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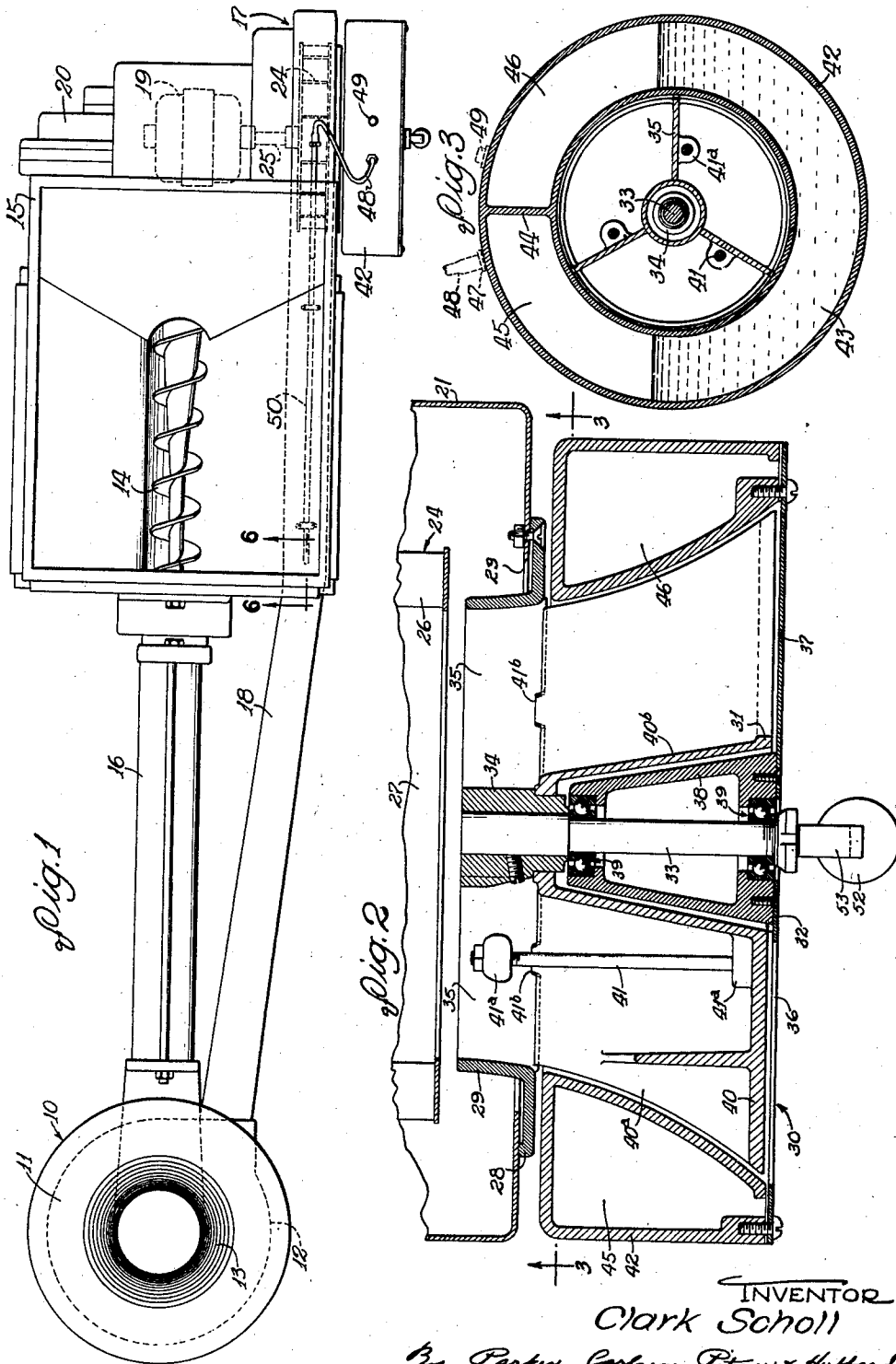
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2,109,240

AIR CONTROL MEANS FOR COMBUSTION APPARATUS

Filed Nov. 15, 1935

2 Sheets-Sheet 1



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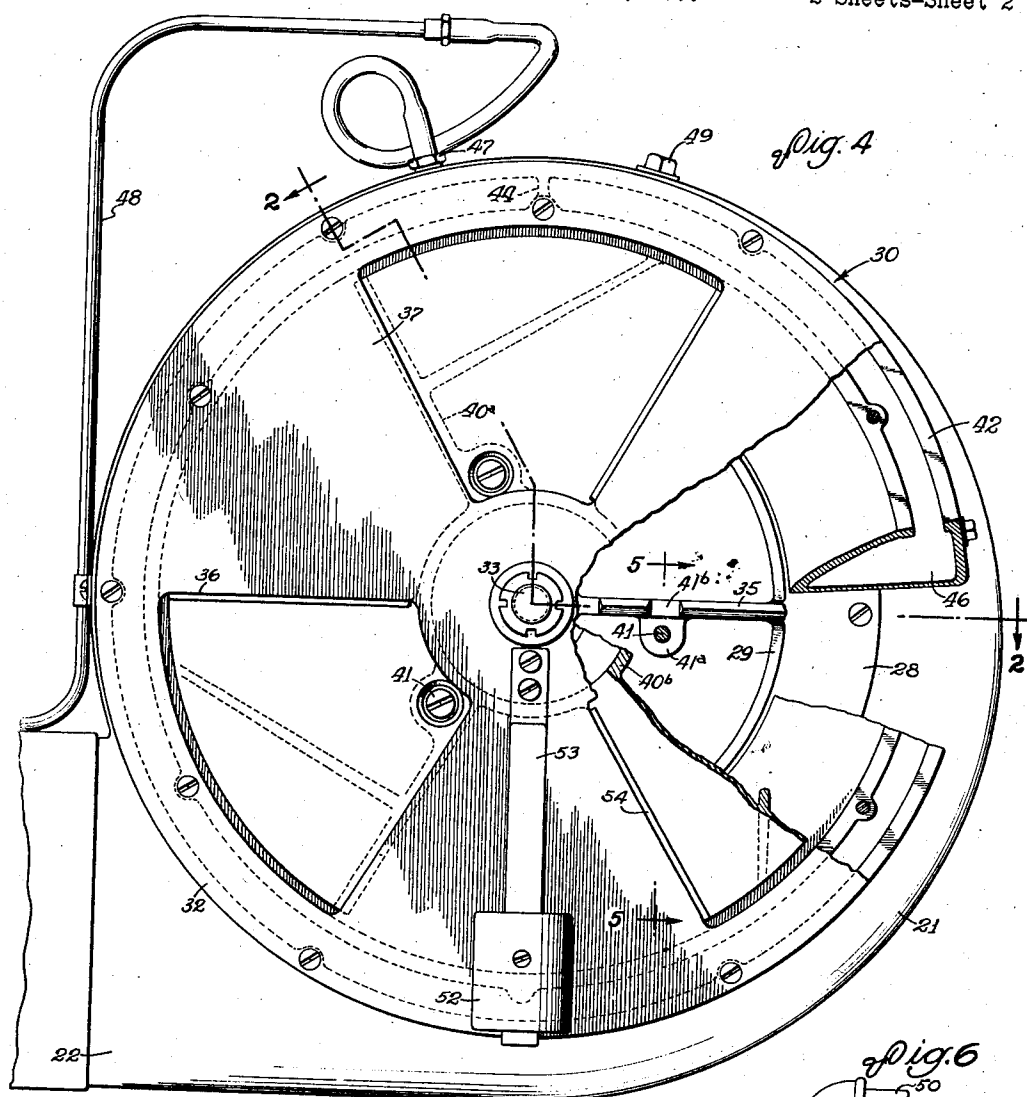
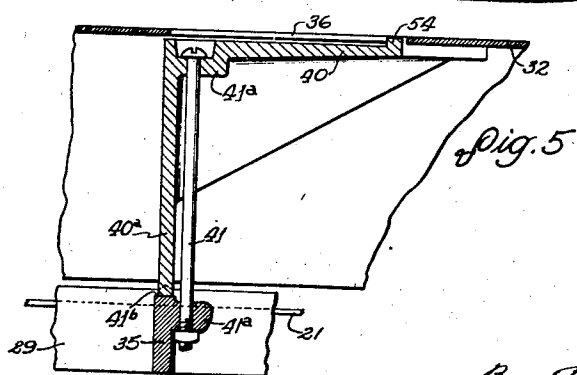
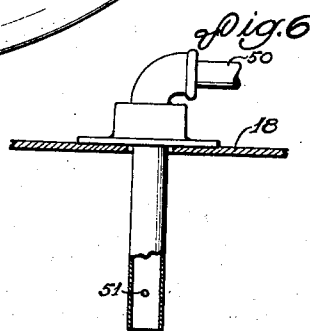
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2 Sheets-Sheet 2



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AIR CONTROL MEANS FOR COMBUSTION APPARATUS

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10 Claims. (Cl. 230-114)

The present invention relates to improvements in automatic air control means for combustion apparatus, and has particular reference to a new and improved automatic damper for controlling the supply of air under pressure to the fuel bed of a furnace, as for example in the retort of an underfeed coal stoker.

It is well recognized that a proper ratio of fuel and finely dispersed air must be maintained in order to obtain efficient and satisfactory combustion. Such ratio is difficult to obtain in stokers with forced draft because of variations in operating conditions influencing the amount of air supplied to the combustion zone. In one common type of underfeed stoker, fuel is fed through a duct into the bottom of a retort to form a fuel bed, and air for combustion is supplied under pressure by a fan or blower through a duct to a plenum chamber, and then through tuyère openings into the bed. When the fuel bed is heavy and dense, the static pressure of the air will be relatively high, and at times may reach the maximum that the blower can develop. Conversely, when the fuel bed is thin and porous, its resistance to the passage of air is greatly reduced, and hence the static pressure of the air may be very low. The volume of air delivered by the blower varies inversely with the static pressure in the air passages. Thus, when the fuel bed is heavy, and the volume of air should be correspondingly high, the actual volume of air supplied is relatively low. When the fuel bed is light, and a relatively small amount of air is required, the amount of air actually supplied may be considerably in excess of that required for combustion, thus resulting in serious heat losses. The condition of the fuel bed is determined by the kind of fuel that is used, the rate of fuel feed, and the rate of combustion.

One of the primary objects of the present invention resides in the provision of novel means for supplying air under pressure automatically in accordance with the conditions of the fuel bed, thereby avoiding the inconvenience of and necessity for manual supervision and adjustment, and the undesirable consequences of failure to make proper adjustments.

Another object is to provide a novel form of automatic damper for the air supply means which is responsive to the static pressure of the air passing to the fuel bed so that when the static pressure increases, the damper is moved correspondingly toward open position, and when the static pressure drops, the damper is moved correspondingly toward closed position to restrict

the flow of air, thereby permitting the fuel bed to build up to the proper depth, and preventing substantial combustion losses because of an undue volume of excess air.

A more specific object resides in the provision in an air blower of a novel rotary inlet damper automatically adjustable in accordance with a rotary liquid reservoir outside of said damper and responsive to the differential between the static pressure of the air delivered by the blower and the pressure of the atmosphere.

Further objects and advantages will become apparent as the description proceeds.

In the accompanying drawings, Figure 1 is a plan view of an underfeed stoker provided with automatic air supply means embodying features of my invention.

Fig. 2 is an axial sectional view of the air supply means taken substantially along line 2-2 of Fig. 4.

Fig. 3 is a transverse sectional view on a reduced scale taken substantially along line 3-3 of Fig. 2.

Fig. 4 is a fragmentary side elevational view on an enlarged scale of the air supply means.

Fig. 5 is a fragmentary sectional view taken along line 5-5 of Fig. 4.

Fig. 6 is a fragmentary sectional view taken along line 6-6 of Fig. 1.

Referring more particularly to the drawings, the underfeed stoker disclosed in Fig. 1 has a burner 10 comprising an upwardly opening fire pot or retort 11, a plenum chamber 12 surrounding the pot, and tuyères 13 opening from the chamber to the top of the pot. Solid fuel, such for example as coal, is fed by a conveyer 14 from a hopper 15 through a duct 16 into the bottom of the fire pot 11 to form a fuel bed. Air under pressure is supplied by a fan or blower 17 through a duct 18 to the plenum chamber 12 for discharge through the tuyères 13 into the top portion of the fuel bed. The conveyer 14 and blower 17 are driven in timed relation from an electric motor 19. A variable speed mechanism 20 is interposed between the conveyer 14 and the motor 19. Preferably, the blower 17, the variable speed mechanism 20, and the motor 19 are rigidly mounted on the base of the hopper 15.

The blower 17, which constitutes the air supply means, may be of any suitable character and is herein shown as of the rotary type. More particularly, the blower 17 comprises a generally cylindrical housing 21 which has a tangential outlet 22 connected to the duct 18, and which is formed in one side wall with a circular opening

23. A rotor or fan wheel 24 is fixed on a shaft 25 for rotation within the housing 21, and comprises a plurality of annularly arranged peripheral vanes 26 defining a hollow interior space 27 open at one side adjacent the opening 23 and closed at the other side. The shaft 25 is driven by the motor 19. Attached in fixed position to the housing 21 about the front opening 23 is an inlet ring 28 having an inwardly tapering conical flange 29 for directing air to the interior space 27 of the rotor 24.

An important feature of the present invention resides in the provision of a new and improved air control means, preferably in the form of a damper, which serves to control the volume of air supplied through the duct 18 to the fuel bed, and which is automatically adjustable with changes in the static pressure of the air. In the preferred form of the invention, the air control means comprises a damper 30 of the rotary type which is adapted for adjustment automatically out of closed position against the action of a counterweight.

In its preferred form, the damper 30 comprises a stationary member 31 suitably mounted on the inlet ring 28, and a rotary member 32 journaled on a fixed shaft 33. This shaft is secured in a central bearing 34 interconnected at uniformly spaced points with the flange 29 by a plurality of radial arms 35.

More particularly, the rotary damper member 32 is in the form of a flat plate having a plurality of annularly arranged air inlet openings 36 separated by uniformly spaced radial arms 37. In the present instance, three openings 36 are shown. The openings 36 and the arms 37 are in the form of equal circle sectors. Secured to the central portion of the disk or plate 32 is an inwardly extending hub 38 which is axially elongated and in the form of a cone, and which is supported at opposite ends by anti-friction bearings 39 on the shaft 33.

The stationary damper member 31 comprises a plurality of radial cut-off plates 40 which are annularly arranged immediately back of the rotary member 32, and which correspond in number, size, shape and spacing to the openings 36. The plates 40 are formed integral with the forward ends of a like number of radially and axially extending ribbed supporting brackets 40^a. An axially extending conical sleeve 40^b is integral with the plates 40 and brackets 40^a, and encloses the hub 38, and at its rear or inner end embraces the bearing 34. The inlet ring 28 and the damper member 31 are connected by a plurality of bolts 41 respectively engaging lugs 41^a on the arms 35 and plates 40. Suitable inter-fitting connections 41^b between the contacting radial edges of the arms 35 and the brackets 40^a are provided to locate the damper member 31 in correct position for assembly. Thus, the forward edges of the arms 35 may be V-shaped, and the mating edges of the brackets 40^a may be grooved to effect an angular location of the parts. Also, tongues or lugs on the rear edges of the brackets 40^a may engage in notches in the forward edges of the arms 35 to effect coaxial location. It will be seen that the damper member 32 is rotatable to move the air inlet openings 36 into various degrees, from zero to maximum, of registration with the cut-off plates 40 and the spaces therebetween, and thereby to adjust the volume of air entering the blower. Thus, the damper member 32 is rotatably adjustable to vary the effective air inlet to the blower.

The adjustment is effected, automatically in accordance with changes in the static pressure of the air in the duct 18. In the present instance, this is accomplished through the medium of an adjusting member 42 which is operatively connected to the damper member 32, and which is movable in one direction in response to the static pressure against the opposition of a counterweight adapted to exert a force increasing progressively in accordance with the opening movements of the damper member. Thus, when the opposing forces exerted by the static pressure and the counterweight are in balance, the damper member will be at rest in a position of adjustment corresponding to the degree of static pressure then prevailing.

The adjusting member 42 is herein shown in the form of an annular reservoir adapted to contain a liquid or displacement fluid 43 and operatively connected for synchronous movement to the damper member 32. Preferably, the reservoir is directly attached to the rim of the damper member 32, and encircles and conforms closely to the stationary member 31. A partition wall 44 is provided in the top of the reservoir 42, thereby separating the interior of the reservoir into two legs constituting chambers 45 and 46 intercommunicating below the liquid level. A fitting 47 opens to the top of the chamber 45 and is adapted for the connection of a flexible conduit 48 leading to the air duct 18. The upper end of the other chamber 46 is in direct communication with the atmosphere at all times through an opening 49. The conduit 48 is connected to a pipe 50 which extends transversely into the air duct 18 and which is formed therein in one side with air inlet openings 51 disposed at right angles to the air flow.

In effect, the sleeve 40^b, being secured in fixed relation to the hub 34, constitutes a part of the hub 34, and defines a recess or well into which the shaft 33 extends and in which the sleeve 38 is supported on the shaft.

Operatively connected to the reservoir for synchronous movement therewith is a swinging counterweight 52 adapted to occupy a vertical position when the damper 30 is closed and to occupy positions of gradually increasing horizontal moment arm as the damper is moved toward open position. In the present instance, the counterweight is supported by and adjustable along a depending bar or rod 53 bolted at its upper end to the damper member 32 directly beneath the shaft 33. It will be understood that the effective action of the counterweight may be varied by adjusting the location of the counterweight 52 on the rod 53.

When the stoker is idle, the same pressure prevails in both chambers 45 and 46 and hence the damper 30 is closed, with the counterweight 52 disposed in vertical position as indicated in Fig. 2. The closed position is defined by forwardly extending generally radial ribs 54 on the plates 40 adapted to constitute abutments for the arms 37.

In operation, the static pressure in the duct 18 is transmitted through the conduit 48 to the chamber 45. Since the static pressure exceeds the atmospheric pressure more or less, it will depress the liquid in the chamber 45 and will cause a corresponding rise of the liquid in the chamber 46. This will throw the liquid in the reservoir 42 out of balance and cause the latter to rotate in a direction to open the damper 30. In this adjustment, the counterweight 52 is swung out of vertical position and tends to oppose the

adjustment. It will be seen that the opposing force exerted by the counterweight 52 increases in accordance with the extent of opening of the damper 30 due to the increasing moment arm of the weight 52 relative to the axis of rotation 34. When the force exerted by the counterweight 52 equals the off-balance force of the liquid 43 in the reservoir 42, the damper 30 will come to rest in a position of adjustment corresponding to the degree of static pressure prevailing in the air conduit 18.

When the fuel bed is light and porous, the static pressure in the duct 18 will be low. As a result, the reservoir 42 will be rotated only slightly out of initial position to restrict the flow of air through the damper 30. This will cut down the supply of air to the fuel bed, thereby giving the bed a chance to build up to a proper depth, and preventing an undue volume of excess air from passing through the bed, accelerating combustion, and diluting the products of combustion. As the fuel bed increases in depth and the holes fill up, the static pressure increases, thereby increasing the angular adjustment of the reservoir 42 and damper 30 against the correspondingly increasing opposing force exerted by the counterweight 52. Thus, the adjustment is substantially in accordance with the conditions of the fuel bed and takes into account the kind of fuel burned, the rate of feed and the rate of combustion in so far as these factors affect the condition of the fuel bed. The aggregate area of the openings 36 and also of the openings between the plates 40, preferably is at least as great, if not greater, than the area circumscribed by the flange 28 so that there will be no restriction in the flow of air to the blower 17 by the damper 30 when the latter is wide open.

The automatic damper herein disclosed insures efficient combustion at all times. It obviates the necessity and inconvenience of constant manual supervision and adjustment, and avoids the ill effects which normally result from lack of proper attention.

I claim as my invention:

1. A damper comprising, in combination with an air-flow passage, a fixed damper member defining a plurality of sector-shaped annularly spaced openings in a plane and separated by closed areas, a shaft supported axially of said member, a movable damper member mounted over said fixed damper member and having a central hub rotatably supported on said shaft, said movable damper member having an outer peripheral rim connected to said hub by generally radial arms defining openings movable into various degrees of registration with said first mentioned openings to control the volume of air flowing through said passage, an annular reservoir secured to said rim concentrically about said shaft and defining two liquid chambers respectively at opposite sides of said shaft and in intercommunication below the liquid level, one chamber being closed to the atmosphere and communicating above the liquid level with said passage at the discharge side of said damper, the other chamber communicating above the liquid level with a fixed pressure, and a counterweight connected to said reservoir for movement therewith and oscillatory away from a depending vertical position as said arms move to uncover said openings.

2. An automatic damper comprising, in combination with a rotary blower having a peripheral discharge air passage and an air inlet opening in

one side, a damper for controlling said opening and having a fixed damper member and a co-acting movable damper member, said members having air inlet openings movable respectively into different degrees of registration to define the effective air inlet area, a rotatable liquid reservoir having two counterbalancing liquid chambers at opposite sides and in intercommunication below the liquid level, one chamber being closed above the liquid level to the atmosphere and communicating with said passage, the other of said chambers being open to a source of fixed pressure, said reservoir being rotatable out of an initial position in which the damper is substantially closed in response and proportionately to the static pressure in said passage, a weight suspended from said reservoir and movable therewith out of said initial position to resist rotation of said reservoir with increasing force in response to increasing static pressure, and means whereby said movable damper member is adjusted out of closed position in synchronism with the rotation of said reservoir out of said initial position.

3. An automatic damper comprising, in combination with a rotary blower having a discharge air passage and an air inlet, a damper for controlling said inlet and having a fixed damper member and a coacting rotatable damper member, said members having air inlet openings movable respectively into different degrees of registration to define the effective air inlet area, a rotatable liquid reservoir having two counterbalancing liquid chambers at opposite sides and in intercommunication below the liquid level, one chamber being closed to the atmosphere and communicating above the liquid level with said passage, the other of said chambers being open to the atmosphere, said reservoir being mounted coaxially on said rotary damper member about said damper, and a weight supported by said reservoir and movable therewith to resist rotation of said reservoir with increasing force in response to increasing pressure in said passage.

4. A damper comprising, in combination with a blower having a peripheral discharge duct and an air inlet in one side, a relatively fixed damper member across said inlet, a relatively movable damper member adjustably cooperating with said fixed damper member to control the effective area of said inlet, a rotatable reservoir connected for synchronous movement with said movable damper member and having two liquid chambers disposed at opposite sides of the axis of rotation and in intercommunication below the liquid level, one of said chambers being open to the atmosphere, the other of said chambers being closed to the atmosphere and in intercommunication above the liquid level with said duct, and a counterweight mounted for oscillation out of vertical position in synchronism with said movable damper member and said reservoir, whereby the liquid in said chambers tends to become unbalanced in response to the static pressure in said duct and tends to rotate said reservoir proportionately against the action of said counterweight.

5. A damper comprising, in combination with a blower having a discharge duct and an air inlet, a relatively fixed damper member for said inlet, a relatively movable damper member adjustably cooperating with said fixed damper member to control the effective area of said inlet, a rotatable reservoir outside of said damper members connected for synchronous movement with said movable damper member and having two liquid chambers disposed at opposite sides of the axis

of rotation and in intercommunication below the liquid level, one of said chambers being open to a fixed pressure source, the other of said chambers being closed to the atmosphere and in intercommunication above the liquid level with said duct, and a counterweight mounted for oscillation out of vertical position in synchronism with said movable damper member and said reservoir, whereby the liquid in said chambers tends to become unbalanced in response to the static pressure in said duct and tends to rotate said reservoir proportionately against the action of said counterweight.

6. A damper comprising, in combination with a blower having a discharge duct and an air inlet, a relatively fixed damper member for said inlet, a relatively movable damper member adjustably cooperating with said fixed damper member to control the effective area of said inlet, a rotatable reservoir outside of said damper members connected for synchronous movement with said movable damper member and having two liquid chambers disposed at opposite sides of the axis of rotation and in intercommunication below the liquid level, one of said chambers being open to a fixed pressure source, the other of said chambers being closed to the atmosphere and in intercommunication above the liquid level with said duct, and a counterweight mounted for oscillation out of vertical position in synchronism with said movable damper member and said reservoir and being adjustable in mass and moment arm, whereby the liquid in said chambers tends to become unbalanced in response to the static pressure in said duct and tends to rotate said reservoir proportionately against the action of said counterweight.

7. A damper comprising, in combination, a fixed damper member having a central hub, a plurality of uniformly peripherally spaced plane radial web brackets extending axially, and a plurality of flat sector-shaped like damper plates rigid with the ends of said brackets in a plane and defining intermediate air openings, a shaft supported in said central hub, a movable damper member positioned across said plates and having a central hub mounted for rotation on said shaft, said movable damper member having a rim connected to said last mentioned hub by radial arms corresponding in number, shape, size and spacing to said openings and defining intermediate openings movable into various degrees of registration with said first mentioned openings, an annular reservoir closely encircling said brackets between said rims and rigidly secured to said last mentioned rim, said reservoir having a partition wall in the top to define therein two liquid chambers respectively at opposite sides of said shaft and in intercommunication at the bottom below the liquid level, one of said chambers being closed to the atmosphere and being adapted to be connected above the liquid

level to a damper controlling pressure, the others of said chambers being open to the atmosphere, and a counterweight suspended from below said shaft for movement with said movable damper member and tending to resist with gradual increasing force the turning effort of increasing differences in the respective levels of the liquid in said chambers.

8. A damper comprising, in combination, a flange member having an outer peripheral mounting rim, a central hub having a recess in one end thereof, and a plurality of annularly spaced radial arms connecting said rim and said hub, a fixed damper member having a plurality of annularly arranged spaced radial brackets secured to said hub and said arms, and a plurality of flat damper plates rigid with the ends of said brackets in a plane parallel to said rim and defining intermediate air openings, a shaft supported in said central hub and extending into said recess, and a movable damper member positioned across said plates and having a central hub mounted for rotation on the portion of said shaft in said recess and having openings movable into various degrees of registration with said first mentioned openings.

9. A damper comprising, in combination, a fixed damper member having a mounting, a plurality of annularly spaced generally radial web brackets extending axially of said mounting, and a plurality of flat damper plates rigid with the ends of said brackets in a common plane and defining intermediate air openings, and a movable damper member rotatably positioned across said plates and having openings movable into various degrees of registration with said first mentioned openings, an annular reservoir closely encircling said brackets and secured coaxially to said movable damper member and having two liquid chambers respectively at opposite sides of its axis of rotation and in intercommunication below the liquid level, one of said chambers being closed to the atmosphere and being adapted to be connected above the liquid level to a damper controlling pressure, the others of said chambers being open to a source of fixed pressure, and a counterweight suspended from below said axis for movement with said movable damper member and tending to resist with gradual increasing force increasing differences in the respective levels of the liquid in said chambers.

10. An automatic damper for controlling the volume of air under pressure flowing through a passage, coacting relatively adjustable damper members, and means including a rotary actuator provided with an annular chamber extending about said damper members and containing a displacement fluid subjected to the pressure of the air in said passage for adjusting said damper members automatically in accordance with variations of the air pressure in said passage.

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