A heat exchanger with rotary heat accumulator, comprising a disc-shaped honeycomb heat accumulator element having a protective ring or rim mounted around the periphery thereof, a sprocket splittable into a plurality of sections and mounted around the periphery of said protective ring with a gasket and a plurality of keys interposed therebetween, and non-expansion steel rings fitted over the rim or flange of said sprocket from both sides thereof in shrinkage fit engagement therewith to securely hold said gasket and said keys on said sprocket, said non-expansion steel rings and said keys being secured to each other by means of pins.

3 Claims, 4 Drawing Figures
BACKGROUND OF THE INVENTION

1. Field of the Invention
The present invention relates to a heat exchanger with rotary heat accumulator, which is adapted for use mainly in gas turbine engines to be mounted on vehicles, and more particularly to improvements in the rotary accumulator thereof.

2. Description of the Prior Art
Conventional rotary heat accumulators of this type of heat exchanges comprise a disc-shaped ceramic heat accumulator element having a plurality of honeycomb holes perforated therein for the passage of the combustion gas of a gas turbine engine and air therethrough, a driving ring such as a sprocket fitted around the periphery of said honeycomb heat accumulator element and driven from a prime mover through a chain or the like to drive said heat accumulator element, and a plurality of leaf springs interposed between the outer periphery of said honeycomb heat accumulator element and the inner periphery of said driving ring to eliminate the influence of thermal expansion of the heat accumulator element, particularly of the driving ring, and thereby to ensure that the drive from said prime mover be transmitted circumferentially uniformly to said honeycomb heat accumulator element.

However, the prior art rotary heat accumulators of heat exchangers described above have the shortcomings that the rotary heat accumulator as a whole becomes extremely large in size relative to the area of the honeycomb heat accumulator element effective for heat exchanging, due to a plurality of leaf springs interposed between said honeycomb heat accumulator element and the driving ring. They have additional disadvantages that, since the honeycomb heat accumulator element is supported at points on the outer peripheral surface by a plurality of said leaf springs and the rotational force is transmitted thereto at said points, the outer peripheral surface of the honeycomb heat accumulator element undergoes a large pressure and the strength of the heat accumulator element becomes a problem where the element is made of a fragile material such as ceramics; and that, since the rotational force is transmitted to the heat accumulator element through a plurality of said leaf springs, the transmission of the rotational force is extremely unstable.

SUMMARY OF THE INVENTION
In order to obviate the above-described disadvantages of the conventional heat exchangers, the present invention has for its object the provision of a heat exchanger with rotary heat accumulator, in which a sprocket splittable into a plurality of sections is mounted around the periphery of a disc-shaped honeycomb heat accumulator element and non-expansion steel rings are fitted over the rim or flange of said sprocket to shrinkage fit engagement therewith, whereby the size of the entire rotary heat accumulator can be made small relative to the area of the honeycomb heat accumulator element effective for heat exchanging and the destruction of the heat accumulator element otherwise caused by vibration, shock, etc. applied thereto can be prevented by a slight tightening compressive force which is constantly applied to the outer periphery of said honeycomb heat accumulator element and is almost unchangeable even when the heat exchanger is used under a temperature condition of 100°C. or higher, and further a driving force from a prime mover can be transmitted directly positively to said honeycomb heat exchanger element.

The present invention will be described in detail by way of example with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS:
FIG. 1 is a front elevational view, partially cut away, of an embodiment of the heat exchanger with rotary heat accumulator according to the present invention;
FIG. 2 is a side elevational view of the heat exchanger shown in FIG. 1;
FIG. 3 is an enlarged view of a portion A of FIG. 1; and
FIG. 4 is a fragmentary enlarged plan view illustrating the manner in which the heat exchanger of the invention is used.

DESCRIPTION OF THE PREFERRED EMBODIMENT
In the drawings, reference numeral 1 designates a disc-shaped honeycomb heat accumulator element made of a ceramic material of small coefficient of thermal expansion and having a plurality of apertures perforated therein for the passage of the combustion gas of a gas turbine engine and air therethrough and further having a mounting hole 2 formed centrally thereof. A protective ring or rim 3 made of a ceramic material is fitted around the outer periphery of the honeycomb heat accumulator element 1 to protect said heat accumulator element. The protective ring or rim 3 has a plurality of keyways 4 formed in the outer periphery thereof. Further, a bushing 5 made of a ceramic material is fitted in the mounting hole 2 of the honeycomb heat accumulator element 1 to protect said hole.

A plurality of keys 6, each having a pin hole 8 bored therethrough, are received in the respective keyways 4 in a wedge-like fashion. A chain-driven sprocket 9 splittable into a plurality of sections is mounted on the outer periphery of the protective ring 3, with the keys 6 and the gasket 7 interposed therebetween, and said sprocket 9 has pin holes 10 formed therein at locations corresponding to the pin holes 8 in the keys 6.

Rings 11a, 11b made of non-expansion metallic alloy are fitted over the rim or flange of the sprocket 9 from both sides thereof to securely hold the sprocket 9, the keys 6 and the gasket 7 on the protective ring 3 fitted on the honeycomb heat accumulating element 1 and to constantly impart a slight tightening compressive force thereto. The rings 11a, 11b are provided with pin holes 12 at locations corresponding to the pin holes 10 of the sprocket 9 respectively when the sprocket 9 expands during operation.

Pins 13 are inserted into the pin holes 12 of the rings 11a, 11b, the pin holes 10 of the sprocket 9 and the pin holes 8 of the keys 6 to hold said respective elements against relative movement to each other and secure the same. Reference numeral 14 designates a rotary shaft extending through the bushing 5 and said bushing 5 is mounted rotatable on said rotary shaft 14 integrally.
with the honeycomb heat accumulator element 1 and the protective ring 3 so as to rotate with said shaft. Reference numeral 15 designates a conduit for air and 16 designates a conduit for the combustion gas of the gas turbine engine. The conduits 15, 16 are arranged such that the honeycomb heat accumulator element 1 rotates across the interior thereof. A rotary shaft 17 which is driven from a prime mover, such as a gas turbine engine or an electric motor, through a reduction gearing as required, has a sprocket 18 mounted at one end thereof and a chain 19 is engaged around the sprocket 9 and the sprocket 18 to transmit the drive of said prime mover to the honeycomb heat accumulator element 1. The reduction ratio of the sprockets 9 and 18 is so selected that the honeycomb heat accumulator element 1 is driven, for instance, at the rate of 20 r.p.m.

The heat exchanger of the invention constructed as described above operates in the following manner: namely, when the prime mover is set in motion, the drive thereof is transmitted to the sprocket 9 through the rotary shaft 17, the sprocket 18 and the chain 19. The drive is further transmitted from the sprocket 19 to the keys 6 through the pins 13, and thence to the protective ring 3, the honeycomb heat accumulator element 1 and the bush 5 through the gasket 7 to drive the same around the rotary shaft 14 at the rate, for example, of 20 r.p.m. The rotating honeycomb heat accumulator element 1 is heated by the combustion gas passing through the conduit 16 and releases the heat, accumulated therein, to the air passing through the air conduit 15, thus transmitting the heat of the combustion gas to the air.

The rings 11a, 11b are made of a non-expansion metallic alloy having a low coefficient of thermal expansion and the value of said coefficient of thermal expansion of the metallic material is substantially constant and small in the temperature range from normal temperature to 300°C. Therefore, even when the temperature of the combustion gas, passing in the gas conduit 16, is as high as 200°C or even higher and the rings 11a, 11b are heated to 200°C or higher temperature by the radiant heat from the combustion gas, the heat of the honeycomb heat accumulator element 1 and/or the ambient temperature, they are not subjected to thermal expansion and hold the sprocket 9, the keys 6 and the gasket 7 securely on the outer periphery of the protective ring 3 and the honeycomb heat accumulator element 1, while constantly imparting a slight tightening force thereto. In addition, the honeycomb heat accumulator element 1 is made of a ceramic material whose coefficient of thermal expansion is smaller than that of the metallic material of which the rings 11a, 11b are made. Therefore, in no case will the honeycomb heat accumulator element 1 be destroyed by high temperature, vibration or shock.

In the embodiment described above, the protective ring 3 and the sprocket 9 are connected by the keys 6, the pins 13 and the gasket 7 so as to prevent a relative movement thereof and destruction of the same caused by vibration, shock, etc. However, it will be understood that the pins 13 may be eliminated by wedging the keys 6 into both the protective ring 3 and the sprocket 9, instead of wedging the same only into protective ring 3 as shown. It is also possible to provide the sprocket 9 directly on the periphery of the protective ring 3 and to fit the rings 11a, 11b over the outer peripheral surface of said sprocket 9 by shrinkage, without using the keys 6, the pins 13 and the gasket 7. In this case, a slip-free, positive engagement between the protective ring 3 and the sprocket 9 and between the sprocket 9 and the rings 11a, 11b can be obtained only by the friction between the contacting surfaces thereof and thereby a relative movement and destruction of said elements caused by vibration and/or shock can be prevented. It is also possible to fit the rings 11a, 11b directly over the outer peripheral surface of the honeycomb heat accumulator element 1 by shrinkage, without using the protective ring 3, and in this case, a slip-free, positive engagement can also be obtained between the honeycomb heat accumulator element 1 and the rings 11a, 11b by the friction between the contacting surfaces thereof and the tightening force of said rings 11a, 11b, and a relative movement of said elements can be prevented within the range allowable from the strength point of view.

Further, although in the embodiment described above the honeycomb heat accumulator element 1 is made of a ceramic material, the material thereof is not restricted only to ceramics and other materials such as stainless steel, glass, etc. which are resistant to heat and have a low coefficient of thermal expansion may also be used for the honeycomb heat accumulator element within the scope of the invention, and furthermore the apertures formed in the honeycomb heat accumulator element may be of any shape including a polygonal shape, circular shape and wavy shape, provided that the apertures are capable of passing the so-called fluid, such as the combustion gas and air, therethrough.

Further, although the invar material only is mentioned as the material of the rings 11a, 11b, the material is not restricted only to the one metallic material but other non-expansion steels which are alloys of low coefficient of thermal expansion, may of course be used for the rings within the scope of the invention. Obviously, the heat exchanger of the present invention is applicable, not only to gas turbine engines but also internal combustion engines, boilers, etc.

As described herein, the heat exchanger according to the present invention comprises a disc-shaped honeycomb heat accumulator element, a sprocket splittable into a plurality of sections and provided around the periphery of said disc-shaped honeycomb heat accumulator element, and rings fitted over the rim of said sprocket from both sides in shrinkage fit engagement therewith. Therefore, there can be achieved such excellent advantages that the size of the entire rotary heat accumulator relative to the area of the honeycomb heat accumulator element effectively used for heat exchanging can be made small as compared with the conventional heat exchanger comprising leaf springs; that the shrinkage fit rings made of a non-expansion steel of low coefficient of thermal expansion constantly apply a slight tightening force to the periphery of the honeycomb heat accumulator element without substantially expanding and thereby prevent destruction of said heat accumulator element caused by vibration, shock, etc., even when the heat exchanger is used under a temperature condition of 200°C or higher; and that the driving force of the prime mover can be directly positively transmitted to the honeycomb heat accumulator element through the chain.
We claim:

1. A heat exchanger comprising:
   a rotary heat accumulator consisting of a disc-shaped honeycomb heat accumulator element formed from a material having substantially no thermal expansion at temperatures up to 200°C,
   a plurality of ring-like sprocket sections mounted around the periphery of said heat accumulator element to form a sprocket having flanges,
   a driving means engaged around said sprocket for driving said rotary heat accumulator,
   at least two support rings fitted over the sprocket flanges on opposite sides of said sprocket in shinkage fit engagement with said sprocket, said support rings being formed from a material having substantially no thermal expansion at temperatures up to 200°C,
   conduit means disposed at least one planar surface of said honeycomb heat accumulator element, for supplying fluids to be heat-exchanged to said elements.

2. The heat exchanger recited in claim 1 wherein a protective rim is fitted around the outer periphery of said honeycomb heat accumulator element, and a gasket is mounted upon said protective rim, said sprocket sections and said support rings being mounted about said gasket and rim.

3. A heat exchanger as in claim 2 further comprising:
   at least one keyway formed in the outer periphery of said protective rim,
   a key having a pin hole inserted in said keyway through said gasket,
   a pin hole formed through said protective rims and said sprocket at locations corresponding to the pin hole of said key, and
   a pin inserted into the pin hole of said support rings and sprocket and that of said key to hold the heat exchanger together.

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