

A Slat and a Roller Shutter Incorporating Same

[0001] This invention relates to a slat, a roller curtain incorporating at least such a slat, and a roller shutter incorporating at least one such roller curtain, and in particular such a slat, roller curtain and roller shutter which are, though not limited to, fire-resistant and heat-resistant.

[0002] According to building regulations and ordinances, in public areas of buildings, a fire compartment is required to be set for each specified floor area, e.g. every 2,000 m², of indoor area, for preventing or at least hindering the spread of fire, for protection of life and property. Fire-rated roller shutters are generally installed between fire compartments for such a purpose. When fire breaks out, the roller shutters can close quickly, so as to prevent or at least hinder the spread of fire, smoke and heat.

[0003] According to Hong Kong building regulations, for fire-rated roller shutters installed on walls of a building, as the walls possess fire integrity and heat resistance, the roller shutters should be of equal fire integrity and heat resistance.

[0004] It is now common for the premium payable on fire insurance policies and compensation paid out in case of fire to depend at least partly on the measures which the owner of the premises has taken to prevent or at least minimize the occurrence and spread of fire. There is thus a demand in the market for roller shutters with fire-integrity and heat-resistant capabilities.

[0005] However, although most fire-rated roller shutters now available in the market possess fire-proof integrity, they are not heat-resistant. When fire breaks out, even with a fire-rated roller shutter fully extended across an opening to separate the building into a fire side and an adjacent non-fire side, the high temperature of the fire may cause the side of the roller shutter facing the non-fire side to rise up to at least 800 °C. In particular, heat may be transmitted from the fire side of the roller shutter to the non-fire side of the roller shutter by radiation, convection and/or conduction. Fire may then break out in the adjacent non-fire side, thus causing more serious damage to life and property.

[0006] It is thus an object of the present invention to provide a slat member, a roller curtain, and a roller shutter in which the aforesaid shortcomings are mitigated or at least to

provide a useful alternative to the trade and public.

[0007] According to a first aspect of the present invention, there is provided a slat member including a first steel layer with a first outer surface and a first inner surface, and a
5 second steel layer with a second outer surface and a second inner surface, wherein said first steel layer and said second steel layer are engaged with each other, with said first inner surface and said second inner surface facing each other and defining a cavity there-between, wherein at least a layer of heat-resistant material is contained within said cavity, wherein a first heat-resistant member is fixedly engaged with said first outer surface of said first steel
10 layer *via* a connecting member, and wherein said connecting member includes at least a first piece of metal plate and a second piece of metal plate welded with each other by soldering.

[0008] According to a second aspect of the present invention, there is provided a roller curtain including a plurality of interlocking slat members, at least one of said slat members
15 including a first steel layer with a first outer surface and a first inner surface, and a second steel layer with a second outer surface and a second inner surface, wherein said first steel layer and said second steel layer are engaged with each other, with said first inner surface and said second inner surface facing each other and defining a cavity there-between, wherein at least a layer of heat-resistant material is contained within said cavity, wherein a first
20 heat-resistant member is fixedly engaged with said first outer surface of said first steel layer *via* a connecting member, and wherein said connecting member includes at least a first piece of metal plate and a second piece of metal plate welded with each other by soldering.

[0009] According to a third aspect of the present invention, there is provided a roller
25 shutter including at least one roller curtain, said roller curtain including a plurality of interlocking slat members, at least one of said slat members including a first steel layer with a first outer surface and a first inner surface, and a second steel layer with a second outer surface and a second inner surface, wherein said first steel layer and said second steel layer are engaged with each other, with said first inner surface and said second inner surface facing
30 each other and defining a cavity there-between, wherein at least a layer of heat-resistant material is contained within said cavity, wherein a first heat-resistant member is fixedly engaged with said first outer surface of said first steel layer *via* a connecting member, and wherein said connecting member includes at least a first piece of metal plate and a second piece of metal plate welded with each other by soldering, wherein said roller curtain is

movable between a retracted position and an extended position.

[0010] Fire-proof, heat-resistant and fire-rated slats, roller curtains and roller shutters according to various embodiments of the present invention will now be described, by way of

5 examples only, with reference to the accompanying drawings, in which:

Fig. 1 is a sectional view of a slat according to a first embodiment of the present invention;

Fig. 2 is a schematic exploded view showing engagement of a connecting plate to the main body of the slat of Fig. 1;

Fig. 3 is a front view of the connecting plate of Fig. 2;

10 Fig. 4A is a front view of an alternative connecting plate for use in the slat of Fig. 1;

Fig. 4B is a side view of the connecting plate of Fig. 4A;

Fig. 5 is a sectional view of a slat according to a second embodiment of the present invention;

Fig. 6 is a sectional side view of a roller curtain formed of a number of the slats of Fig. 1 interlocked with one another;

15 Fig. 7 is a sectional side view of a roller curtain formed of a number of the slats of Fig. 5 interlocked with one another;

Fig. 8 is a perspective view of a vertically-sliding roller shutter formed of a roller curtain of Fig. 6 or of a roller curtain of Fig. 7;

Fig. 9 is a sectional top view of a further roller curtain formed of a number of the slats of Fig. 1 interlocked with one another;

20 Fig. 10 is a sectional top view of a further roller curtain formed of a number of the slats of Fig. 5 interlocked with one another;

Fig. 11 is a perspective view of a laterally-sliding roller shutter formed of a roller curtain of Fig. 9 or of a roller curtain of Fig. 10;

25 Fig. 12 is a sectional side view of a yet further roller curtain formed of a number of the slats of Fig. 1 interlocked with one another;

Fig. 13 is a sectional side view of a yet further roller curtain formed of a number of the slats of Fig. 5 interlocked with one another;

30 Fig. 14 is a perspective view of a horizontally-sliding roller shutter formed of a roller curtain of Fig. 12 or of a roller curtain of Fig. 13;

Fig. 15 is a perspective view of a further vertically-sliding roller shutter formed of two roller curtains of Fig. 6, two roller curtains of Fig. 7, or one roller curtain of Fig. 6 and one roller curtain of Fig. 7;

Fig. 16 is a perspective view of a further laterally-sliding roller shutter formed of two roller

curtains of Fig. 9, two roller curtains of Fig. 10, or one roller curtain of Fig. 9 and one roller curtain of Fig. 10;

Fig. 17 is a perspective view of a further horizontally-sliding roller shutter formed of two roller curtains of Fig. 12, two roller curtains of Fig. 13, or one roller curtain of Fig. 12 and one

5 roller curtain of Fig. 13;

Fig. 18 is a schematic exploded view showing engagement of a connecting plate to the main body of a slat according to a third embodiment of the present invention;

Fig. 19A is a front view of the connecting plate of Fig. 18;

Fig. 19B is a side view of the connecting plate of Fig. 19A;

10 Fig. 20 is a sectional view of the slat of Fig. 18;

Fig. 21 is a sectional view of a slat according to a fourth embodiment of the present invention;

Fig. 22 is a further sectional view of the slat of Fig. 20;

Fig. 23 is a further sectional view of the slat of Fig. 21;

15 Fig. 24 is a sectional side view of a vertically-sliding roller curtain formed of a number of the slats of Fig. 20 interlocked with one another;

Fig. 25 is a sectional side view of a vertically-sliding roller curtain formed of a number of the slats of Fig. 21 interlocked with one another;

Fig. 26 is a sectional top view of a laterally-sliding roller curtain formed of a number of the slats of Fig. 20 interlocked with one another;

20 Fig. 27 is a sectional top view of a laterally-sliding roller curtain formed of a number of the slats of Fig. 21 interlocked with one another;

Fig. 28 is a sectional top view of a horizontally-sliding roller curtain formed of a number of the slats of Fig. 20 interlocked with one another; and

25 Fig. 29 is a sectional top view of a horizontally-sliding roller curtain formed of a number of the slats of Fig. 21 interlocked with one another.

[0011] A slat for a roller curtain of a roller shutter according to a first embodiment of the present invention is shown in Fig. 1 and generally designated as 10. The slat 10 has a main body 12 fixedly engaged with a heat-resistant member 14.

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[0012] The main body 12 has two layers of steel sheets 16a, 16b which are of a thickness of 0.6 mm to 1.2 mm. The steel sheet 16a has an outer surface 18a and an opposite inner surface 20a. Similarly, the steel sheet 16b has an outer surface 18b and an opposite inner surface 20b. The two steel sheets 16a, 16b are engaged with each other such that their inner

surfaces 20a, 20b face each other and define a cavity 22 there-between. A piece of heat-resistant and fire-proof fibre glass cloth 24 of a thickness of 0.5 mm and a layer of heat-resistant and fire-proof ceramic blanket 26 of a thickness of 20 mm are contained within the cavity 22. Each lateral end of the main body 12 is formed into a hook to allow adjacent
5 slats 10 to be interlocked with each other for relative pivotal movement. A number of such slats 10 may thus be interlocked with one another to form a roller curtain for a roller shutter.

[0013] The heat-resistant member 14 is made up of a layer of fire-proof and heat-resisting cloth 28 of a thickness of 2 mm, a layer of heat-resistant and fire-proof ceramic
10 blanket 30 of a thickness of 20 mm, and a layer of heat radiation resisting cloth 32 (which may be a piece of fibre glass cloth) of a thickness of 0.5 mm, the arrangement being that the layer of heat-resistant and fire-proof ceramic blanket 30 is sandwiched between and contacts the layer of fire-proof and heat-resisting cloth 28 and the layer of heat radiation resisting cloth 32.

[0014] A hole 34 is drilled through the steel sheet 16a, so that some of the heat-resistant and fire-proof ceramic blanket 26 in the cavity 22 in the main body 12 is exposed to the outside environment through the hole 34. To fixedly engage the heat-resistant member 14
15 with the main body 12, the heat radiation resisting cloth 32 of the heat-resistant member 14 is brought into contact with the outside surface 18a of the steel sheet 16a. A connecting plate 36 is provided between the heat-resistant member 14 and the main body 12, such that the connecting plate 36 is in contact with the heat radiation resisting cloth 32 of the heat-resistant member 14 and a layer of heat radiation resisting cloth 40 of a thickness of 0.5 mm. The layer of heat radiation resisting cloth 40 may be a layer of fibre glass cloth. The connecting
20 plate 36 is made of a material of a melting point of not more than 660 °C (such as aluminum, antimony, polycarbonate, copper or a combination of such materials) or a material which is burnt out by fire of a temperature of not more than 600 °C (such as wood).

[0015] The heat-resistant member 14 is secured with the main body 12 *via* a screw 42,
30 although it should be understood that other securing members, e.g. rivets, may also be used. The head of the screw 42 is received with a recess 52 of a “弓”-shaped steel piece 44. A respective washer 46a, 46b is provided above and below the head of the screw 42. It should be noted that a tail 48 of the screw 42 is received through the hole 34 on the steel sheet 16a of the main body 12. The screw 42 is thus in contact with the layer of ceramic blanket 26

contained within the cavity 22 of the main body 12, but is out of contact with the steel sheet 16a.

[0016] As shown in Fig. 2, some of the ceramic blanket 26 contained within the main body 12 is exposed to the outside environment through the hole 34 provided through the steel sheet 16a of the main body 12. The connecting plate 36 is secured to the outer surface 18a of the steel sheet 16a by screws 50, such that the connecting plate 36 covers the hole 34. As shown in Fig. 3, the connecting plate 36 may be an aluminum plate of a thickness of 1.2 mm, an antimony plate of a thickness of 1.2 mm, or a polycarbonate plate of a thickness of 3 mm. Alternatively, as shown in Figs. 4A and 4B, the connecting plate 36 may be made of a larger piece of metal plate, such as copper plate 36a, of a thickness of 1.2 mm with a hole of a similar size to the hole 34, and a smaller piece of metal plate, such as copper plate 36b, of a thickness of 1.2 mm covering the hole of the copper plate 36a. The copper plates 36a, 36b are welded with each other by soldering. In addition, the connecting plate 36 may be a piece of wood.

[0017] To the slat 10 shown in Fig. 1 may be fixedly engaged a second heat-resistant member 14', so that each side of the main body 12 is fixedly engaged with a heat-resistant member 14, 14', thus forming a slat 10', as shown in Fig. 5. The second heat-resistant member 14' is also made up of a layer of fire-proof and heat-resisting cloth 28' of a thickness of 2 mm, a layer of heat-resistant and fire-proof ceramic blanket 30' of a thickness of 20 mm, and a layer of heat radiation resisting cloth 32' (which may be a piece of fibre glass cloth) of a thickness of 0.5 mm, the arrangement being that the layer of heat-resistant and fire-proof ceramic blanket 30' is sandwiched between and contacts the layer of fire-proof and heat-resisting cloth 28' and the layer of heat radiation resisting cloth 32'.

[0018] A hole 34' is drilled through the steel sheet 16b, so that some of the heat-resistant and fire-proof fibre glass cloth 24 in the main body 12 is exposed to the outside environment through the hole 34'. To fixedly engage the heat-resistant member 14' with the main body 12, the heat radiation resisting cloth 32' of the heat-resistant member 14' is brought into contact with the outside surface 18b of the steel sheet 16b. A connecting plate 36' is provided between the heat-resistant member 14' and the main body 12, such that the connecting plate 36' is in contact with the heat radiation resisting cloth 32' of the heat-resistant member 14' and a layer of heat radiation resisting cloth 40' of a thickness of 0.5

mm. The layer of heat radiation resisting cloth 40' may be a layer of fibre glass cloth. The connecting plate 36' is made of a material of a melting point of not more than 660 °C (such as aluminum, antimony, polycarbonate, copper or a combination of such materials) or a material which is burnt out by fire of a temperature of not more than 600 °C (such as wood).

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[0019] The heat-resistant member 14' is secured with the main body 12 *via* a screw 42', although it should be understood that other securing members, e.g. rivets, may also be used. The head of the screw 42' is received with a recess 52' of a “弓”-shaped steel piece 44'. A tail 48' of the screw 42' is received through the hole 34' on the steel sheet 16b of the main body 12. The screw 42' is thus in contact with the layer of ceramic blanket 26 and the heat-resistant and fire-proof fibre glass cloth 24 in the main body 12, but is out of contact with the steel sheet 16b.

[0020] In case of fire, the heat-resistant members 14, 14' hinder the spread of heat to the main body 12. In addition, in case of fire, the temperature of the screws 42, 42' will rise, thus conducting heat to the connecting plates 36, 36'. When the temperature of the connecting plates 36, 36' rises to 660 °C, and if the connecting plates 36, 36' are made of a material of a melting point of not more than 660 °C, the connecting plates 36, 36' will melt, whereupon there will be no heat-conducting material between the screws 42, 42' and the main body 12 which conducts heat from the screws 42, 42' to the main body 12. This arrangement therefore also assists in hindering the rise of temperature of the main body 12 in case of fire, in particular when the fire temperature on the fire-side rises to at least 660 °C. In the alternative case in which the connecting plates 36, 36' are made of a material which is burnt out by fire of a temperature of not more than 660 °C (such as wood), when the connecting plates 36, 36' are exposed to fire of a temperature of at least 660 °C, the connecting plates 36, 36' will be burnt out, thus also assisting in hindering the rise of temperature of the main body 12 in case of fire.

[0021] Fig. 6 shows a number of the slats 10 interlocked with one another to form a roller curtain, generally designated as 60. Fig. 7 shows a number of the slats 10' interlocked with one another to form a roller curtain, generally designated as 60'. Fig. 8 shows a vertically-sliding fire-rated roller shutter 70 with a roller curtain which may be the roller curtain 60 or the roller curtain 60'. In case of fire, the roller shutter 70 may be moved from a retracted position when it is wound around an axle 72 and an extended position (as shown in

Fig. 8) in which it is unwound from the axle 72, and therefore can span across an opening in a building. When the roller shutter 70 is in the extended position, it can serve to prevent or at least hinder the spread of fire, heat and smoke there-across.

5 [0022] Fig. 9 shows a number of the slats 10 interlocked with one another to form a roller curtain, generally designated as 62. Fig. 10 shows a number of the slats 10' interlocked to form a roller curtain, generally designated as 62'. Fig. 11 shows a laterally-sliding fire-rated roller shutter 74 with a roller curtain which may be the roller curtain 62 or the roller curtain 62'. In case of fire, the roller shutter 74 may be moved from a retracted position when it is within a housing 76 and an extended position (as shown in Fig. 10 11) in which it can span across an opening in a building. When the roller shutter 74 is in the extended position, it can serve to prevent or at least hinder the spread of fire, heat and smoke there-across.

15 [0023] Fig. 12 shows a number of the slats 10 interlocked with one another to form a roller curtain, generally designated as 64. Fig. 13 shows a number of the slats 10' interlocked to form a roller curtain, generally designated as 64'. Fig. 14 shows a horizontally-sliding fire-rated roller shutter 78 with a roller curtain which may be the roller curtain 64 or the roller curtain 64'. In case of fire, the roller shutter 78 may be moved from a retracted position when it is within a housing 80 and an extended position (as shown in Fig. 20 14) in which it can span across an opening in a building. When the roller shutter 78 is in the extended position, it can serve to prevent or at least hinder the spread of fire, heat and smoke there-across.

25 [0024] To further enhance the capability of prevention or hindering of spread of fire, smoke and heat, and as shown in Fig. 15, a vertically-sliding fire-rated roller shutter 82 includes two roller curtains, each of which may be the roller curtain 60 or 60'. Similarly, as shown in Fig. 16, a laterally-sliding fire-rated roller shutter 84 includes two roller curtains, each of which may be the roller curtain 62, 62'. Furthermore, and as shown in Fig. 17, a 30 horizontally-sliding fire-rated roller shutter 86 includes two roller curtains, each of which may be the roller curtain 64, 64'.

[0025] When the slats 10, 10' are used in the vertically-sliding roller shutters 60, 60' and laterally-sliding roller shutters 62, 62', the “弓”-shaped steel piece 44, 44' will deform in case

of fire, thus pulling the screws 42, 42' out of engagement from the main body 12 and assisting in detaching the heat-resistant members 14, 14' from the main body 12 of the respective roller shutters 60, 60', 62, 62'. On the other hand, when the slats 10, 10' are used in the horizontally-sliding 64, 64', upon occurrence of a fire, the heat-resistant members 14, 14' will
5 fall on its own weight away from the main body 12 of the respective roller shutters. Thus, when used in the horizontally-sliding 64, 64', the slats 10, 10' may be without the “弓”-shaped steel pieces 44, 44'.

[0026] A slat for a roller curtain of a roller shutter according to a third embodiment of the
10 present invention is shown in Figs. 18, 20 and 22 and generally designated as 110. The slat 110 has a main body 112 fixedly engaged with a heat-resistant member 114. The main body 112 has two layers of steel sheets 116a, 116b which are of a thickness of 0.6 mm to 1.2 mm. The steel sheet 116a has an outer surface 118a and an opposite inner surface 120a. Similarly, the steel sheet 116b has an outer surface 118b and an opposite inner surface 120b. The two
15 steel sheets 116a, 116b are engaged with each other such that their inner surfaces 120a, 120b face each other and define a cavity 122 there-between. A layer of heat-resistant and fire-proof ceramic blanket 126 of a thickness of 20 mm is contained within the cavity 122. Each lateral end of the main body 112 is formed into a hook to allow adjacent slats 110 to be interlocked with each other for relative pivotal movement. A number of such slats 110 may
20 thus be interlocked with one another to form a roller curtain for a roller shutter.

[0027] The heat-resistant member 114 is made up of a layer of fire-proof and heat-resisting cloth 128 of a thickness of 2 mm, a layer of heat-resistant and fire-proof ceramic blanket 130 of a thickness of 20 mm, and a layer of heat radiation resisting cloth 132
25 (which may be a piece of fibre glass cloth) of a thickness of 0.5 mm, the arrangement being that the layer of heat-resistant and fire-proof ceramic blanket 130 is sandwiched between and contacts the layer of fire-proof and heat-resisting cloth 128 and the layer of heat radiation resisting cloth 132.

[0028] Two non-combustible composite panels 133 of fibre reinforced cement bonded to punched steel sheets on both outer surfaces and a non-combustible matrix engineered silicate board 134 reinforced with fibres and fillers are engaged and placed in abutment with the layer of steel sheet 116a of the main body 112, with the non-combustible matrix engineered silicate board 134 positioned between and in contact with the two non-combustible composite panels
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133, each on one end thereof. Each of the non-combustible composite panels 133 is fixedly engaged with the main body 112 *via* a respective screw 143. The non-combustible composite panels 133 may be such a panel of a thickness of 6 mm sold under the trade mark Promat DURASTEEL® by Promat International (Asia Pacific) Ltd. The non-combustible matrix engineered silicate board 134 may be such a board of a thickness of 9 mm sold under the trade mark PROMATECH®-H also by Promat International (Asia Pacific) Ltd.

[0029] Figs. 19A and 19B show a connecting plate 136 with an outer metal plate 136a and an inner metal plate 136b. The connecting plate 136 is made of a material of a melting point of not more than 660 °C (such as aluminum, antimony, copper or a combination of such materials). The outer metal plate 136a is generally rectangular in shape, with one larger circular aperture 140a and two smaller circular apertures 140b each on one said of the larger circular aperture 140a. The inner metal plate 136b is circular in shape and is of a size slightly smaller than that of the larger circular aperture 140a of the outer metal plate 136a. The inner metal plate 136b is fit within the outer metal plate 136a and welded with the outer metal plate 136a by soldering.

[0030] As shown in Figs. 18, 20 and 22, the non-combustible matrix engineered silicate board 134 and the two non-combustible composite panels 133 are kept in place relative to the layer of steel sheet 116a of the main body 112 by the connecting plate 136. To fix the non-combustible matrix engineered silicate board 134, the two non-combustible composite panels 133 and the connecting plate 136 to the layer of steel sheet 116a of the main body 112, a screw 141 is received through a respective of the smaller circular apertures 140b of the outer metal plate 136a, such that the screws 141 penetrate a respective of the two non-combustible composite panels 133, through the layer of steel sheet 116a of the main body 112, and into the layer of heat-resistant and fire-proof ceramic blanket 126 in the main body 112. By such an arrangement, the connecting plate 136 is spaced apart from the layer of steel sheet 116a of the main body 112 by the non-combustible matrix engineered silicate board 134.

[0031] To fixedly engage the heat-resistant member 114 with the layer of steel sheet 116a of the main body 112 (and thus with the main body 112), and as shown in Figs. 20 and 22, a screw 142 is received through the heat-resistant member 114 and the inner metal plate 136b of the connecting plate 136 and into the non-combustible matrix engineered silicate board 134. It should be noted that the screw 142 is received within but does not penetrate through the

non-combustible matrix engineered silicate board 134.

[0032] To the slat 110 shown in Figs. 18, 20 and 22 may be fixedly engaged a second heat-resistant member 114', so that each side of the main body 112 is fixedly engaged with a respective heat-resistant member 114, 114', thus forming a slat 110', as shown in Figs. 21 and 23. The second heat-resistant member 114' is also made up of a layer of fire-proof and heat-resisting cloth 128' of a thickness of 2 mm, a layer of heat-resistant and fire-proof ceramic blanket 130' of a thickness of 20 mm, and a layer of heat radiation resisting cloth 132' (which may be a piece of fibre glass cloth) of a thickness of 0.5 mm, the arrangement being that the layer of heat-resistant and fire-proof ceramic blanket 130' is sandwiched between and contacts the layer of fire-proof and heat-resisting cloth 128' and the layer of heat radiation resisting cloth 132'.

[0033] Two non-combustible composite panels 133' of fibre reinforced cement bonded to punched steel sheets on both outer surfaces (such as a panel of a thickness of 6 mm sold under the trade mark Promat DURASTEEL® by Promat International (Asia Pacific) Ltd.) and a non-combustible matrix engineered silicate board 134' reinforced with fibres and fillers (such as a board of a thickness of 9 mm sold under the trade mark PROMATECH®-H also by Promat International (Asia Pacific) Ltd.) are engaged and placed in abutment with the layer of steel sheet 116b of the main body 112, with the non-combustible matrix engineered silicate board 134' positioned between and in contact with the two non-combustible composite panels 133', each on one end thereof. Each of the non-combustible composite panels 133' is fixedly engaged with the main body 112 *via* a respective screw 143'.

[0034] As shown in Figs. 21 and 23, the non-combustible matrix engineered silicate board 134' and the two non-combustible composite panels 133' are kept in place relative to the layer of steel sheet 116b of the main body 112 by a connecting plate 136' of the same structure as the connecting plate 136. To fix the non-combustible matrix engineered silicate board 134', the two non-combustible composite panels 133' and the connecting plate 136' to the layer of steel sheet 116b of the main body 112, a screw 141' is received through an outer metal plate 136a' of the connecting plate 136', such that the screws 141' penetrate a respective of the two non-combustible composite panels 133', through the layer of steel sheet 116b of the main body 112, and into the layer of heat-resistant and fire-proof ceramic blanket 126 in the main body 112. By such an arrangement, the connecting plate 136' is spaced apart from

the layer of steel sheet 116b of the main body 112 by the non-combustible matrix engineered silicate board 134'.

[0035] To fixedly engage the heat-resistant member 114' with the main body 112, and as shown in Figs. 21 and 23, a screw 142' is received through the heat-resistant member 114' and an inner metal plate 136b' of the connecting plate 136' and into the non-combustible matrix engineered silicate board 134'. It should be noted that the screw 142' is received within but does not penetrate through the non-combustible matrix engineered silicate board 134'.

[0036] In case of fire, the heat-resistant members 114, 114' hinder the spread of heat to the main body 112. In addition, in case of fire, the temperature of the screws 142, 142' will rise, thus conducting heat to the connecting plates 136, 136'. When the temperature of the connecting plates 136, 136' rises, the solder between the inner metal plate 136b, 136b' and the respective outer metal plate 136a, 136a' will melt, thus allowing the inner metal plate 136b, 136b' to be released from the respective outer metal plate 136a, 136a'. When temperature is sufficiently high, the inner metal plate 136b, 136b' will deform, thus forcing the screws 142, 142' to move out of engagement with the respective non-combustible matrix engineered silicate board 134, 134'. The heat-resistant members 114, 114' is thus disengaged from the outer metal plate 136a, 136a', and thus from the main body 112. There will then be no heat-conducting material between the screws 142, 142' and the main body 112 which conducts heat from the screws 142, 142' to the main body 112. This arrangement therefore further assists in hindering the rise of temperature of the main body 112 in case of fire.

[0037] Fig. 24 shows a number of the slats 110 interlocked with one another to form a roller curtain, generally designated as 160. Fig. 25 shows a number of the slats 110' interlocked with one another to form a roller curtain, generally designated as 160'. Both roller curtains 160, 160' are suitable for use in forming a vertically-sliding fire-rated roller shutter. In case of fire, each of the roller curtains 160, 160' may be moved from a retracted position when it is wound around an axle and an extended position in which it is unwound from the axle, and therefore can span across an opening in a building. When the roller curtains 160, 160' are in the extended position, they can serve to prevent or at least hinder the spread of fire, heat and smoke there-across.

[0038] Fig. 26 shows a number of the slats 110 interlocked with one another to form a

roller curtain, generally designated as 162. Fig. 27 shows a number of the slats 110' interlocked to form a roller curtain, generally designated as 162'. Both roller curtains 162, 162' are suitable for use in forming a laterally-sliding fire-rated roller shutter. In case of fire, each of the roller curtains 162, 162' may be moved laterally from a retracted position when it is within a housing and an extended position in which it can span across an opening in a building. When the roller shutters 162, 162' are in the extended position, they can serve to prevent or at least hinder the spread of fire, heat and smoke there-across.

[0039] Fig. 28 shows a number of the slats 110 interlocked with one another to form a roller curtain, generally designated as 164. Fig. 29 shows a number of the slats 110' interlocked to form a roller curtain, generally designated as 164'. Both roller curtains 164, 164' are suitable for use in forming a horizontally-sliding fire-rated roller shutter. In case of fire, each of the roller shutters 164, 164' may be moved horizontally from a retracted position when it is within a housing and an extended position in which it can span across an opening in a building. When the roller shutters 164, 164' are in the extended position, they can serve to prevent or at least hinder the spread of fire, heat and smoke there-across.

[0040] When the slats 110, 110' are used in the vertically-sliding roller shutters 160, 160' and laterally-sliding roller shutters 162, 162', the slats 110, 110' also include “弓”-shaped steel pieces (as shown in Figs. 1 and 5 and designated under reference numerals 44, 44') which will deform in case of fire, thus pulling the screws 142, 142' out of engagement from the main body 112 and assisting in detaching the heat-resistant members 114, 114' from the main body 112 of the respective roller shutters 160, 160', 162, 162'. In this scenario, the “弓”-shaped steel pieces 44, 44' are engaged with the heat-resistant members 114, 114' in the same manner as they are engaged with the heat-resistant members 14, 14' as shown in Figs. 1 and 5 and discussed above. On the other hand, when the slats 110, 110' are used in the horizontally-sliding 164, 164', upon occurrence of a fire, the heat-resistant members 114, 114' will fall on its own weight away from the main body 112 of the respective roller shutters. Thus, when used in the horizontally-sliding 164, 164', the slats 110, 110' may be without the “弓”-shaped steel pieces 44, 44'.

[0041] It should be understood that the above only illustrates examples whereby the present invention may be carried out, and that various modifications and/or alterations may be

made thereto without departing from the spirit of the invention.

[0042] It should also be understood that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may be provided in combination in a single embodiment. Conversely, various features of the invention which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any appropriate sub-combinations.

CLAIMS:

1. A slat member including:
 - a first steel layer with a first outer surface and a first inner surface, and
 - a second steel layer with a second outer surface and a second inner surface,
 - 5 wherein said first steel layer and said second steel layer are engaged with each other, with said first inner surface and said second inner surface facing each other and defining a cavity therebetween,
 - wherein at least a layer of heat-resistant material is contained within said cavity,
 - wherein a first heat-resistant member is fixedly engaged with said first outer surface
 - 10 of said first steel layer *via* a connecting member, and
 - wherein said connecting member includes at least a first piece of metal plate and a second piece of metal plate welded with each other by soldering.
2. A slat member according to Claim 1 wherein said first and second pieces of metal plates
- 15 are copper plates.
3. A slat member according to Claim 1 or 2 wherein said first and second pieces of metal plates are of different sizes.
- 20 4. A slat member according to any of the preceding claims wherein said first heat-resistant member includes at least a layer of fire-proof and fire-resisting cloth, a layer of ceramic blanket, and a layer of heat radiation resisting cloth.
5. A slat member according to Claim 4 wherein said layer of heat radiation resisting cloth is
- 25 a layer of fibre glass cloth.
6. A slat member according to Claim 4 or 5 wherein at least part of said layer of heat radiation resisting cloth is in contact with at least part of said first outer surface of said first steel layer.
- 30 7. A slat member according to any of the preceding claims wherein said first outer surface of said first steel layer includes a hole.
8. A slat member according to Claim 7 wherein said first heat-resistant member is fixedly

engaged with said first outer surface of said first steel layer *via* a first securing member.

9. A slat member according to Claim 8 wherein said first securing member is in contact with said layer of heat-resistant material contained within said cavity between said first steel layer and said steel layer, and is out of contact with said first steel layer.
10. A slat member according to Claim 8 or 9 wherein said first securing member is a screw or rivet.
11. A slat member according to any one of Claims 8 to 10 wherein said first securing member is engaged with said first heat-resistant member and said first steel layer *via* a generally “弓”-shaped steel member.
12. A slat member according to Claim 1 wherein said connecting member is spaced apart from said first outer surface of said first steel layer by at least a non-combustible matrix engineered silicate board.
13. A slat member according to Claim 12 wherein said first outer surface of said first steel layer is engaged with at least one non-combustible composite panel of fibre reinforced cement bonded to steel sheets on both outer surfaces.
14. A slat member according to Claim 13 wherein said first outer surface of said first steel layer is engaged with at least two said non-combustible composite panels.
15. A slat member according to Claim 14 wherein said at least one non-combustible matrix engineered silicate board is positioned between and in contact with said at least two non-combustible composite panels.
16. A slat member according to Claim 14 or 15 wherein said first piece of metal plate of said connecting member is fixedly engaged with said non-combustible composite panel(s) *via* at least at least a second securing member received at least partly within said non-combustible composite panel(s).
17. A slat member according to any one of Claims 12 to 16 wherein said first heat-resistant

member is fixedly engaged with said first outer surface of said first steel layer *via* a third securing member which is received through said second piece of metal plate of said connecting member and partly within said non-combustible matrix engineered silicate board.

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18. A slat member according to any of the preceding claims wherein a second heat-resistant member is fixedly engaged with said second outer surface of said second steel layer.

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19. A roller curtain including a plurality of interlocking slat members, at least one of said slat members being according to any one of Claims 1 to 18.

20. A roller shutter including at least one roller curtain according to Claim 19 wherein said roller curtain is movable between a retracted position and an extended position.

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21. A roller shutter according to Claim 20, including a plurality of said roller curtains.

22. A roller shutter according to Claim 20 or 21 wherein said roller shutter is a vertically-sliding roller shutter, a laterally-sliding roller shutter or a horizontally-sliding roller shutter.

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23. A roller shutter according to any one of Claims 19 to 22 wherein said roller shutter is a fire-rated roller shutter.