

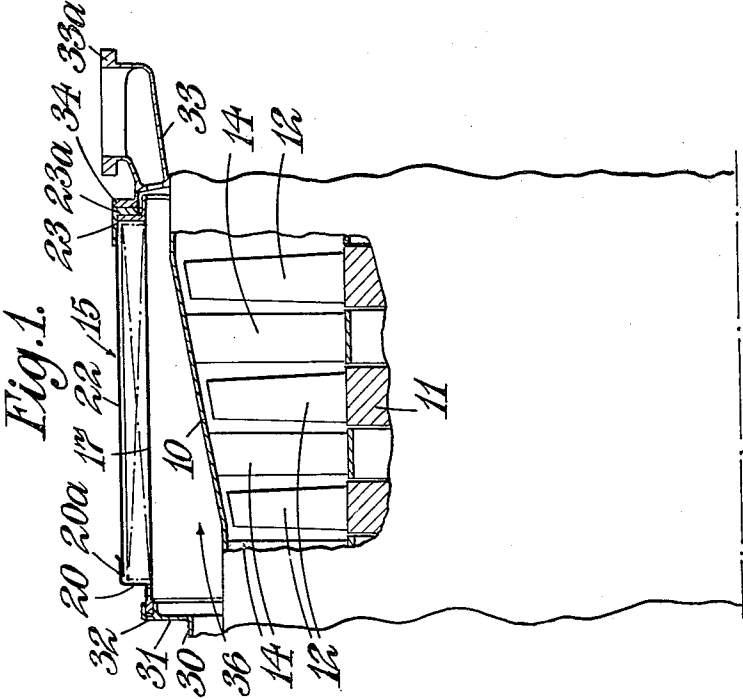
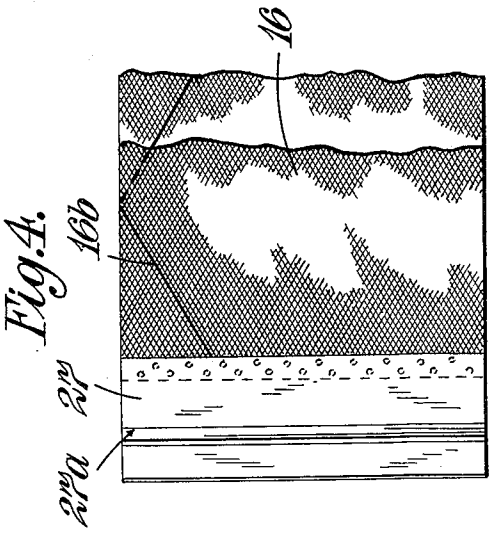
Sept. 12, 1961

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OR MACHINES HAVING ROTATING PARTS

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3 Sheets-Sheet 1



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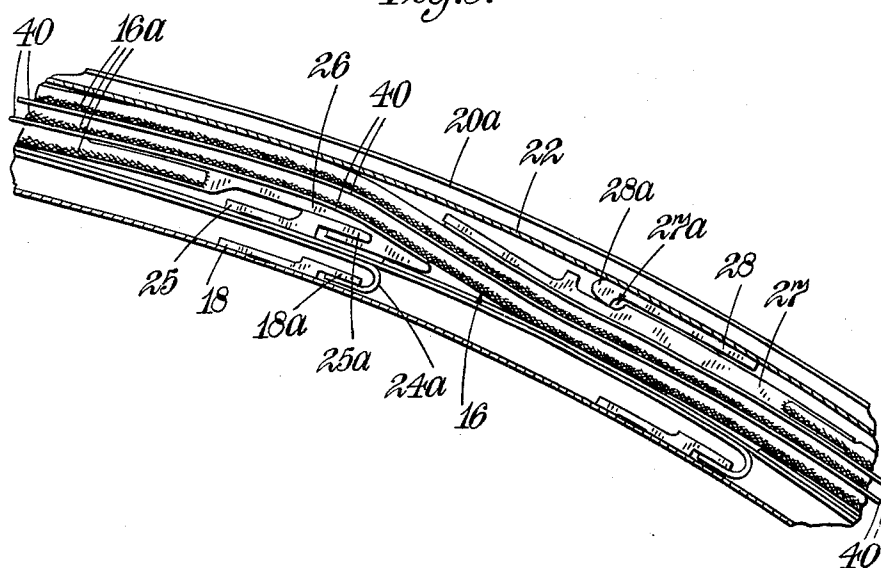
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Fig. 5.



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PROTECTIVE ARRANGEMENT FOR USE WITH APPARATUS OR MACHINES HAVING ROTATING PARTS

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This invention relates to protective arrangements for use with rotating parts.

The breaking-off of some fragment of a part which is rotating at high speed is in effect the release of a high-energy projectile, and serious consequences may result, as for example, in the case of the fracture of a turbine blade or part of a turbine disc from the rotor of an aircraft gas-turbine engine. It is an object of the present invention to reduce the risk of serious damage resulting from such breakage.

According to the present invention there is provided for use with a rotating part from breaking of which protection is desired, a protective arrangement comprising a web fabricated from closely woven or braided wire, strip or the like, said web being adapted to be supported by stationary structure to surround the rotating part so as to intercept fragments breaking off the rotating part. The protective arrangement may comprise more than one layer of such a web, the layers being conveniently formed from one continuous web wound into an open-centred coil.

According to a preferred form of this invention, a protective arrangement for use with an apparatus or machine having a rotating part from breaking of which protection is desired, for example for use with a gas turbine, comprises a web constituted by a flattened tube of closely interwoven wires which extend from end to end of the tube, the web being wound into an open-centred coil of a plurality of layers which in use surrounds the rotating part of the apparatus or machine in spaced relation thereto, and the web being adapted to be supported from stationary structure of the apparatus or machine.

According to a preferred feature of this invention, the protective arrangement may also comprise a sheet metal tubular liner inside the wound web to assist distribution of loads resulting from impact of a broken fragment.

In one arrangement employing this latter feature of the invention, the liner is spaced radially away from the web and carries on its external surface a series of circumferentially-extending overlapping plates, and the liner has secured to it a series of axially-extending bars having flanges which are spaced from the liner and provide each a hook location for one of the overlapping plates, the plates having each an intumed edge engaging the corresponding flange. One of the said plates may have secured to it means for locating one end of the web. For instance said means may comprise a flanged bar and the web may have at its end a hooked fitting co-operating with the flange of the bar. The web is preferably accommodated within a casing of which the liner may form an inner wall.

This invention also comprises the combination with a gas turbine or the like, of a protective arrangement as above set forth, the protective arrangement surrounding the turbine casing in spaced relation thereto. The protective arrangement may if desired form a wall of a cooling air jacket around the turbine.

A construction of gas-turbine incorporating a form of protective arrangement of this invention will now be described with reference to the accompanying drawings, in which:

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FIGURE 1 is a diagrammatic section through the turbine and protective arrangement;

FIGURE 2 is a corresponding view to a larger scale of the protective arrangement;

FIGURE 3 is a section on the line 3-3 of FIGURE 2 and shows the line of section 2-2 of FIGURE 2;

FIGURE 4 illustrates a detail of one end of the web, and

FIGURE 5 is a view similar to FIGURE 3 but shows the use of layers of sheet metal.

The gas turbine illustrated in FIGURE 1 comprises a main casing 10 enclosing a rotor. The rotor comprises three turbine discs 11 each carrying a ring of turbine blades 12. The turbine also comprises a ring of nozzle guide vanes 14 at the entry to each ring of turbine blades 12, the vanes 14 being mounted on the casing 10.

It will be appreciated that in event of breakage of a rotor blade 12 or of failure of a rotor disc 11 in operation of the turbine, considerable damage may be caused due to fragments of the blade or disc being thrown off at high speed and passing through the casing 10.

There is therefore provided a protective arrangement 15 surrounding the turbine in spaced relation to the casing 10 to intercept such fragments.

The protective arrangement illustrated in FIGURES 2 to 4 comprises primarily a long web 16 of interwoven wires which are continuous from one end of the web to the other, the web 16 surrounding the turbine in a coil of a number of layers 16a say three to six layers (three such layers are shown).

In the form illustrated, the wires are braided into a tube which is then flattened, the flattened tube having a width say 12 inches, sufficient to extend axially from one end to the other of the turbine and a length sufficient to provide the desired number of layers. Each layer thus comprises two thicknesses of interwoven wires. The course of a wire in the flattened tube is indicated at 16b each wire passing unbrokenly around the engine a number of times and also between the lengthwise edges of the web a large number of times. Thus the web 16 is capable of absorbing large amounts of energy by virtue of its capacity for deformation under strain. Also the reaction force involved in stopping a piece which breaks off the rotor is spread evenly over a large portion of the engine frame. The wire from which the web is made may be, for example, steel having an ultimate tensile stress of 130 tons per square inch, or drawn aluminum.

The web 16 may be supported by being enclosed in coil form in a casing. The casing comprises an inner tubular sheet metal liner 17 to the external surface of which are welded at circumferentially spaced positions a series of axially-extending bars 18 which have flanges 18a spaced radially from the liner 17. The liner 17 has welded to it at one of its axially-spaced edges a ring 19 with a thickened axially-projecting edge 19a, and a flanged end wall 20, and has welded to its opposite edge a ring 21 with a bolting flange 21a which provides the other end wall of the casing. The casing also comprises a detachable outer wall 22 one end of which slidably engages below a flange 20a on the end wall 20 and the opposite edge of which carries a ring 23 with a bolting flange 23a which bears against the bolting flange 21a. Removal of the outer wall 22 exposes the web 16.

The bars 18 provide hook locations for a series of overlapping, circumferentially-extending plates 24 each of which has at one edge an intumed flange 24a engaging below the flange 18a of one of the bars 18.

The main portions of the plates are thus held in radially-spaced relation to the liner 17.

The liner 17 and the plates 24 assist to prevent a sharply pointed broken portion penetrating between and

shearing through the wires of the web 16 at the point of impact, and to assist in spreading of the load.

The assembly may be further reinforced and distribution of the load resulting from impact of the broken piece further improved by intercalating sheets of metal between the layers of the web.

One of the plates 24 has welded to its outer surface an axially extending bar 25 having an edge flange 25a spaced away from the plate. This bar 25 serves to locate one end of the web 16 which is fitted, as by brazing and stapling, with a co-operating hook fitting 26 extending across the whole width of the web 16. The opposite end of the web 16 is located with a limited circumferential freedom by being provided with a fitting 27 with a channel 27a in its outer surface extending across the width of the web, and the channel is engaged by a rib 28a on a bar 28 welded to the outer wall 22 of the casing.

In the illustrated construction, the protective arrangement 15 is supported from stationary structure of the turbine to form part of an air jacket surrounding the casing 10 so as to offset in part the increase in weight of the engine due to the provision of the protective arrangement. The air jacket comprises a wall 30 spaced from the casing 10 and having at its downstream end a radial flange 31 which has a bead 32 at its outer edge. The thickened edge 19a of the ring 19 slidingly engages an axially-facing channel in the bead 32.

The air jacket also comprises an air outlet manifold structure 33 including an air outlet connection 33a which structure is spaced axially from the wall 30 by a distance approximately equal to the axial length of the protective arrangement and which is provided with a bolting flange 34 which abuts the bolting flange 23a. Retaining bolts 35 pass through the flanges 34, 23a and thread into the flange 21a. The protective arrangement 15 is thus held in spaced relation to the casing 10 and forms part of the wall of the cooling air passage 36 leading to the manifold structure 33. The spacing of the liner 17 and casing 10 is such that a piece breaking off the rotor 11, 12 shall have sufficient space to avoid its being punched through the protective arrangement 15 by the remainder of the turbine disc. The mounting of the protective arrangement 15 also allows for diametral expansion and contraction of the turbine casing 10.

In one example the liner 17 is 0.1 inch thick steel and the web 16 is made of braided .030 inch thick steel wire. The reinforcing plates 24 are .030 inch thick steel sheets, and similar sheets 40 may be intercalated between the layers of the web, as shown in FIGURE 5. The diametral dimensions of the protective arrangement 15 are such that a minimum radial gap of 1 inch is left between the arrangement 15 and the turbine casing.

I claim:

1. A protective device for use with apparatus having a rotating part and stationary structure, said device comprising a tubular liner member which in use of the device surrounds the rotating part, a plurality of layers of interwoven wire encircling said liner member, means supporting said layers of interwoven wire in radially spaced relation to said liner member, an outer tubular wall member surrounding said plurality of layers of interwoven wire, said outer tubular wall member being secured to said liner member, and means for securing the device to the stationary structure of the apparatus.

2. A protective device for use with apparatus having a rotating part and stationary structure, said device comprising a continuous web of interwoven wire wound into an open-centered coil having a plurality of layers, a tubular liner member internally of said coil, means supporting said coil in radially spaced relation to said liner member, an outer tubular wall member surrounding said coil, the outer tubular wall member being secured to the liner member, and means for securing the device to the stationary structure of the apparatus.

3. A protective device according to claim 2, wherein the continuous web is constituted by a flattened tube of closely interwoven wires which extend from end to end of the flattened tube.

4. A protective device according to claim 2, wherein the means for supporting the coil in radially spaced relation to the liner member comprises a series of circumferentially-extending overlapping plates disposed in annular assembly between the liner and the coil, the plates each having a portion in contact with the innermost layer of the coil, and each plate having circumferentially spaced edges and being attached at one of its circumferentially spaced edges to the liner member.

5. A protective arrangement according to claim 2, comprising also layers of sheet metal between the layers of the web.

6. A protective arrangement according to claim 2 wherein the web is formed from interwoven steel.

7. A protective arrangement according to claim 2, wherein the web is formed from interwoven drawn aluminum wires.

8. A protective device according to claim 4, wherein the tubular liner member has secured to it a series of axially-extending bars having flanges which are radially spaced from the tubular liner member, there being one such axially-extending bar for each of the overlapping plates, the plates having each an intumed flange at one edge engaging below the flange on the corresponding axially-extending bar.

9. A protective device according to claim 8, one of said overlapping plates having one end of the web attached to it.

10. A protective device according to claim 8, comprising a flanged bar secured to one of said plates on the side thereof remote from the tubular liner member and having a flange radially spaced from said one of said plates, said web having at one end a hook fitting interengaging with the flange of the bar to attach the web to said one of said plates.

11. A protective device according to claim 2, said tubular liner member and said outer tubular wall member forming an inner wall and an outer wall respectively of a casing for the web, and comprising wall-forming means secured to the tubular liner member at axially spaced positions to form a pair of end walls of the casing and also to form the means by which the device is secured to the stationary structure, the tubular outer wall member being detachably connected with the end walls to permit its removal to expose the web.

12. A protective device according to claim 11, said wall-forming means comprising an axial flange on one of said end walls, the outer tubular wall member slidingly engaging below said axial flange and having a radial flange abutting the other of said end walls, said other of the end walls being formed as a radial flange projecting radially from the tubular liner member.

13. A protective device according to claim 12, said stationary structure including a part defining an axially-facing channel, said means by which the device is supported from the stationary structure including an axially-extending part at the end of the tubular liner member remote from said radial flange thereof, said axially-extending part being adapted slidingly to engage said axially-facing channel, and retaining bolts engaging and securing together said radial flanges and the stationary structure.

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