Title: METAL PLATE HAVING MESH-TYPE BEAD FOR DUCT AND APPARATUS OF PRODUCING THE SAME

Abstract: The present invention relates to a metal having mesh-type beads for duct and apparatus of producing the same, in which mesh-type grooves are formed in the surface of the metal plate in a regular uneven-shaped grid pattern so that the duct is increased in outer appearance and stiffness. An apparatus for producing the metal plate for duct of the invention comprises a base frame constituted by a rectangular base plate for settling a driving motor as a driving unit, four posts respectively erected on four corners of the base plate and an upper plate connected to the upper ends of the posts as an upper part of the base frame; a pair of roll stands erected on both ends of the upper plate of the base frame; a pair of upper and lower pinch rolls inserted into roll chokes assembled to choke-assembling recesses at the both roll stands; a pair of working rolls assembled to the both roll stands in the same manner parallel with the pinch rolls and having groove-shaped embossments and intaglio in the surface for forming grooves; a power transmission unit for transmitting power from the driving motor to the pinch rolls and the working rolls.
METAL PLATE HAVING MESH-TYPE BEAD FOR DUCT AND APPARATUS OF PRODUCING THE SAME

Technical Field

The present invention relates to a metal plate having mesh-type bead for duct and apparatus of producing the same. In particular, the metal plate has mesh-type beads with a regular uneven-shaped grid pattern in the surface thereof to allow the duct to have increased stiffness so that the metal plate for duct can be reduced in thickness thereby saving the manufacturing cost of the duct and improving the appearance of the same as well.

Background Art

Modern buildings are getting higher due to development of constructional technologies and for effective utilization of land as well. In particular, higher-storied business buildings are mainly steel-framed, in which sealed windows are employed, and even if openable windows are employed, the size thereof tends to be small for the purpose of saving the air-conditioning cost of the buildings.

Therefore, in the case of a higher-storied business building, the artificial air conditioning system is generally adopted rather than the natural air-conditioning, and the importance of a duct as an air path for circulation of the conditioning air is gradually increasing in the artificial air-conditioning system.

As above, the conventional duct which is essential to the modern building is generally manufactured through bending a zinc-plated steel plate to have a quadrangle-shaped section, in which increase in the thickness of the steel plate for the purpose of enhancing the stiffness of the duct requires the manufacturing cost of the duct to be raised while increase in the self-weight of the duct requires increase in the stiffness of the building thereby assisting the building cost to be raised.
Moreover, the conventional duct is required to be large-sized as the buildings are getting large-sized and high-storied requiring so that the plates for duct should be increased in thickness. However, there are limitations in improving the stiffness of the duct through increase in thickness, in which the duct is necessarily decreased in length and increased in number as well as reinforcing materials should be used in a great quantity. As a result, the duct is increased in the whole self-weight and complicated in conveyance and construction so as to increase the overall manufacturing cost of the duct.

Also, an industrial duct is outwardly exposed different from the foregoing ducts for the air-conditioning system which are concealed by interior materials and facings, and thus have problems of poor outer appearance as well as the foregoing increase in stiffness. In other words, the metal plate generally used in manufacturing the conventional duct has linear grooves formed at a certain interval in a direction perpendicular to the longitudinal direction of the duct, in which the aesthetic aspect revealed for the construction of the duct is not considered at all as a drawback.

In particular, the duct has a fatality that can hardly absorb vibration from earthquake or machinery when using the flat plate.

Disclosure of the Invention

Accordingly, the present invention has been proposed to solve the foregoing problems of the related art and it is an object of the present invention to provide a metal plate having mesh-type bead for duct and apparatus of producing the same, in which the metal plate has regularly intersecting grooves in the surface thereof so that a duct can be enhanced in stiffness and vibration applied to the duct can be absorbed at a certain degree by bent portions for forming the grooves as well as a regular pattern in the surface can provide an effect of improving the outer appearance of the duct.

According to an embodiment of the invention to obtain the object, it is provided a
metal plate for duct which uses work-hardening features of metal in which the stiffness thereof increases due to hardening, bent portions are followed by groove formation to enhance deformation resistance against external forces acting in longitudinal directions of the bent portions as well as imparts a force for absorbing vibration acting in lateral directions of the bent portions so that the duct is enhanced in overall stiffness and ability of absorbing vibration.

Each of the grooves across the metal plate has a certain width and direction while one group of the linear grooves parallel in one direction and another group of linear grooves parallel in another direction are mutually intersected to define a grid-shaped or mesh-shaped regular crossing pattern in the surface of the metal plate so that the metal plate for duct has the same deformation resistance against external load and vibration in all directions rather than applied in one direction.

The grooves in the surface of the metal plate for duct of the invention are obtained through passing a flat plate through a pair of cylindrical working rolls of an apparatus of the invention, in which the working rolls have embossments and intaglios formed in the same shape as the grooves.

**Brief Description of the Drawings**

Fig. 1 shows a metal plate for duct of the invention, in which (A) is a perspective view of the metal plate, (B) is a sectional view of the metal plate having grooves with a triangle-shaped section, and (C) is a sectional view of the metal plate having grooves with an arc-shaped section;

Fig. 2 schematically shows a method of stiffness test of the metal plate for duct of the invention;

Fig. 3 is a graph for showing results of stiffness test of the metal plate for duct of the invention;

Fig. 4 is a perspective view seen from the right of an apparatus for manufacturing the
metal plate for duct of the invention;

Fig. 5 is a perspective view seen from the left of the apparatus for manufacturing the metal plate for duct of the invention;

Fig. 6 is a rear elevation view of the apparatus for manufacturing the metal plate for duct of the invention; and

Fig. 7 shows an operational stage of the apparatus for manufacturing the metal plate for duct of the invention.

**Best Mode for Carrying out the Invention**

Specific features about the object and technical structures of the invention and operational effects thereof will be understood clearly from the following description in reference to the accompanying drawings disclosing a preferred embodiment of the invention.

Fig. 1 shows a perspective view and sectional view of metal plate for duct of the invention.

As shown in Fig. 1, the metal plate 1 for duct of the invention is provided in the surface with grooves or beads B as triangle-shaped grooves 11 or arc-shaped grooves 12 in the sectional shape, in which two differently oriented groups of linear grooves parallel to one another are mutually intersected to define a network-shaped pattern as a whole.

In this case, each of the grooves B is linear in a longitudinal direction, however, it is also preferable to provide the each groove B in the form of a wave with the same advancing direction as the linear one so as to enhance the amount of work-hardening by the groove.

Therefore, the metal plate 1 for duct of the invention having the network-shaped or grid-shaped grooves is enhanced in stiffness over a conventional metal plate for duct via the grooves as work-hardened portions. In order to inspect the degree of stiffness enhancement, a test is carried out to the metal plate 1 of the invention as follows.

Unworked metal plates and metal plates for duct having grooves with triangle-shaped
sections of the invention are provided by using zinc-plated steel plates having width 700mm, length 1000mm and thickness 0.5 and 0.6mm. Then, as shown in Fig. 2, each of those plates is supported at the bottoms 21 of the both longitudinal ends thereof followed by placing a weight W on the center thereof to measure the amount of downward deflection or droop \( d \), and then results are displayed in Fig. 3.

As can be seen in Fig. 3, the metal plates 32 and 31 for duct having the thickness of 0.5 and 0.6mm and the grooves of the invention have smaller amount of droop than the metal plates 32A and 31A for duct of the related art. Moreover, the 0.5mm-thick metal plate 32 for duct of the invention is remarkably decreased in the amount of droop \( d \) than the 0.6mm-thick metal plate 31A for duct that is thicker than the metal plate 32 of the invention.

In other words, the metal plate for duct of the invention has the same amount of stiffness in the thickness at least 20% thinner than the flat metal plate of the related, which means weight reduction can be achieved for at least 20wt%.

An apparatus for manufacturing the metal plate for duct for forming the grooves in the surface of the metal plate for enhancing stiffness according to the invention comprises a pair of working rolls with groove-shaped embossments and intaglions for forming the grooves in the surface of the metal plate in a rolling fashion, a pair of pinch rolls for stably supplying the metal plate introduced into a roll byte of the working rolls at the rear of the working rolls while holding the metal plate so that the grooves can be correctly formed in the metal plate, a roll stand were the working rolls and the pinch rolls are assembled, a base frame where the roll stand is settled and supported, a driving unit for driving the working rolls and the pinch rolls, a power transmission unit for transmitting the power of the driving unit and a control unit, in which the type of a driving motor employed in the driving unit and the structure of the power transmitting unit are not restricted.

Figs. 4 to 7 are perspective and rear elevation views for showing the apparatus for manufacturing the metal plate for duct according to an embodiment of the invention.
As shown in the drawings, the apparatus for manufacturing the metal plate for duct of the invention comprises a base frame 41 constituted by a rectangular base plate 41B for settling a driving motor M as a driving unit, four posts 41A respectively erected on four corners of the base plate 41B and an upper plate 41C connected to the upper ends of the posts 41A as the upper part of the base frame 41; a pair of roll stands 42 erected on both ends of the upper plate 41A of the base frame 41; a pair of upper and lower pinch rolls 43 inserted into roll chokes RC assembled to choke-assembling recesses H at the both roll stands 42; a pair of working rolls 44 assembled to the both roll stands 42 in the same manner parallel with the pinch rolls 43 and having groove-shaped embossments and intaglios in the surface for forming the grooves; a power transmission unit constituted by sprockets MS, 43A and 44A respectively arranged at one ends of the rotary axis of the driving motor M, the pinch rolls 43 and the working rolls 44 and a chain C for connecting the sprockets MS, 43A and 44A.

The lower one of the pinch rolls 43 has a sprocket 43B at the other end together with the sprocket 43B at the one end, whereas the upper one does not have a sprocket. In the case of the working rolls 44, the lower one has a sprocket 44B at the other end together with the sprocket at the one end, whereas the upper one has sprocket at one end.

In other words, the lower one of the pinch rolls 43 is a driving roll and the upper one is an idle roll, which does not require the sprocket. In this case, if the upper roll 43 is required to be driven, the upper roll 43 can be provided with a sprocket coupled with the sprocket 43B at the other end of the lower roll which is not connected with the chain C.

In the working rolls 44, the lower one is a main driving roll, whereas the upper one is coupled with the lower one via the sprockets and driven together with the lower one by the same. Since the metal plate is worked in the roll byte of the working rolls to apply a great amount of load to the working rolls, the upper and lower rolls should be driven to restrain slip between the rolls and a rolled piece in the roll byte as the contacting portion of the working rolls 44 and the metal plate for smooth working of the grooves.
Further, the pinch rolls 43 and the working rolls 44 respectively have intervals between the upper and lower rolls, which are very important variables in the productivity and quality in metalworking. Therefore, in order to adjust the intervals between the upper and lower rolls or intervals between the upper and lower roll chokes RC having bearings so that the rolls are assembled and rotated, bolts B for adjusting the intervals between the upper and lower chokes are provided in central portion of cover plates 42A that are coupled on choke assembling recesses 42B of the roll stands 42.

The operating principle of the apparatus for manufacturing the metal plate for duct of the invention configured as above will be described in reference to Fig. 7 as follows.

The sprocket MS at the rotary axis of the driving motor is connected to the sprocket 43A at one end of the lower pinch roll and the sprocket 44A at one end of the lower working roll. Between the lower pinch roll sprocket 43A and the lower working roll sprocket 44A, a tension sprocket TS is provided at an outer side of the one roll stand for imparting tension to the chain C and ensuring correct and stable power transmission. Therefore, when the driving motor M is rotated, the lower pinch roll and the lower working roll are rotated together.

In this case, the upper pinch roll is a non-driving roll which is rotated only if contacted with the lower pinch roll, and a sprocket 44C arranged at the other end of the upper working roll is coupled to the sprocket 44B arranged at the other end of the lower working roll so that the upper working roll is driven together with the lower working roll.

In other words, after the driven motor is operated as the interval of the pinch rolls is adjusted at or under the thickness of the metal plate, to which the grooves are supposed to be formed, the metal plate P is inserted into the roll byte of the pinch rolls and moved into the roll byte of the working rolls 44 by the upper and lower pinch rolls 43 so that the grooves are formed in the surface of the metal plate between the upper and lower working rolls having the groove-shaped embossments and intaglios to obtain a metal plate DP for duct.
Industrial Applicability

As described hereinbefore, the metal plate for duct having the mesh-type grooves according to the invention is remarkably enhanced in stiffness compared to the metal plate for duct of the related art and thus can reduce the thickness of the metal plate thereby saving the manufacturing cost of a duct and the transporting and constructing cost according to installation of the duct.

Also, in the case of a higher-storied building requiring the ducts in a large amount, decrease in the overall duct weight can reduce the endurance required to the building so that the building cost can be reduced. In the case of outwardly exposed ducts, the grooves regularly formed in the surface thereof can improve the aesthetic appearance. Bent portions are regularly formed across the whole plate so that vibration induced by an earthquake, for example, can be self-absorbed for a certain degree thereby having an effect for preventing deformation of the ducts caused by vibration.

Further, according to the apparatus for manufacturing the metal plate for duct having the mesh-type grooves, the metal plate of the duct is manufactured to have the grooves through only one rolling via the pair of working rolls having the groove-shaped embossments and intaglios so that the grooves in the metal plate have a correct and regular groove pattern and the productivity can be enhanced.
What is claimed is:

1. A metal plate for duct comprising: uneven grooves regularly formed in the surface of the metal plate, with each of said grooves being linear and having a sectional shape of triangle or arc with a certain width, wherein said grooves form two groove groups which are parallel to each other and different in direction to define a mesh-shaped regular pattern across the surface of the metal plate.

2. The metal plate for duct according to claim 1, wherein said each groove is wave-shaped having the same advancing direction as the line.

3. An apparatus for manufacturing the metal plate for duct of the invention comprising:
   a base frame constituted by a rectangular base plate for settling a driving motor as a driving unit, four posts respectively erected on four corners of said base plate and an upper plate connected to the upper ends of said posts as an upper part of said base frame;
   a pair of roll stands erected on both ends of said upper plate of said base frame;
   a pair of upper and lower pinch rolls inserted into roll chokes assembled to choke-assembling recesses at said both roll stands;
   a pair of working rolls assembled to said both roll stands in the same manner parallel with said pinch rolls and having groove-shaped embossments and intaglios in the surface for forming grooves;
   a power transmission unit for driving said working rolls and pinch rolls and constituted by sprockets respectively arranged at one ends of said rotary axis of said driving motor, said pinch rolls and said working rolls and a chain for connecting said sprockets.
A. CLASSIFICATION OF SUBJECT MATTER

IPC7 B21D 53/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC B21D 17/00-55/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C. See patent family annex.

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Date of the actual completion of the international search
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