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[54] **AIR-COOLED LIGHT PROJECTION UNIT**

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[58] **Field of Search** 353/53-61; 240/47; 352/146, 202; 355/30, 110

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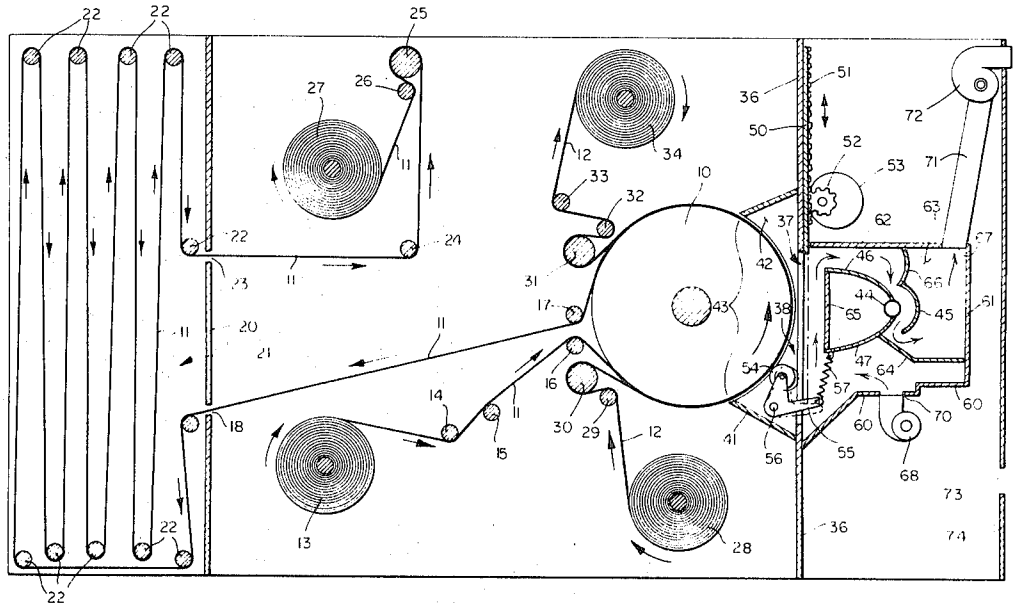
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[57] **ABSTRACT**

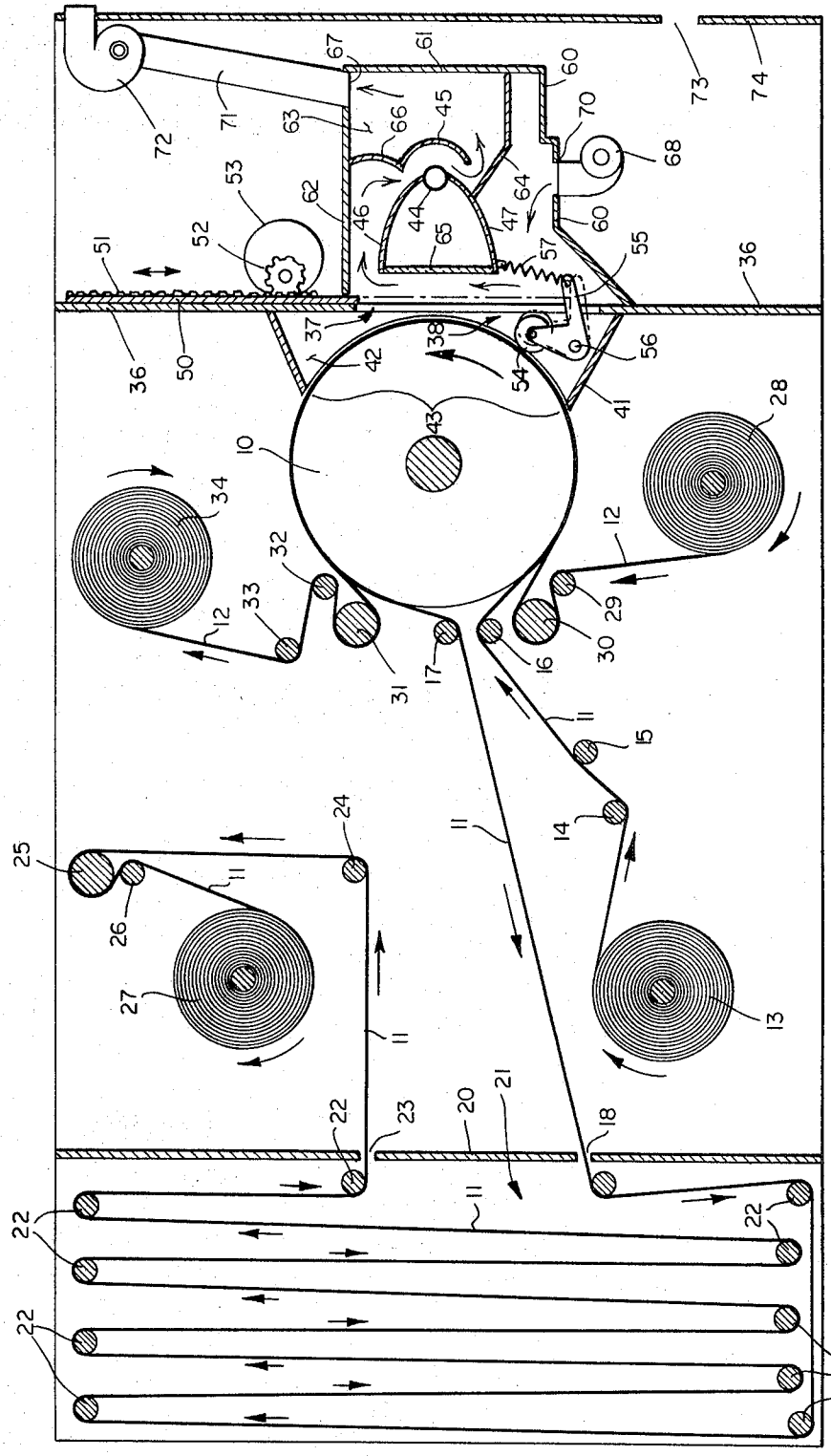
An air-cooled light projection unit for use in apparatus in which film is exposed to light, such as apparatus for projecting or duplicating film images. A heat-radiating light source is enclosed in a housing from which light is projected toward a film located at an illumination station. Walls within the housing define a tortuous cooling passageway through the housing. The passageway extends first past the illumination station between the film and the light source and secondly past a heat radiating portion of said light source. Blowers are associated with the housing for causing a flow of cooling air through the passageway. A method performed by the projection unit is disclosed in which cooling air is introduced into the light projection unit, directed past the illumination station between the light source and the film, and past a heat-emitting portion of the light source. The cooling air is then emitted from the light projection unit.

2 Claims, 1 Drawing Figure



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AIR-COOLED LIGHT PROJECTION UNIT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to improvements in apparatus in which film is exposed to light, such as apparatus for projecting or duplicating film images, and particularly to a new and improved air-cooled light projection unit for use in such apparatus.

2. Brief Description of the Prior Art

There are many different forms of apparatus in which film is exposed to light emitted from a closely spaced light source. Such light sources generally generate and radiate a considerable amount of heat as well as light, due to the fact that large quantities of power must be utilized to create light of sufficiently high intensity to accomplish the intended purpose. For example, where the light generated is used to project a film image onto a remotely positioned surface such as a screen, light of very high intensity must be generated since the light intensity dininishes in an amount proportional to the square of the distance between the light source and the remote surface on which the image is to be displayed or projected.

In addition, for certain purposes, it is also required that the light source be closely spaced to the film containing an image to be projected. This is particularly the case in film duplication apparatus in which the image on a master film is transferred to a duplicating film by light passing through the imaged master film when it is in contact with the duplicating film. Such a process involves the activation of a photosensitive layer on the duplicating film, which may be of any one of a number of different types known to those skilled in the art. Regardless of the type of film system employed, this rate of this activation is generally responsive to the intensity of the light striking the photosensitive layer on the film and accordingly, a light source is generally placed quite close to the duplicating film in order to maximize the speed of film duplication and to make the process commercial, as well as to optimize the duplication process itself from the photographic quality standpoint.

However, one of the problems experienced with such film projection and film duplication apparatus has been the damage caused to the film or films when the heat radiated by the light source exceeds a certain amount, which often occurs when the apparatus has been in operation for a considerable period of time and heat builds up to a high temperature. Where the film material constitutes the only copy of such image information, as is usually the case where a master film is involved which is being used to make a duplicate copy, the loss or damage of this information due to excessive heating of the film and distortion, blistering or melting of the film can be extremely expensive and costly and in many cases, causes irreparable damage.

In addition, high intensity light sources utilized in such apparatus are generally of an electrical type and comprise extremely expensive elements of the apparatus. It has been found that when such light sources are operated at high temperatures or in a high temperature environment, their operating life is severely curtailed. The cost of replacing such light sources constitutes a significant portion of the cost of operation of such apparatus. However, when such light sources are operated in a cooler environment, their operating life is substantially increased, thereby reducing the cost of operating such apparatus.

In view of the above-mentioned difficulties and shortcomings, it has been discovered that the operating life of a light source can be greatly extended by cooling the light projection unit in which it is mounted. Furthermore, such an arrangement is also advantageous in reducing or eliminating risk of heat damage to the film being projected or duplicated.

Accordingly, it is a chief object and advantage of the present invention to eliminate the damage previously caused by a heat-radiating light source in a light projection unit. It is a further object and advantage of the present invention to greatly extend the operating life of the light source in a light projection unit.

SUMMARY OF THE INVENTION

The invention is an air-cooled light projection unit for use in apparatus in which film is exposed to light. The unit includes a heat-radiating light source which directs light toward a film at an illumination station. The light source is at least partially enclosed by a housing which defines an opening through which light is projected toward the film at the illumination station. Wall means within the housing define a tortuous passageway through the housing. The passageway includes a first portion extending past the illumination station, between the film and the light source, and a second portion connected to the first portion and extending past a heat-radiating portion of the light source. Means are associated with the housing for causing a flow of air through the passageway from the first portion to the second portion. In some embodiments, the apparatus includes blowers at either or both ends of the passageway to create the flow of air therethrough. In a preferred embodiment, the light source is located in front of an arcuate reflecting element within the housing, and two spaced reflecting elements divergingly extend from the light source toward the illumination station in order to more efficiently concentrate and redirect divergent rays of light toward the illumination station. A plate, at least a portion is transparent, extends between the divergent ends of the two spaced reflecting elements. A wall within the house connects the side of the housing to one of the two spaced reflecting elements to form a portion of the passageway, and another wall extends from the housing to the arcuate reflecting element to define another portion of the passageway.

In a particular embodiment, the invention comprises an improvement in apparatus for duplicating film, wherein a master film and a duplicate film are brought into overlying relationship with one another and light is projected through the master film and onto the duplicate film at an illumination station. In that instance, the heat-radiating light source must be of relatively high intensity in order to accomplish film duplication at commercial speeds. In addition, it must be placed fairly close to the film in order to further maximize the intensity of the light striking the film.

The invention also includes a method for cooling a light projection unit having a heat-radiating light source which directs light toward a film at an illumination station. In the method, cooling air is introduced into the light projection unit and directed past the illumination station between the light source and the film. The cooling air is then directed past a heat-radiating portion of the light source when it issues from the illu-

mination station. The cooling air is then emitted from the light projection unit.

DESCRIPTION OF THE DRAWING

The above-mentioned and additional objects and advantages of the present invention will become apparent from the following description thereof, taken in conjunction with the drawing which is a sectional side elevation view of one form of microfilm duplication apparatus which includes one embodiment of the air-cooled light projection unit of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The drawing shows a portion of one form of film duplicating apparatus in which the air-cooled light projection unit of the present invention is incorporated. The film duplicating apparatus includes a rotatably mounted support cylinder **10** on the surface of which an unimaged photosensitive duplicating film **11** is supported. An original master film **12**, that is, a light-stable, previously exposed film which already contains a developed visible image, is superimposed upon the duplicating film **11**. The films **11** and **12** are supported in this manner and run in contact with one another and the surface of the support cylinder **10** through about 270° of rotation of the support cylinder **10**. The duplicating film **11** is fed onto the support cylinder **10** from a feed reel **13** and after it passes around a guide roller **14**, a guide roll **15**, and a guide roller **16**.

The duplicating film **11** is of a nature such that it is photosensitive, so that when it is exposed to a light-shadow image, as by transmission of light through the master film onto the duplicating film, a developable image will be created on the duplicating film. Upon leaving the support cylinder **10**, the duplicating film **11** passes around a guide roller **17** and advances through an opening **18** in the dividing wall or partition **20** and into the developing chamber **21** where it is developed in accordance with well-known techniques, the nature of which depends upon the type of film system employed. The duplicating film **11**, for example, may be of a conventional silver halide form or of a conventional diazo form, the nature of each being well-known to those skilled in photography and copying.

The drawing shows the type of developing chamber commonly employed for developing a diazotype film, in which the film is exposed to ammonia gas formed by volatilizing an aqueous ammonia solution by heating means (not shown) to develop the image thereon. To insure exposure of the film to ammonia for a sufficient time while it is continuously fed into the chamber **21**, a substantial length of the film is accumulated within the chamber **21** by running it between a plurality of rollers **22** to create many stretches of the film which permit exposure of the film surface to the atmosphere in chamber **21**. The developed film is fed through a second opening **23** in dividing wall **20** and is passed over guide roll **24**, guide roll **25**, and guide roll **26**, after which it is wound upon a takeup reel **27**.

The imaged master film **12** is fed from a supply reel **28** around a snubbing roller **29**, and then around a guide roller **30**, after which it is fed around the periphery of the support cylinder **10** on top of the duplicating film **11**. Upon leaving the support cylinder **10** and the duplicating film **11**, the master film **12** is fed around a guide roller **31** and then around a snubbing roller **32**, around guide roller **33** and onto a takeup reel **34**. The entire film system is driven by a drive motor (not shown) operably connected by a belt (not shown) to pulleys (not shown) on certain of the guide rollers and reels, such as the two takeup reels **27** and **34**, as are necessary to advance the duplicating film **11** and the master film **12** through the apparatus. Therefore, it is tension on the films **11** and **12** and friction between the outer periphery of the driven rollers and the films which advances the duplicating film **11** and the master film **12** around the support cylinder **10** and through the duplicating apparatus. These details have been omitted to avoid obscuring the invention, but the details of such a drive arrangement would be readily apparent to one skilled in the art.

The side wall **36** of the duplicating apparatus has an opening **37** therein radially disposed from the support cylinder **10**. A light chamber **38** is formed by spaced-apart upper and lower inclined walls **40** and **41**, respectively, radially extending from the side wall **36** at the top and bottom of the opening **37** to a point closely spaced from the surface of the support cylinder **10** and side walls **42**, only one of which is shown, which connect the respective ends of upper and lower walls **40** and **41** to generally define an exposure station, indicated generally by the bracket **43**. Thus, exposure of the duplicating film **11** to light projected through the master film **12** only occurs when the films **11** and **12** pass over the support cylinder **10** between the lower side wall **41** and the upper side wall **40**.

A lamp **44** is spaced from the side wall **36** in line with the opening **37** therein. The lamp **44** is partially enclosed by an arcuate reflecting element **45** and outwardly diverging upper and lower reflecting elements **46** and **47**, respectively, spaced apart from one another. All of the reflecting elements **45**, **46** and **47** combine to project light from the lamp **44** through the opening **37** into the light chamber **38** and through the master film **12** onto the duplicating film **11** as they move through the exposure station **43**. The lamp **44** may comprise any of the high intensity electric light sources typically employed in film projection apparatus and film duplicating equipment.

A shutter **50** is disposed adjacent the side wall **36** and the opening **37** therein, and is movable from an open position where it is adjacent the side wall **36** as shown in FIG. **1** in solid line, to a closed position where it is in front of the opening **37** and is in front of the space between the reflecting elements **46** and **47**, as shown in phantom line in FIG. **1**. In the open position, light from the lamp **44** can strike the films **11** and **12** at the exposure station **43**, but in the closed position, light which enters the light chamber **38** is essentially precluded from striking the films **11** and **12** at the exposure station **43**. Movement of the shutter **50** is accomplished by a rack and pinion mechanism, the shutter **50** being attached to the lower end of the rack **51** which is meshed with and driven by a pinion gear **52** which is attached to the drive shaft of a shutter drive motor **53**. The shutter drive motor **53** is a reversible AC motor and the direction of its operation may be controlled by a simple switch (not shown) or by more automatic means (not shown), the arrangement and operation of which would be understood by those skilled in the art.

A pressure roller **54** is disposed within the light chamber **38** and arranged to contact the surface of the master film **12** to press it against the duplicating film **11**

just prior to the point where the films 11 and 12 are struck by light. This pressure substantially eliminates any air gaps between the two films 11 and 12 and ensures uniform contact therebetween which is essential to avoid undercutting of the image during exposure. In the duplication of images, and particularly microimages on microfilm, close contact during exposure to light is extremely important to avoid the loss of resolution which otherwise occurs due to non-radial light rays passing through the imaged film. Such diverging light rays tends to undercut the image on the master film 12 if the master film 12 and the duplicating film 11 are not in close contact with one another.

The pressure roller 54 is rotatably mounted on one end of a pivotably mounted support arm 55 which pivots about a pin 56 connected to the side plate 42. The other end of the support arm 55 is connected by a tension spring 57 to the back side of the lower reflecting element 47. From this arrangement, it can be seen that the pressure roller 54 is spring-biased into contact with the master film 12 when the shutter 50 is opened. In accordance with the invention, the pressure roller 54 is moved away from and out of contact with the master film 12 when the shutter 50 is moved to its closed position. This is accomplished by the lower end of the shutter 50 striking the support arm 55 holding the pressure roller 54 and overcoming the force of the spring 57 by the force of the shutter drive motor 53 operating through the rack 51 and pinion gear 52 so that the pressure roller 54 is pivoted out of contact with the master film 12. This position of the support arm 55 and pressure roller 54 is shown in phantom in the drawing.

The lamp 44 and reflecting elements 45, 46 and 47 are enclosed within a housing formed by walls 60, 61 and 62, and spaced side walls 63, only one of which is shown in the drawing. The resulting housing is open along its side directed toward the opening 37 and the support cylinder 10 so that light from the lamp 44 may be directed onto the film 11 and 12 carried over the support cylinder 10 when the shutter 50 is in its open position.

One of the problems experienced with this type of arrangement in the past has been the excessive buildup of heat within the housing and within the light chamber 38 through which the films 11 and 12 pass. This heat which results primarily from the unusually high intensity light source 44 is required for film duplication and particularly for the duplication of microfilm at high speeds. The result of such a buildup of heat is to temporarily distort the film and often permanently damage the film by blistering or melting it. In addition, the high temperatures greatly shorten the life of the lamp 44, resulting in the expense of replacing the lamp.

In accordance with the present invention, a passageway is formed through the housing through which cooling air is circulated to cool specifically both the region between the lamp 44 and the films 11 and 12 and the region behind the lamp in order to greatly improve the operation of the film duplication apparatus. This cooling reduces or eliminates any risk of damage to the films 11 and 12, and enables the lamp 44 to operate in a cooler environment, thereby greatly prolonging its life. In the apparatus shown in the drawing, the upper and lower reflecting elements 46 and 47 extend into contact with the lamp 44. A partition 64 extends from the lower reflecting element 47 to the back wall 61 of the housing and defines a first duct between the lower side wall 60 of the housing and the partition 64 and the reflecting element 47.

A glass plate 65 extends from one end of upper reflecting element 46 to one end of lower reflecting element 47 to separate the lamp 44 from the films 11 and 12 and to somewhat reduce the amount of heat radiating from the lamp 44 toward the films. A passageway or duct is thus formed between the light source 44 and the films 11 and 12 which connects with the passageway described previously. This duct is present regardless of the position of the shutter 50. However, when the shutter 50 is closed and covers the opening 37, cooling air directed through the passageway past the illumination station 43 is excluded from the light chamber 38 and from contact with the films 11 or 12. However, it cools the shutter 50 and the glass plate 65.

The arcuate reflecting element 45 is connected by a wall 66 to the upper wall 62 of the housing so as to further define a passageway between the reflecting element 46, the light source 44 and a portion of reflecting element 47 and the upper wall 62, wall 66, and reflecting element 45. The passageway thus described extends beyond the light source 44. It then turns and extends toward an outlet through the upper wall 62. The above-described passageways form one continuous tortuous passageway through the housing which allows both the region between the light source and the films, and the region behind the light source, to be cooled.

A blower 68 is connected to lower wall 60 of the housing so as to blow cooling or ambient air into the tortuous passageway thus described through the housing 70 and lower wall 60. Inlet air enters the apparatus through an opening 73 in the end wall 74. The cooling air is directed past the illumination station between the light source 44 and the film 12. It then is directed past a heat-radiating portion of the light source. Preferably the cooling air is first directed past the region between the light source 44 and the films since that region is generally cooler than the heat-radiating portion of the lamp 44. In this manner, the coolest air operates on the coolest elements, thereby obtaining maximum heat removal efficiency in true countercurrent fashion. As the air passes through the passageway thus described, it first removes heat from the region between the films and the glass plate 65, and then removes heat from the heat-radiating back side of the lamp 44 and from the reflecting elements 45, 46 and 47 which tend to become heated during operation of the apparatus. The cooling air then passes through an opening 67 of upper wall 62 of the housing and into a duct 71 which connects with a second blower 72. Blower 72 emits the cooling air, which at this point is at a higher temperature than when it entered the light projection unit, through an opening in the end wall 74.

In view of the above description of the invention and of the drawings, it can be seen that the invention provides a new and improved method and apparatus for use in instances where film is exposed to light, and particularly in film projection and film duplication apparatus in which the above-mentioned problems have previously been experienced. It also can be seen that the air-cooled light projection unit of the present invention overcomes many of the problems which have been experienced previously in such apparatus, such as damage or distortion of the film due to heat from the light source which, because of the requirements for light of unusually high intensity, radiates a considerable quan-

tity of heat. In addition, by operating the light source in a cooler environment, which is provided by the apparatus of the present invention, the operating life of the light source is substantially increased.

From the above description of the invention, it will be apparent that various modifications in the method and apparatus described in detail herein may be made within the scope of the invention. For example, the tortuous passageway might be of a substantially different configuration than that shown and described above so long as the cooling air is directed through the illumination station between the light source and the film, and also past a heat-radiating portion of the light source. Thus, it is this combination of cooling steps which has been found to result in maintaining the environment within the housing much cooler than that in similar light projection units utilized in the past. Therefore, the invention is not to be limited to the specific details of the method and apparatus described herein except as may be required by the following claims.

What is claimed is:

1. Apparatus for duplicating film, wherein a master film and a duplicate film are brought into overlying relationship with one another and light is projected through said master film and onto said duplicate film at an illumination station, comprising

a heat radiating light source which directs light toward said films when they are disposed at said illumination station,

a housing at least partially enclosing said light source, said housing defining an opening through which light is projected toward said films at said illumination station,

wall means within said housing which define a tortuous passageway through said housing, said passageway including

a first portion extending past said illumination station between said film and said light source, and

a second portion connected to said first portion and extending past said heat-radiating light source, said wall means including,

two spaced-apart reflecting elements extending and diverging from said light source toward said illumination station, and

a transparent plate extending between and joined to the divergent ends of said two reflecting elements, said first portion of said passageway extending past only the side of said plate opposite said heat-radiating light source, and

means associated with said housing for causing a flow of cooling air through said passageway from said first portion to said second portion.

2. Apparatus for duplicating film according to claim 1, wherein said means associated with said housing for causing a flow of cooling air through said passageway comprise a first blower for introducing said cooling air into said first portion of said passageway, and a second blower for exhausting said cooling-air from said second portion of said passageway.

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