,773**

[45] **Aug. 5, 1975**


[54] **DAMPER**


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[73] Assignee: **Henry Vogt Machine Co.,** Louisville, Ky.



[22] Filed: **Nov. 7, 1973**

[21] Appl. No.: **413,500**

**Related U.S. Application Data**

[62] Division of Ser. No. 322,019, Jan. 8, 1973, Pat. No. 3,805,884.

[52] **U.S. Cl.** .............. **126/285 R;** 110/163; 137/610

[51] **Int. Cl.** .............................................. **F23l 13/02**

[58] **Field of Search** ................ 126/285 R; 137/610; 110/163


[56] **References Cited**

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| | | | |
|---|---|---|---|
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| 2,148,713 | 2/1939 | Roof | 126/285 R |
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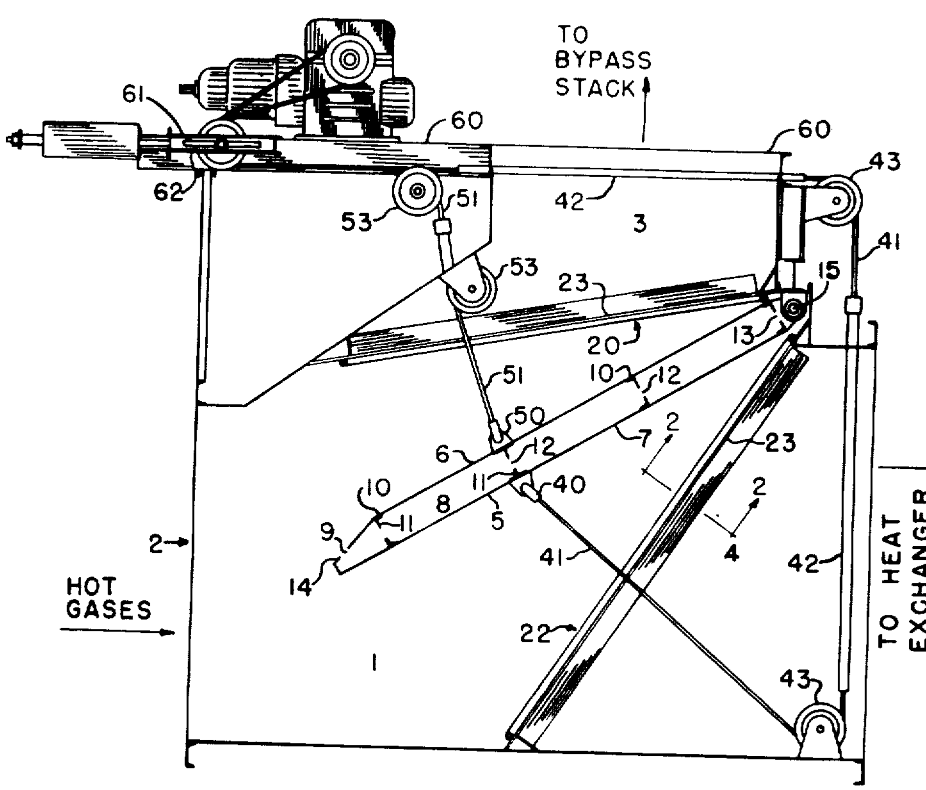
*Primary Examiner*—William F. O'Dea
*Assistant Examiner*—Ronald C. Capossela


[57] **ABSTRACT**

A large pivotably mounted damper comprising a damper blade pivotable between two outlets in a duct. The blade, when in seating engagement with one outlet, leaves the other outlet completely open. In intermediate position between said outlets the damper directs hot gases in said duct to both of said outlets. Thus disastrous accidents cannot occur, since in either of the two seating positions, one outlet is completely open. The damper blade comprises an upper and lower wall. A means for equalizing the stress and the temperature in said walls includes a gas space coextensive with the inner surface of said walls and a set of gas ports in open communication with the gases in said duct. Warpage is eliminated or minimized through the use of a heating fluid consisting of process gases directed through the gas space defined by the spaced apart walls of said blade. This contrasts with prior art techniques which used cooling fluids such as water or atmospheric air to cool damper blades. A novel means for moving the damper blade between seating and modulating positions and holding the blade under tension in seating is disclosed.


**6 Claims, 5 Drawing Figures**



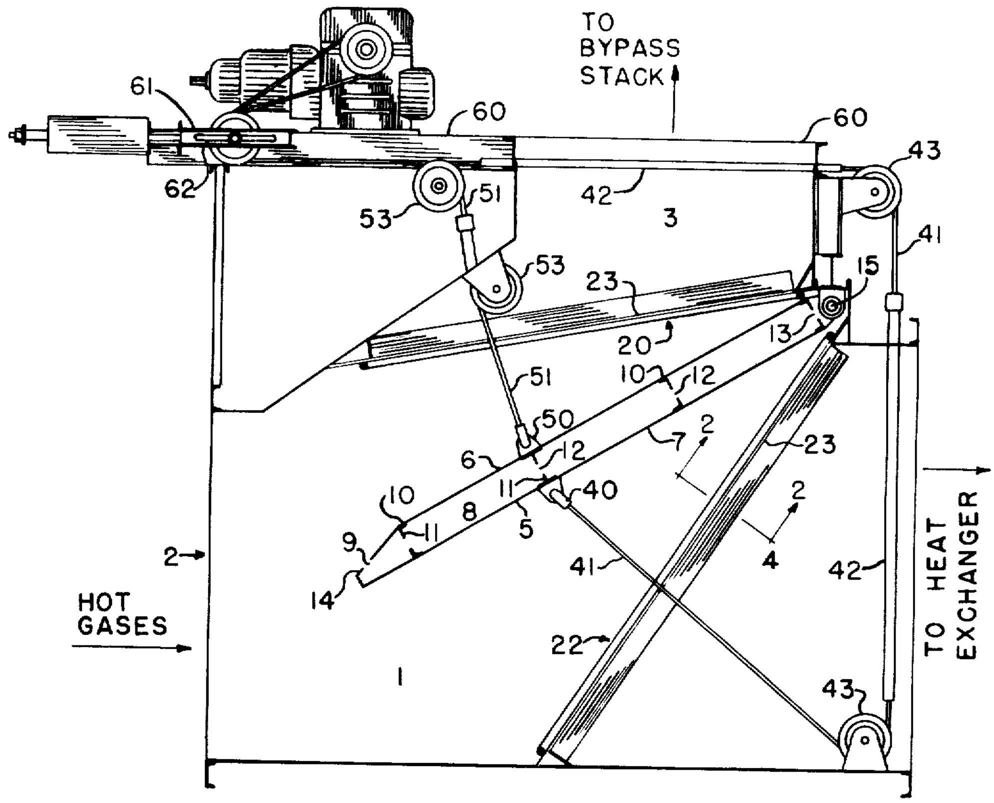



FIG. 1

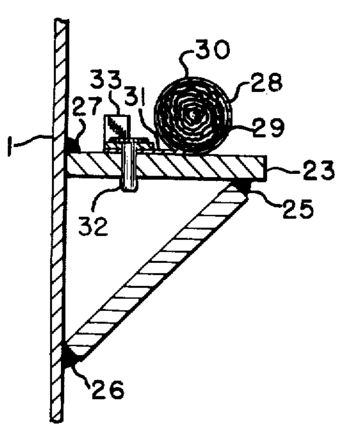



FIG. 2

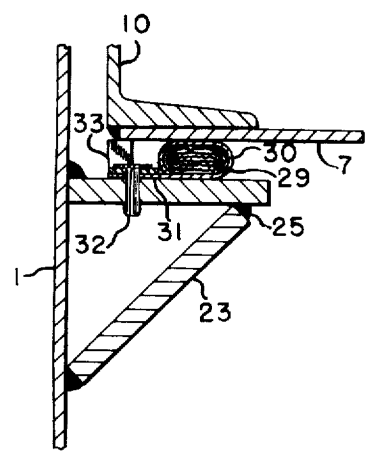



FIG. 3

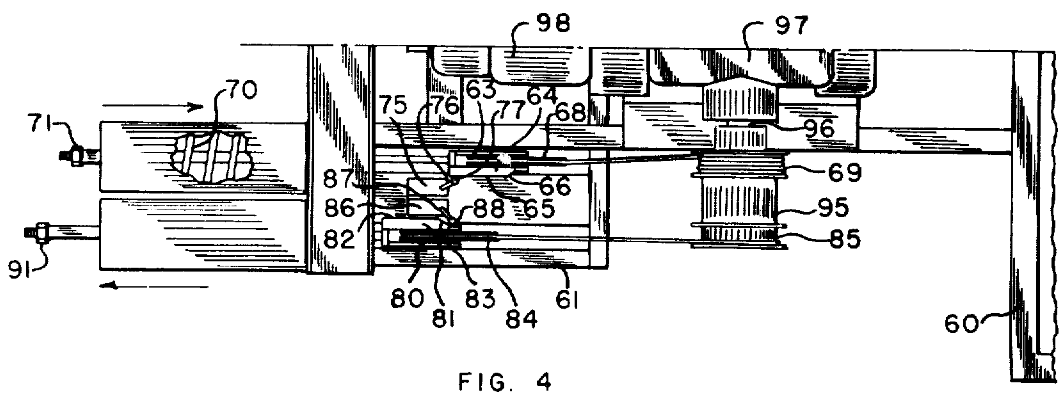

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FIG. 4

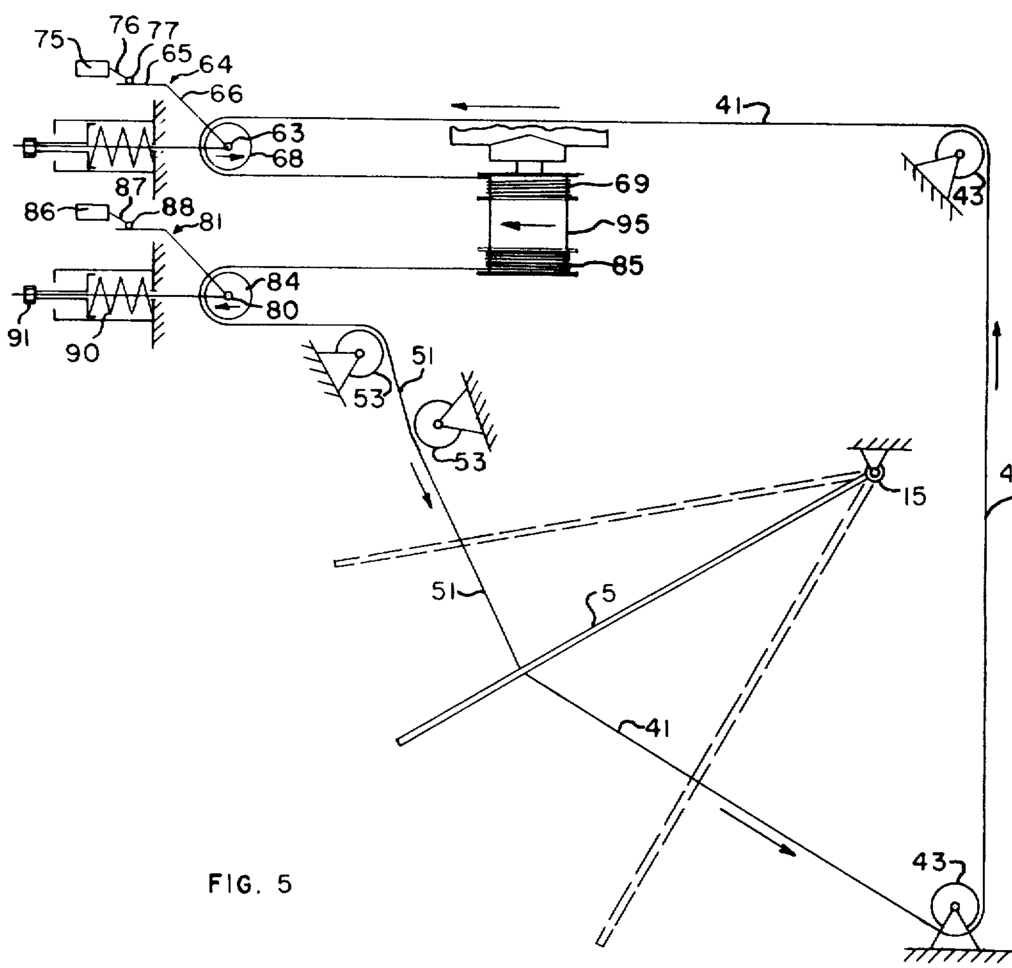
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FIG. 5

# DAMPER

## CROSS REFERENCE TO RELATED APPLICATIONS

This application is a division of our copending application Ser. No. **322,019** and filed Jan. **8, 1973 now** U.S. **Pat. No. 3,805,884** 4-23-74.

## FIELD OF THE INVENTION

This invention relates to improvements in dampers particularly for use with steam generators and other heat exchange apparatus. More particularly, this invention relates to improvements in dampers for regulating the passage of a hot medium such as gas turbine effluent through a duct to a heat exchanger for recovery of sensible heat and for the production of steam.

## DESCRIPTION OF THE PRIOR ART

Continuous gas turbine operation is of sufficient importance in many instances that recovery of sensible heat from the effluent is relatively insignificant in comparison. Thus isolation of the boiler by venting to a bypass stack may allow for continuity of turbine operation and allow access to the boiler at the same time.. Therefore a damper which can effectively direct the flow of exhaust gases to a bypass stack without impairing gas turbine operation may be of critical importance in many industrial operations. These dampers must be large in face area ranging between **60** and **260** square feet. Any leakage from the damper is either lost to the system in the case of the bypass stack damper or does not completely isolate the boiler or steam generator when bypassing to the stack. According to Hambleton*, as late as **1968,** leakage around dampers of between **1** and **3%** could be anticipated.

*Hambleton, Warner V.: GENERAL DESIGN CONSIDERATION FOR TURBINE WASTE HEAT STEAM GENERATION. **13th** International Gas Turbine Conference, Washington, D.C., March, **1968**

Dampers for both bypass stack and isolation fall into three basic types: (**1**) Multilouver design with and without compressible seats, (**2**) Butterfly dampers using a single blade, and (**3**) Guillotine dampers using a flat blade type plate.

Multilouvered dampers are well suited to modulating control of gas flow when partial bypassing of the process gases to the stack is required to control steam flow from a sensible unit. Multilouvered dampers have the disadvantage of a high leakage due to the large number of joints and the expansion differential between the damper frame and the connecting linkage. Further, multilouvered dampers have another disadvantage in that they are quite expensive to manufacture and to maintain. Guillotine dampers consist of a large heavy steel plate that is either lowered by gravity or moved into place across the duct area with a gear system. The problem with guillotines is that they are cumbersome, slow to operate and in the vertical position they must be safety locked in place to avoid the possibility of falling across the duct, should the actuating mechanism fail.

Butterfly dampers are similar in construction to multilouvered dampers, except that they use a single blade. These dampers are less expensive to manufacture and exhibit less leakage than a multilouvered damper, due to the smaller peripheral seating surface. Butterfly dampers are subject to warping due to the large blade area.



A problem with each of these dampers has been the fact that two dampers are required, one to each outlet. Thus, through human failure or through mechanical failure, if both dampers are simultaneously closed, or if one damper is not opened when the other damper is closed, this can result in serious industrial accidents from duct rupture and/or from turbine damage. With the use of multilouvered dampers, in some instances, such dampers have blown apart with pieces blowing into the heat exchanger, causing plant shutdown for repair. Due to the possibility of personnel injury, the repair costs of such machinery and due to the critical power shortages effected by prolonged plant shutdown, such accidents are intolerable.

The use of a single damper blade, pivotable at one end so as to effectively close one opening in one seating position and another opening in another seating position has been recognized as early as **1905** by Suzuki in U.S. Pat. No. **803,027.** However, Suzuki required a connecting linkage between the two pivotably disposed dampers so that a failure of the linkage could result in both dampers remaining closed. A pivotable damper without Suzuki's connecting linkage is presently commercially available, but only in limited sizes, i.e., about **5** to **10** square feet in face area. This is due to the fact that warpage is such a large factor in the single blade type dampers. Prior art attempts have been made to relieve the stress and therefore relieve the warpage due to temperature differential in said dampers by the use of cooling fluids. Thus, Roof in U.S. Pat. No. **2,148,713** proposed the use of cooling air drawn from the atmosphere through an upper port into a gas space between the walls of a guillotine type damper to a lower port communicating with the downstream portion of the duct. Dalin, in U.S. Pat. No. **2,391,010,** proposed the use of a cooling medium in the form of water circulating in serpentine tubes between the space formed by the walls of the damper. These proposals have found use commerically, but of course, produce dampers which are quite expensive and quite large and cumbersome.

## SUMMARY OF THE INVENTION

According to this invention, there is provided a single blade damper of large face area having spaced apart upper and lower walls, and means for equalizing the stress and temperature between the upper and lower walls by the passage of hot process gases through the gas space formed by said upper and lower walls.

Ports in open communication with the upstream and downstream portions of said duct and with said gas space direct hot gases from said duct through said ports into said gas space to heat the walls of the damper and to minimize heat differential between the two walls.

Further, according to this invention, there is provided a single blade damper, movable between two outlets, one to a bypass stack and the second to a heat exchanger.

According to this invention, there is provided means for moving said damper between seating engagement to one outlet and seating engagement with the second outlet and to an intermediate modulating position whereby gases may be diverted to both outlets and thereby control the production of steam. According to this invention, there is provided, further, a damper, arranged so that if all should fail, one outlet is completely open, thus avoiding an industrial accident. This invention also provides for spring tensioned seating engagement of the damper against a high temperature resistant gasket so as to reduce leakage of process gases to less than 1%. This compares to an anticipated damper leakage, as late as **1968**, of between **1** and **3%**. Hambleton, op.cit.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a sectional view with parts in elevation, illustrating a portion of the ductwork, the damper of this invention mounted therein, the seats for the damper and the means for moving said damper between the two seats.

FIG. **2** is a sectional view taken along lines **2—2** of FIG. **1**, illustrating the projecting shoulder and the heat resistant gasket mounted thereon which forms a seat for said damper.

FIG. **3** is sectional view, analogous to FIG. **2**, showing the gasket in compressed condition and in contact with the lower wall of said damper.

FIG. **4** is a partial plan view of the cable drive, the spring loaded tensioning sheaves and the limit switch cut off assembly, illustrating the upper limit switch closed and the lower limit switch in open condition.

FIG. **5** is a schematic view, illustrating the damper in modulating or intermediate position, the spring loaded cable drive and the limit switch cut off assembly with arrows indicating movement of the damper to the right toward heat exchanger isolation, and illustrating the associated tensioning sheaves and the cams moving toward the position shown in FIG. **4** in which the lower limit switch is open and in which the upper spring is compressed.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

As has been previously indicated, the damper of this invention is designed for use in recovering the sensible heat from gas turbine effluent. These hot gases enter the ductwork **1** at velocities in excess of hurricane scale and at temperatures in the range of from **750°F** to **1250°F**. Since the size of these dampers is equivalent to a face area ranging from **60** to **260** square feet, the problem of warpage due to temperature differential between the two walls of the damper is enormous. Thus, for example, when the damper **5** is in seated condition against the seat **20**, thus closing off the outlet **3** to the bypass stack, the temperature adjacent the upper wall **6** of the damper is in the area of **80°F** to **150°F**, while the temperature inside the ductwork and adjacent to lower wall **7** of the damper is in the area of **750°F** to **1250°F**. Thus, there may be as much as **1000°**of difference in the temperature adjacent the upper wall **6** and the temperature adjacent the lower wall **7**. The problem when the damper is in the heat exchanger isolation position, i.e. in contact with seat **22**, thus closing off gas outlet **4**, is not so severe, since the heat exchanger is some distance away from atmospheric temperature. Nevertheless, with dampers of this size and bulk, subjected to the rigorous conditions of hurricane velocity gases at elevated temperatures, warpage has been and is a problem as is actual destruction of the damper itself.

Accordingly, the damper of this invention utilizes supporting frame members **10**, to which are welded metal plates to form the upper walls **6** and the lower walls **7** of said damper. A gas space **8**, generally coextensive with said walls, is thus formed. The process gases from the duct are admitted through inlet ports **9** and through ports **12** in the webs **11** of supporting frame members **10** and through outlet ports **13** to the downstream side of the ductwork. The nose **14** of the damper **5** is tapered. The inlet ports **9** are in open communication with the upstream portion of duct **1** and transmit hot gases coming through inlet **2** through the inlet ports **9**, the intermediate ports **12** and out through the outlet ports **13** to the downstream portion of the duct. The ports ar designed so that the flow through the gas space **8** is not heavy but merely sufficient to equalize the temperatures between the upper wall **6** and the lower wall **7** and thus to prevent warpage of the blade **5**. As indicated, these blades are quite large in face area ranging in square feet from **60** up to **260**. As is shown in the drawing, the damper **5** pivots on pivot point **15** between seating position against seat **20** and seating position against seat **22**, so that in either position or in the intermediate position as shown in the drawing, at least one of the outlets **3** or **4** is open. This prevents accidental closure of both outlets which can lead to disastrous industrial accidents.

In order to produce an essentially leakproof seal, the seats **20** and **22** consist of a projecting shoulder made up of two plates, welded at point **25** and welded to the ductwork at points **26** and **27**. Mounted on the projecting shoulder is a heat resistant gasket **28** consisting of a bundle of nickel-chrome-iron alloy fibers **29**, contained inside of a braided high temperature steel jacket **30**. A tangential flap of metal **31**, extends from the jacket **30**, and is used to mount the gasket onto the projecting shoulder **23** by means of drive rivet **32**. A stop **33** is provided to prevent the damper wall **7** from compressing the gasket beyond a certain point since this would result in a permanent set of the compressed gasket. The compressed gasket **28** is shown in the sectional view of FIG. **3**.

As previously indicated, although dampers are normally used to isolate the heat exchanger and to vent to a bypass stack, when the turbine is used without a heat recovery system in full operation, the production of steam may be controlled by partialy bypassing process gases to the stack by placing the damper in a position intermediate of the two outlets. This is shown in FIG. **1**. It will be appreciated, of course, that the modulating position of the damper may be at any point intermediate to the outlet seats **20** and **22** and methods for modulating the gas flow to control steam production are well known in the art. The problem, however, is that with the extremely large and heavy dampers, such as those encompassed within the scope of this invention, fluttering occurs due to the high velocity of the gases. This fluttering can be so severe so as to actually destroy dampers, and the multilouvered type of dampers are particularly vulnerable to this action, resulting in severe industrial accidents. Destruction of such a damper causes parts of the damper blades to be blown into the heat exchanger, causing damage and plant shutdown. In any event, this invention encompasses the use of a damper pivotable between one of the three positions in seating engagement between the outlet **3** and the outlet **4** and at a position intermediate between the two whereby the flow of gases is directed to both outlets. Fluttering is prevented by means of applying tension to both the upper wall **6** and the lower wall **7**. This is accomplished by means of a set of spring loaded cables

41 and 51 attached to the lower and upper walls 7 and 6 of the damper respectively.

Referring now to the drawings, lower clevis 40 is connected to the stainless steel cable 41 which is trained over directional sheaves 43 and guided through protective pipe 42 in the high temperature areas. A clevis 50 is attached to the upper wall 6 of the damper and connected to cable 51 which in turn is trained over directional sheaves 53. A supporting framework 60 is provided to which frame members 61 are connected. Frame member 61 contains a bearing slot 62 into which a slidable clevis 63 is journaled. A cam 64 is mounted to the medial face of said slidable clevis 63 and said cam contains flat camming face 65 and inclined camming face 66. The clevis 63 contains a tensioning sheave 68 over which the lower cable 41 is trained passing to driven sheave 69 contained on cable drum 95. The clevis 63 is restrained by spring 70 which has a tension regulating device 71, projecting from one end of its housing. The cam 64 is in proximity to limit switch 75, containing lever arm 76 and cam follower 77. Cam follower 77 is in physical contact with the cam faces 65 and 66 respectively. The corresponging slidable clevis 80 is used to support tensioning sheave 84 over which cable 51 is trained onto its driven sheave 85 contained on cable drum 95. Clevis 80 contains cam 81 mounted on its medial surface which again contains flat camming face 82 and inclined comming face 83. The cam is mounted in proximity to limit switch 86, and contains lever arm 87 and cam follower 88. Cam follower 88 is in physical contact with the camming faces of cam 81 and as is shown in FIG. 4, cam follower 88 has followed the inclined face of said cam to open the contacts of limit switch 86 and thus cut off power to the motor or prime mover 98. The tensioning sheave 84 mounted in slidably journaled clevis 80 is restrained by spring 90 which is contained within a housing and has a tensioning regulating device 91 at one end. As is clearly shown in FIG. 4, spring 90 is relaxed, thus pulling the tensioning sheave 84 to the left and causing the cam 81, mounted on the medial surface of the slidable clevis 80 to move to the left so that the cam follower 88 follows the flat camming face 82 until it reaches the inclined camming face 83 and thus opens the contacts of limit switch 86 to stop the motor 98.

In illustrating the operation of the cable drive for moving the damper 5 between the seating position at outlet 3 to seating position at outlet 4 or to modulating position intermediate to each of these seating positions, the movement of the damper blade 5 is described from the intermediate modulating position as shown in FIGS. 1 and 5 to the right against seat 22 so that the associated slidable sheaves and cams and limit switches will be in the position shown in FIG. 4. The drive, of course, consists of motor 98, gear reducer 97, driven shaft 96, cable drum 95 and driven shaves 85 and 69.

## OPERATION

Starting from the position illustrated in FIGS. 1 and 5 and moving the damper blade 5 toward outlet 4 into seating engagement with seat 22 the operation is as follows:

As the damper blade 5 moves to the right, the cable 41 must be turned onto the cable drum 95 by rotation of the top of the drum 95 from right to left. At the same time, cable 51 reels off of the top of the drum 95 at the same rate and consequently, the damper 5 is held stable and in tension as it moves from left to right. When it reaches the extreme seating position against seat 22, further movement ceases on the sheave 43 and the movable spring loaded sheave 68 begins to move to the right. In so doing, spring 70 is brought into greater compression and the cam follower 77 of the limit switch 75 rides on the flat face 65 of the cam 64, thus holding the limit switch 75 closed with no effect in the electrical circuit powering the drive motor. At the same time, cable 51 is continuing to unreel from its driven sheave 85 but no further cable is required to pass through the directional sheaves 53 because the damper 5 is moving only fractionally to compress the gasket 28. This, then, allows cable 51 to go slack and relieves the compression on the spring 90 holding the movable clevis 80. As a result, sheave 84 moves to the left and the cam follower 88 of limit switch lever arm 87 moves from the flat face 82 of the cam 81 down the inclined face 83 to its open position. Thus, switch 86 whose contacts were previously held closed, now has open contacts which are electrically in series with the drive motor, now de-energized to stop rotation of the drum 95 in that direction. This produces the position of the sheaves 68 and 84, the lever arms 76 and 87 against cam faces 65 and 83 as illustrated in FIG. 4. The cable 41 is in a condition of increased tension, thus holding the damper blade 5 against the compressed gasket 28 to prevent leakage. The other cable 51 simultaneously is in a condition of decreased tension and the drive motor 98 and gear reducer 97 are incapacitated from one direction of rotation. In order to move the damper from right to left, the direction of rotation of drive motor 98 is reversed, deriving its power through series connected limit switch 75 previously mentioned as having remained closed and having had no effect. As the top of the drum 95 begins to turn from left to right, cable 41 is reeled out, thus reducing the compression on spring 70. This compression begins to balance with increasing compression on spring 90 as its movable sheave 84 moves to the right and closes limit switch 86, thus providing the capability of again reversing the direction of rotation of the motor 98. As the blade 5 moves to the modulating position, it is held in tension, an amount predetermined by the compression set on the two springs 70 and 90. This tension on the upper wall 6 and lower wall 7 of the damper prevents fluttering of the damper as it moves through the high velocity stream of gases.

Recapitulating, the cable drive mechanism rotating capability, whether forward or reverse, is controlled by limit switches in each of the respective electrical circuits determining rotation direction. The drive system places tension onto the seating side of the damper blade against the gasket 28 until released tension on the opposite side caused by decompression of the spring through movement of the associated movable sheave opens its associated limit switch and thus shuts off the motor.

Many modifications will occur to those skilled in the art from the detailed description hereinabove given. Such description is meant to be exemplary in nature and non-limiting except to be commensurate in scope with the appended claims.

We claim:

1. Apparatus for controlling the flow of hot gases in a gas stream which includes:

A. a duct having upstream and downstream portions,

B. a damper blade, mounted entirely within said duct and movable between open and closed positions, said damper blade comprising:

**1.** a supporting frame,

**2.** metal plates mounted on both sides of said frame to form spaced apart walls; and

**3.** a nose portion at one end;

C. the improvement in said damper blade of means for equalizing the stress on said walls and for equalizing the temperature of said walls relative to each other, which comprises:

**1.** a gas space, defined by said walls and by said frame for directing the flow of hot gases between said walls along the length of said damper blade for reinjection back into said gas stream, said gas space being:

a. generally coextensive with said walls, and

b. in direct heat exchange relation with said walls; and,

**2.** inlet ports in the nose portion of said damper blade and outlet ports at the opposite end of said damper blade said ports being in communication with said gas space and with said duct and serving as gas passages for the flow of a portion of said hot gases through said gas space,

a. the further improvement wherein said inlet ports are in communication with the upstream portion of said duct for directing a portion of said hot gases into said gas space and outlet ports are in open communication with said downstream portion of said duct, so as to reinject said portion of said hot gases back into the gas stream.

**2.** A damper blade as defined in claim **1**, the further improving in said supporting frame of:

A. peripheral frame members, and,

B. reinforcing frame members extending between and attached to said peripheral frame members,

C. the futher improvement of openings in the web portions of said reinforcing frame members forming gas passages for the flow of heated gases through said gas space.

**3.** A damper blade, as defined in claim **1**, in which the nose of said blade is tapered and in which said inlet pports in said nose are directed toward the upstream portion of said duct, when said damper blade is in open and closed positions.

**4.** A damper blade, as defined in claim **1**, the further improvement of a seating surface for said damper blade, which comprises:

A. an inwardly projecting shoulder mounted on the inner walls of said duct; and,

B. a high temperature resistant gasket mounted on said shoulder.

**5.** A damper blade, as defined in claim **4**, in which said high temperature gasket comprises a plurality of fibrous forms of a nickel-chrome-iron alloy.

**6.** A damper blade, as defined in claim **4**, the further improvement in said gasket of:

A. a high temperature resistant packing,

B. a braided outer high temperature resistant metal jacket, and,

C. a mounting flap of metal extending tangentially from said jacket.

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