May 4, 1965 A. JOHNSTONE 3,181,602

HEAT EXCHANGERS

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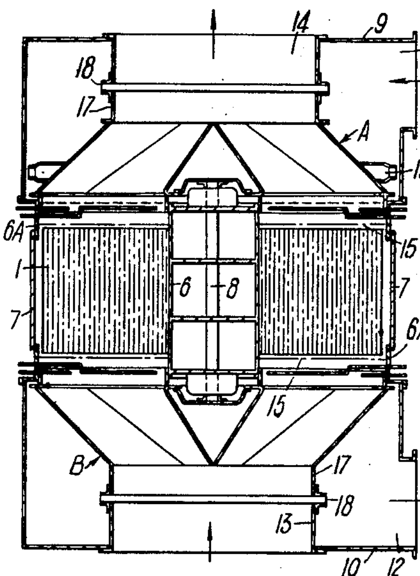

Fig.1.

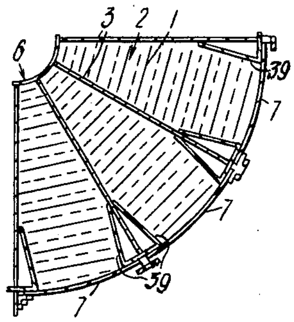

Fig.5.

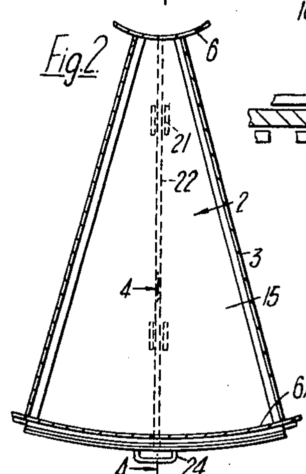

Fig.2.

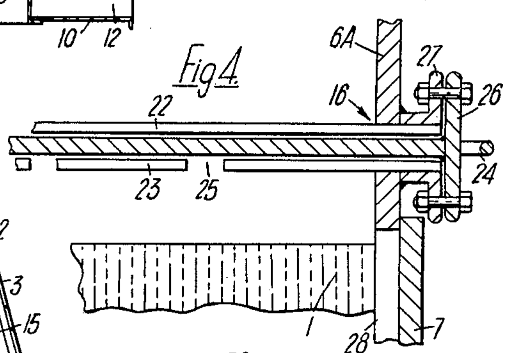

Fig.4.

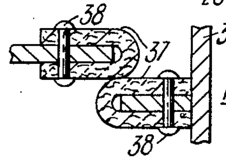

Fig.11.

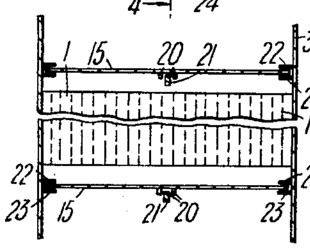

Fig.3.

Fig.12.

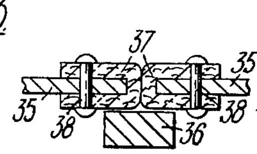

Fig.13.

Inventor
Archibald Johnstone

By
Watson, Cole, Grindle & Watson
Attorneys

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Fig. 8.

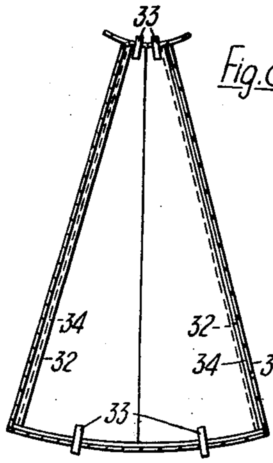


Fig. 6.

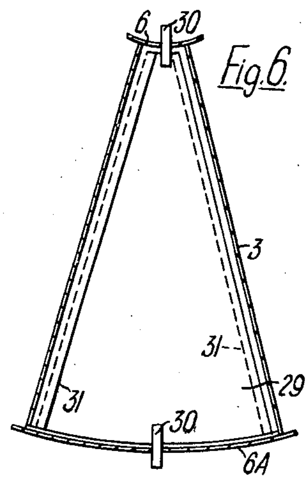


Fig. 9.

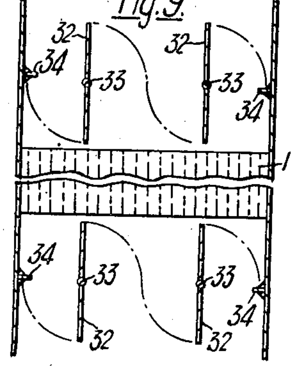


Fig. 7.

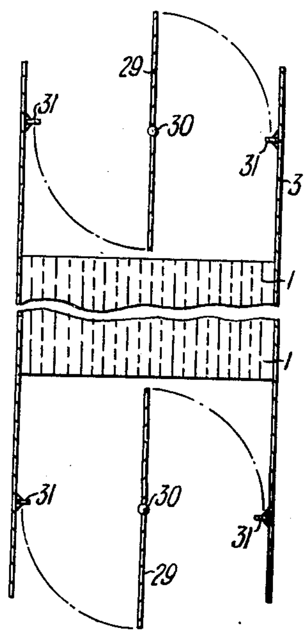
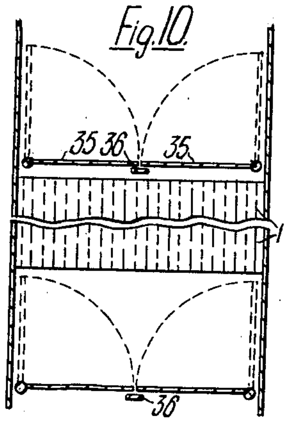


Fig. 10.



Inventor
Archibald Johnstone

By Watson, Cole, Grindle & Watson
Attorneys

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HEAT EXCHANGERS

Archibald Johnstone, Garforth, England, assignor, by mesne assignments, to Davidson & Company Limited, Belfast, Northern Ireland

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4 Claims. (Cl. 165—4)

This invention relates to heat exchangers of the type in which relative rotation is provided between a segmental assembly of regenerative material and ducts at each end of the assembly for the respective passage in opposite directions through the segments of hot gas by which the segments are heated and gas that is in turn heated by the segments, some of the segments at any time receiving heat and others imparting heat. A notable use of heat exchangers of this type is in the heating of combustion air by the waste gases of boiler furnaces. In performing such a duty as this, the regenerative material must take a form that presents a large area for contact by the two gases in turn, and must have good thermal conductivity, to ensure a high rate of heat transfer and yet must not introduce undue pressure-drop between the two ends of the assembly. To satisfy these conditions, it is usual to form a mass of metal plates, shaped to form between each other lengthwise channels. The conditions to which the plates are subjected by the waste gases of boiler or like furnaces result in time in corrosion of the plates. Renewal of the masses of plates in the segments from time to time can seriously interfere with the operation of an exchanger, particularly if access to the segments is only available in the axial direction of the exchanger, even in the case where the regenerative assembly is stationary and the ducts rotate with respect to it.

According to the present invention, a heat exchanger in which the ducts rotate with respect to a stationary segmental assembly of regenerative material has at the circumferential end of each segment an access opening fitted with a door, and movable blanking plates beyond both ends of the space within the segment occupied by the regenerative material to isolate that space from the ducts that are normally put into communication with the space during the operation of the heat exchanger.

With the blanking plates of a segment moved into space-isolating position, the door of that segment may be opened for removal and replacement of the regenerative material while the heat exchanger continues in operation, at only slight expense of efficiency in an exchanger having a large number of segments, say 24, because the opened segment is cut off by the plates from the ducts that continue to move across the ends of the segment. The whole of the regenerative material of the exchanger may thus be replaced by single-segment stages with negligible interference with the working of the exchanger; or, if the opportunity arises to shut down the exchanger, several segments may be opened simultaneously to minimize the shut-down period.

When moved into isolating position, the plates should make a reasonable good gas-tight seal, to minimize loss of gas from the system or drawing of air into the system.

One form of blanking plate is a slide, of the same shape as the cross-section of a segment, introduced through a slot beyond the door opening. Each plate may be guided between runners along the division walls between segments, with the lower runners interrupted to allow the slide to push out any dust and dirt lodging between the runners. The slot may be sealed by a plate carried by the slide, and by a separate plate for application when the slid has been pulled clear of the exchanger casing for return of the segment to operation. Such slides may be located close to the ends of the mass of regenerative material.

Another form of blanking plate consists of a damper hinged along a central radius of the segment and bearing at its edges against stop strips along the divisional walls when it is in isolating position. Again, two such hinged dampers may be mounted side-by-side, to bear on similar stops and on each other. Yet again, two such dampers may be hinged along the division walls, to bear either one on the other support or on a support bar when in isolating position. The bearing edges of the dampers and of the stops may be provided with asbestos strips to improve the sealing, e.g., strips folded round the edges and riveted in position.

The invention will now be further described with reference to the accompanying drawings in which

FIGURE 1 is a diagrammatic vertical section through a heat exchanger with stationary regenerative mass and rotary sets of ducts;

FIGURE 2 is a diagrammatic plan view to a larger scale of a sliding blanking plate for use in the exchanger of FIGURE 1;

FIGURE 3 is a diagrammatic section showing two plates as in FIGURE 2;

FIGURE 4 is a fragmentary section taken on the line 4—4 of FIGURE 2;

FIGURE 5 is a plan view of a number of segments;

FIGURE 6 corresponds to FIGURE 2, but shows a hinged blanking plate;

FIGURE 7 corresponds to FIGURE 2, but shows two plates as in FIGURE 6;

FIGURE 8 corresponds to FIGURE 6, but shows a pair of hinged blanking plates;

FIGURE 9 corresponds to FIGURE 7, but shows two pairs of plates as in FIGURE 8;

FIGURE 10 shows an alternative to FIGURE 9;

FIGURE 11 is an enlarged sectional detail of blanking plate edges and stop strips as in FIGURES 7 and 9; and

FIGURES 12 and 13 respectively show the bearing edges of the dampers of FIGURES 9 and 10.

As shown by FIGURES 1 and 5, the regenerative material **1** of the heat exchanger is contained in segmental compartments **2** formed between radial division plates **3**, arcuate sections of a hub casing **6** and an outer casing **6A** constituted mainly by doors **7** concentric with a central vertical shaft **8**. The doors **7** are secured between stationary upper and lower casings **9**, **10** having respectively a lateral inlet **11** for cold air and a lateral outlet **12** for heated air and co-axial inlet and outlets **13**, **14** for outgoing and incoming waste gas. Sliding blanking plates **15**, as in FIGURE 2 are inserted through slots **16** in the outer casing **6A** (FIGURE 4) above and below the door opening. The casings **9**, **10** contain similar but mutually inverted double rotatable duct units A, B each of which is connected to the appropriate outlet **14**, or inlet **13** by a short circular section **17** and a seal **18**. The duct unit A is driven by a gear (not shown) meshing with a gear ring **19** and in turn drives unit B through the shaft **8**.

The metal plates **1** are formed into several packs, which together fill a segment **2**, inserted through and enclosed by the doors **7**. They can be removed and replaced whilst the exchanger is in operation by the use of blanking plates above and below a door of a segment so as to cut off the air or gas flow from that segment. In FIGURES 2 and 3 a blanking plate **15** in the form of a slide corresponding in shape to a segment **2** to give a close fit, is provided with pairs of guides **20** welded to its underside to fit round a support rail **21** welded at its ends to the hub casing **6** and the outer casing **6A**. The plate also slides along upper and lower runners **22**, **23** welded along the division walls 3 of the segments. This sliding construction enables the blanking plates to be located only a short distance above and below the regenerative material **1**.

The lower runners **23** are provided with slots **25** to allow dust and dirt which has accumulated during operation to fall clear so as not to impede sliding of the blanking plates. To the end of each blanking plate **15** is welded a plate **26**, carrying a handle **24**, to be bolted on to brackets **27** welded to the outer casing **6A** to effect sealing of the slot **16** through which the blanking plate is inserted. When the blanking plates are not in use separate plates are bolted to the brackets **27** to seal the slot **16**.

FIGURES 6 and 7 show a second form of blanking plate comprising a damper **29** of segmental shape adapted to rotate on spindles **30** fixed on the hub casing **6** and outer casing **6A**, from a fully open position (as shown) allowing almost completely unrestricted gas flow, to a fully closed position, its rotation being arrested by stop strips **31** welded to each side of the division plates **3**.

Similarly two narrower segmental dampers **32** may be mounted side by side to rotate on spindles **33** as shown in FIGURES 8 and 9 and to bear on stop strips **34** on the division plates and on each other (FIGURES 11 and 12) when in closed position.

Again two such dampers **35** (FIGURE 10) may be hinged along the division plates **3** to lie along the plates when in open position and to bear on a support bar **36** when in closed position (FIGURE 13).

The bearing edges of the dampers **29**, **32**, **35** and the stops **31**, **34** are provided with asbestos strips **37** (FIGURES 11, 12, and 13) to afford adequate sealing, the strips being secured by rivets **38**.

The width of the door opening (seen at **28** in FIGURE 4) is preferably almost the full width of each segment at the outer casing **6A** to allow the regenerative material to be inserted as large packs. Thus, with the sides of the door opening stayed from the division walls by parallel stays **39** (FIGURE 5), the outermost pack can be parallel-sided to fit the full width between the stays, and the inner packs can be of diminishing width, with tapering sides, to fit between the converging walls to the innermost part of the segment. If necessary, to keep individual packs to a weight permitting of ready handling, one pack may be super-imposed on another to build up the axial dimension of the mass.

The door **7** (FIGURE 4) for each segment may be hinged alongside the door opening, with hinged and sliding wedging plates at the free side to be driven into wedging sockets projecting at the side of the door opening, and with hinge pins that also can be driven at the hinge sides of the doors, to bring the inner faces of the doors into tight sealing position all round the door openings, with asbestos gaskets to complete the seals. Alternatively, lift-out doors may be used, with locking bars to be screwed up or driven to effect sealing.

What I claim is:

1. A regenerative heat exchanger comprising a stationary cylindrical casing divided into segments, regenerative material in the said segments, a plurality of ducts at each end of the casing and rotatable with respect to the segments, an access opening to each segment in the periphery of the casing, a door to each said opening, and movable blanking-off plates for closing the ends of a selected segment, each said plate including means extending to and operable from the exterior of said casing for shifting its position to isolate that segment from the rotatable ducts before the door to that segment is moved to provide access to the segment.

2. A regenerative heat exchanger comprising a stationary casing divided into segments, regenerative material in the said segments, a plurality of ducts at each end of the casing and rotatable with respect to the segments, an access opening to each segment in the periphery of the casing, a door to each said opening, slots in the periphery of the casing at both ends of each segment and outside of the area of said access openings, and slidable blanking-off plates insertable through the slots of a selected segment, each said plate including means extending to and operable from the exterior of said casing for shifting its position to isolate that segment from the rotatable ducts before the door to that segment is moved to provide access to the segment.

3. A heat-exchanger as in claim 2, comprising guiding and sealing runners within each segment for engagement by the slidable blanking-off plates.

4. A regenerative heat exchanger comprising a stationary casing divided into segments, regenerative material in the said segments, a plurality of ducts at each end of the casing and rotatable with respect to the segments, an access opening to each segment in the periphery of the casing, a door to each said opening, slots in the periphery of the casing at both ends of each segment and outside of the area of said access openings, removable plates sealing the said slots, and slidable blanking-off plates insertable through the slots of a selected segment, after removal of the said slot sealing plates, to isolate that segment from the rotatable ducts before the door to that segment is moved to provide access to the segment, each blanking-off plate having attached thereto a plate for sealing a slot through which the blanking-off plate is inserted.

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CHARLES SUKALO, *Primary Examiner.*