Jan. 5, 1932. L. G. SYMONS 1,839,614

SCREEN

Filed Nov. 13, 1929 3 Sheets-Sheet 1

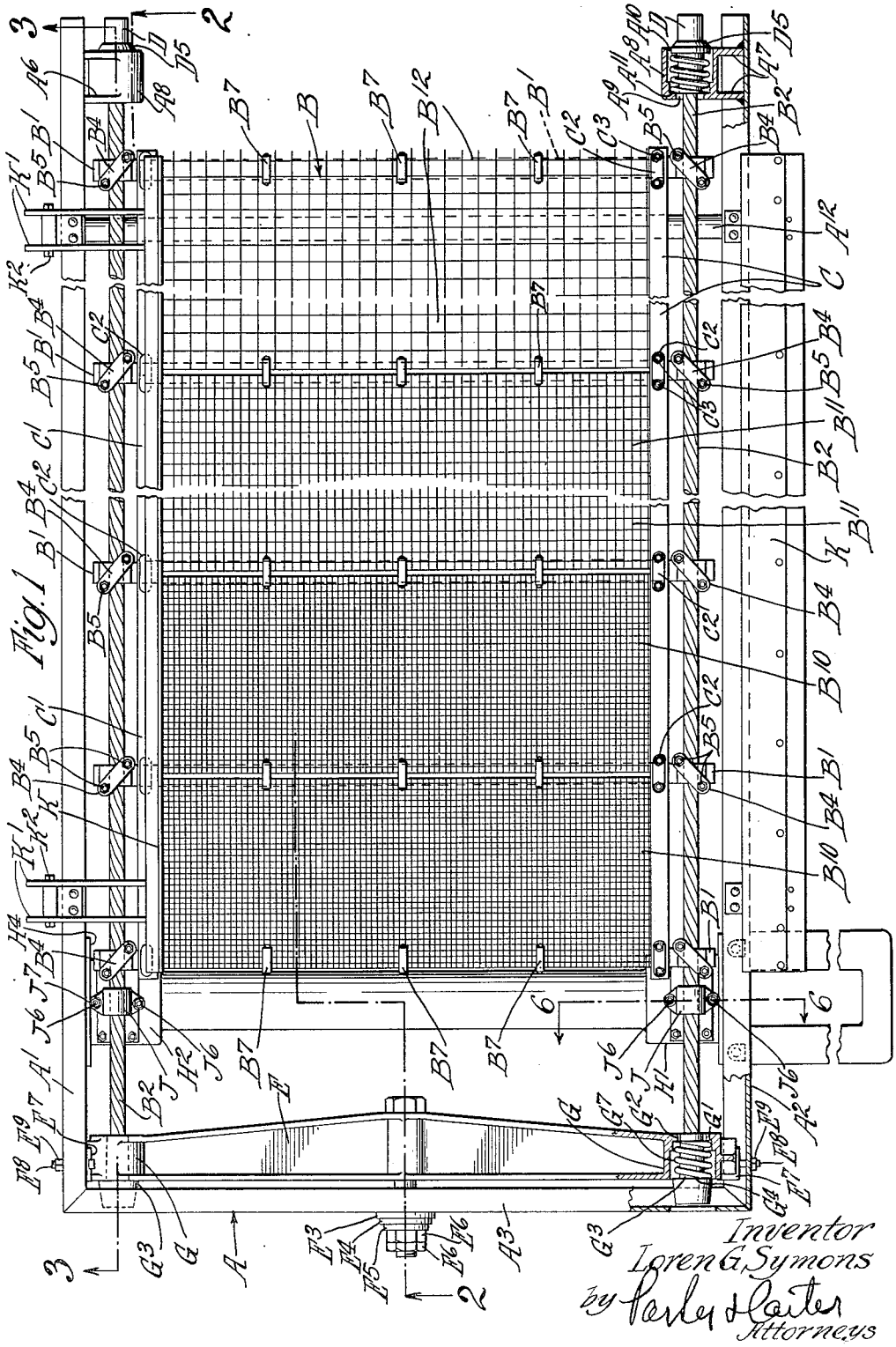


Fig. 1

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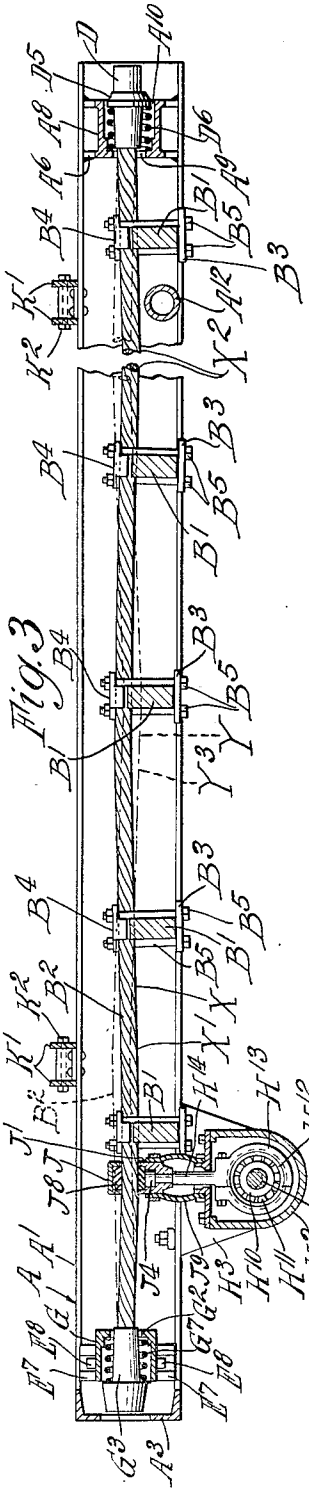


Fig. 3

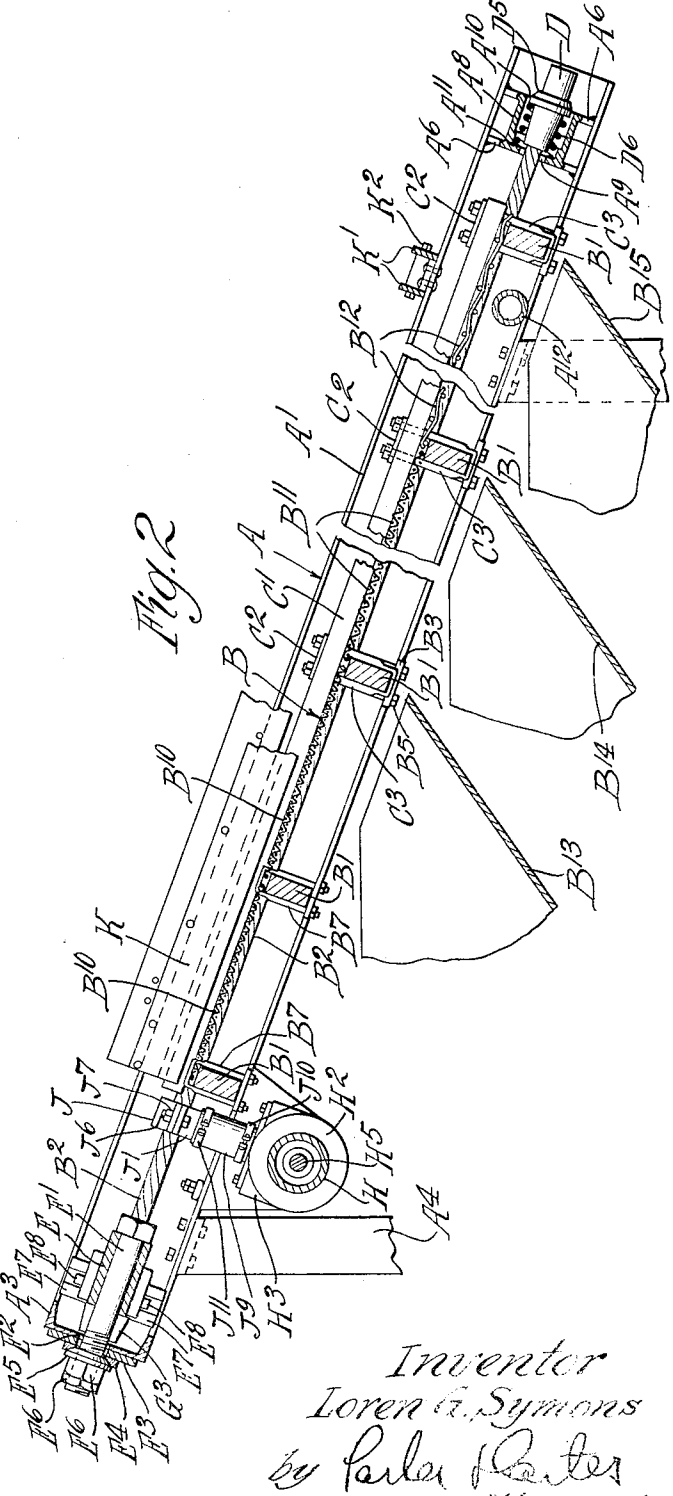


Fig. 2

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Fig. 4

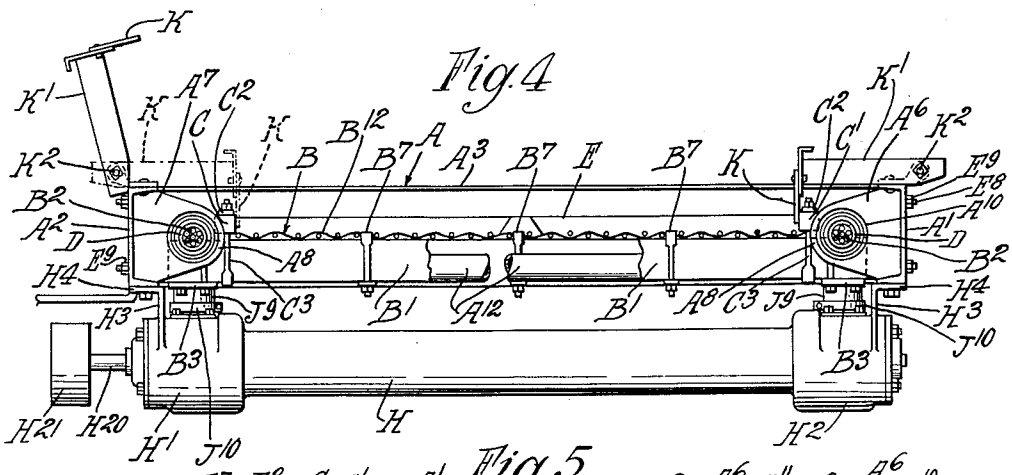


Fig. 5

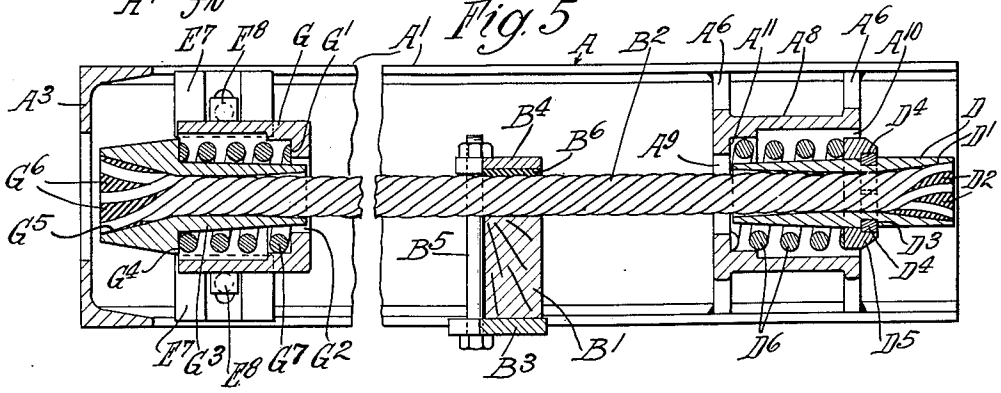
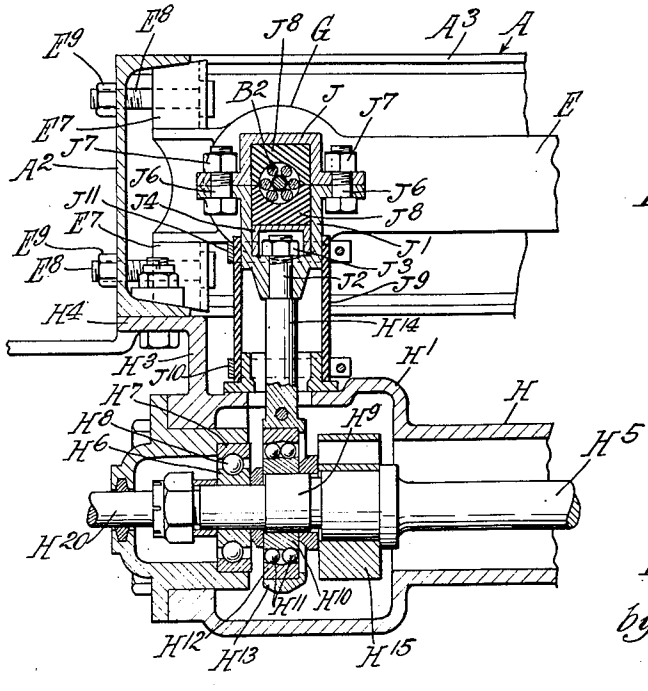


Fig. 6



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Patented Jan. 5, 1932 1,839,614

UNITED STATES PATENT OFFICE

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SCREEN

Application filed November 13, 1929. Serial No. 406,782.

My invention relates to an improvement in screens and relates particularly to an improved vibratory screen. One object of the invention is the provision of a screen, flexible from end to end, which screen includes sections of different mesh. Another object is the provision of a screen structure, including sections of different mesh, to which may be imparted a wavelike vibration the waves of which pass along the entire screen structure, actuating all the various sections and imparting to all of them a vibration of substantially uniform amplitude. Another object is the provision of tensional flexible supporting members for such a screen, which supporting members flex with the screen, and extend along and support the entire screen series of sections of different mesh. Another object is the provision of means permitting the ready removal of individual and separable screen panels or sections. Other objects will appear from time to time in the course of the specification and claims.

I illustrate my invention more or less diagrammatically in the accompanying drawings, wherein—

Figure 1 is a plan view;

Figure 2 is a section on the line 2—2 of Figure 1;

Figure 3 is a section on the line 3—3 of Figure 1;

Figure 4 is an end elevation;

Figure 5 is a detail, and

Figure 6 is a section on the line 6—6 of Figure 1.

Like parts are indicated by like symbols throughout the specification and drawings.

Referring to the drawings, A generally indicates any suitable frame member, of which I show the side channel members A^1 A^2 which may be connected as by the transverse end member A^3. In order to support the frame and screen at any desired angle I may employ supports A^4 A^5 of unequal height. A^6 A^7 are brackets welded to the ends of the channels A^1 A^2, each bracket including a generally cylindrical portion A^8 with a restricted aperture A^9 facing the opposite end of the screen and an enlarged aperture A^{10}. A^{11} indicates a circumferential ledge or seat the purpose of which will later appear. A^{12} is a transverse brace or tube welded to the side channels A^1 A^2.

B generally indicates any suitable screening member, herein shown as of mesh. It is mounted upon a plurality of transverse members B^1, which may be relatively rigid and may, for example, be of wood, and which extend from side to side of the screen. These members B^1 are secured to longitudinal cables B^2 B^2, extending along each side of the screen and being herein shown as of greater length than the screen and extending beyond the screen at each end thereof. The members B^1 may be secured in relation to the cables or flexible tensional members B^2, as by the lower clamp members B^3, the upper clamp members B^4 and the securing bolts B^5. B^6 indicates any suitable cushion or more or less flexible member which may be interposed between the clamp B^4 and the cable, in order to prevent a metal to metal contact, in case a metal cable is employed. B^7 indicate any suitable clamps, spaced along the members B^1, whereby the mesh may be secured to the said transverse members at sufficiently frequent intervals to insure that the entire structure vibrates virtually as a unit, and to constrain the mesh to downward vibration or movement with the supporting structure. Thus any whipping or free movement of the mesh is prevented and the entire structure can be vibrated as a unit.

It will be noted, as in Figures 1 and 2, that the screen or mesh, generally indicated as B, is divided into a plurality of separate and separable sections or panels. Referring to Figure 1, I illustrate panels, B^{10}, of relatively fine mesh, panels B^{11} of intermediate mesh, and panels B^{12} of coarse mesh. Thus as the material undergoing separation passes along the screen there is a successive classification, the fines passing through the sections B^{10} and the largest particles passing over the end of the screen. I may employ any suitable separate means for receiving the discharge from the various sizes of mesh. I indicate, as in Figure 2, any suitable receiving hoppers or chutes B^{13} for the fines, B^{14} for the intermediate size, and B^{15} for the ma-

terial passing through the mesh B^{12}. It will be noted that the individual sections or panels are shown in Figure 1 as having their opposed edges terminating along or above the transverse members B^1, to which they are clamped as by the above described clamp members B^3 B^4 B^5. The individual screen panels, in case they wear or sag or are otherwise damaged, may be separately and individually removed, without the replacement of the entire screening surface.

Positioned along the opposite edges of the screen are the flexible material guiding walls indicated as C C^1. They are preferably of material which will flex with the screening and with the flexible members B^2. I may, for example, employ strips of rubber. These strips may be clamped in place, as by clamping elements C^2 and U-bolts C^3 which may pass about the members B^1. These strips overlie the edges of the individual screen panels and may be employed to serve as clamps or to help in clamping or securing the side edges of the individual screen sections.

Whereas I do not wish to be limited, except so far as I limit myself in the claims, to any specific cable structure, I illustrate the members B^2 as metal cables, formed of a plurality of metal strands or wires. In order to support these cables within the above described frame and to maintain them under tension, I provide an enlarged head at each end of each cable. Referring, for example, to Figure 5, I illustrate one end of the cable as passing through the cylindrical member A^8.

About the end of the cable I illustrate a sleeve D the outer end of which is outwardly tapered as at D^1, to provide an expansion of its bore to a diameter greater than the normal diameter of the cable B^2. The end of the cable may be more or less frayed out, as shown in Figure 5, and metal or any other suitable packing or expanding medium D^2 may be employed, to provide an expansion or enlargement of the cable end which will prevent it from drawing through the sleeve D. Zinc is a satisfactory metal to be employed as an expanding filler for the cable end. In order to prevent the necessity of placing zinc in the cable in the field, I may provide the sleeve D, which is channeled as at D^3, with a pair of outwardly projecting half rings D^4 which may be put in place after the full ring D^5 has been slipped about the cable. D^6 indicates a spring compressed between the ledge A^{11} and the ring D^5, and tending to maintain the cable under constant tension.

In order to maintain both cables under a uniform tension, and to compensate for what would otherwise be differences in tension, I provide a transverse yoke E. This yoke may be secured to the end frame member A^3, as by the pin or bolt E^1 which passes through an aperture E^2 in the frame. Surrounding the end of the member or bolt E^1, where it passes through the aperture, is any suitable washer E^3 having associated therewith a more or less spherical surfaced bearing member E^4 opposed to a spherical surface member E^5 about the bolt E^1. E^6 E^6 are any suitable adjusting and locking nuts, whereby the tension on the entire structure may be varied. It will be understood that the proportion of the parts is such that the yoke E may tilt somewhat about its point of support, this movement being permitted by the size of the aperture E^2 and the spherical formation of the opposed engaging members E^4 and E^5. Preferably I constrain the yoke E to horizontal position, or, rather, to a position normal to the plane of the frame. I may therefore provide blocks E^7 opposed to the ends of the transverse yoke E, the bolts and nuts E^8 E^9 being provided to take up the slack and to prevent any up and down movement of the yoke due to the vibration of the cables.

Formed in each end of the yoke is a socket G with a ledge G^1 and an aperture G^2 through which may pass the end of the cable B^2. G^3 indicates a sleeve about the cable, with the abutment ledge G^4 and the enlarged central aperture G^5 to receive the unraveled end of the cable, with its filler G^6, for example of zinc. Compressed between the ledges or abutments G^1 and G^4 is the spring G^7. As shown in Figure 5 it will be seen that each end of the cable is yieldingly mounted, the two springs D^6 and G^7 serving to put the cable under any desired tension, this tension being equalized by the yoke E.

In order to impart vibration to the cables I provide the vibratory structure below described. A transverse housing H, with terminal enlargements H^1 H^2 is positioned beneath and mounted upon the frame. I may employ for example the supporting webs H^3 with their flanges H^4, which may be bolted to the longitudinal frame members A^1 A^2. Mounted for rotation within the housing H is any suitable shaft or rotary member H^5. It may be provided at each end with an inner ball race H^6 fixed on the shaft, an outer ball race H^7, and the intervening ball bearings H^8. Figure 6 generally illustrates an eccentric at one end of the shaft H^5 and it will be understood that a corresponding eccentric and actuating structure is associated with the opposite end. Referring again to Figure 6, H^9 indicates a cylindrical eccentric member surrounded by the inner ball race H^{10}, the ball bearings H^{11} and the outer race H^{12}. The outer race is mounted in the eye of a vibration transmitting link which includes the annular member H^{13} and the shaft or stem H^{14} extending upwardly therefrom. H^{15} is any suitable counterweight associated with the shaft H^5.

In order to transmit movement of the ele-

ment H^{14} to the cables B^2 I provide a clamping structure which includes the upper clamp element J and the lower clamp element J^1. The lower element J^1 may be secured to the connector H^{14}, as by the screwthreaded bolt portion J^2 and the nut J^3. J^4 is a spacer about said nut. The clamp elements J J^1 may be secured together as by the bolts J^5 and the nuts J^7. J^8 J^8 are yielding pads associated with the clamp member, one engaging the upper and the other the lower side of the cable B^2. These pads serve to prevent a metal to metal contact and to more or less cushion the connection between the connector H^{14} and the cable, thus limiting wear.

In order to prevent the access of dust to the working parts and to reduce the lubricating problem I provide a flexible connection between the above described clamp structure and the enlarged housing portion H^1. This may take the form of a flexible member J^9, herein shown as tubular, the ends of which may be clamped into dust proof engagement with the housing portion H^1 and the clamp structure J^1 respectively, as by the rings J^{10} J^{11}.

I may provide any suitable means for rotating the shaft H^5 and as an illustration of a practical method I illustrate the shaft extension H^{20} with the pulley H^{21} thereupon.

In order further to constrain the material passing over the screen to longitudinal travel along the screen, and to prevent it from escaping from the edge of the screen, I provide, in addition to the flexible walls C^1, the inner guiding walls generally indicated as K. These may be of sheet or strip metal and are shown, as in Figure 4, as terminating somewhat above the mesh, and as being positioned within the flexible walls C C^1. The flexible walls C C^1 bridge the gap between the normally fixed members K, and prevent any friction or damaging or wearing contact between the members K and the mesh. The members K may be mounted upon brackets K^1 pivoted as at K^2 to the longitudinal frame members A^1 or A^2, whereby the members K may be rotated out of vertical alignment with the mesh, as shown at the left of Figure 4. This is advantageous, as giving full contact to the mesh, and as permitting the mesh to be lifted into and out of place, in setting up the screen.

It will be realized that whereas I have described and shown a practical and operative device, nevertheless many changes might be made in the size, shape, number and disposition of parts without departing from the spirit of my invention. I therefore wish my description and drawings to be taken as in a broad sense illustrative and diagrammatic, rather than as limiting me to my specific showing. In particular I wish it to be understood that mere variations in proportion or location of parts do not depart from my invention. Where in certain of the claims I describe cables as extending from end to end of a screen member it will be understood that such claims are to be interpreted sufficiently broadly to cover a screen in which the distance between the cables exceeds the length of the screen.

The use and operation of my invention are as follows:

I provide herein a screen member to which may be imparted a wavelike vibration. In practice I find it desirable and adding highly to the efficiency of the screen that the amplitude of vibration be as nearly as possible uniform throughout substantially all points on the effective screening area. I impart the desired vibration to my screen by supporting the mesh B upon flexible supporting members, for example the cables B^2, which extend along opposite edges of the screen and which not only flexibly support the screen, permitting it to flex freely, but are themselves the intermediary between the vibration imparting mechanism and the screen, and transmit to the screen the vibration which they receive. In order to cause the screen to vibrate completely in unison with the members B^2, I mount the screen upon the relatively rigid transverse members B^1, and clamp the screen to these members B^1 at a number of spaced points. The result is a screen which will flex transversely of its ends but which will not flex longitudinally. Hence I may impart to the screen a uni-directional wavelike vibration, and the crests and troughs of the waves of this vibration will extend from side to side of the screen, with equal ampitude, and will move longitudinally along the screen, unimpeded by any stiffening or hampering frame or other supporting means. The nature of this wavelike vibration which is imparted to the cables B^2, and through them to the screen, is illustrated somewhat diagrammatically in Figure 3. The position of the cable at one instant is indicated in full line as at X. The position of the cable at another limit of its vibration is indicated in dotted line as at Y. Note that the cable indicates the wavelike formation and travel of the vibration, with the wave troughs X^1 X^2 and the wave trough Y^3. Thus each point along the screen is vertically vibrated through a vibration of uniform amplitude, while the individual waves of this vibration travel in definite sequence from end to end of the supporting members and screen.

As the screen structure includes panels of varying mesh, it will be understood that the vibration imparted to the flexible supports extends throughout the entire screen series, imparting a characteristic wavelike vibration of uniform amplitude for all the screening sections.

As an effective means of imparting the de-

sired vibration to the cables B^2 I provide the eccentric structure shown in detail in Figure 6. Its effect, broadly stated, is the vertical reciprocation or oscillation of the upper end of the member H^{14}. The lower end, the eye H^{13}, is constrained to a circular oscillation by its position about the rotated eccentric H^9. But this movement is translated, so far as relates to the point of connection of the clamping structure with the cable, to a vertical reciprocation or oscillation. This oscillation or vibration is imparted to each cable B^2 in unison and it is imparted to the cables, adjacent their upper ends, and adjacent the upper ends of the screen. The point of application shown in Figures 2 and 3 is a convenient one. It will be understood that I might apply the vibrations elsewhere along the length of the flexible members B^2. In any case, the vertical oscillation of the upper end of each of the cables imparts to the cable the characteristic wavelike vibration diagrammatically shown in Figure 3, and this wavelike vibration is fully imparted to the entire surface of the screening mesh through the members B^1 and the clamps. Although the oscillating mechanism is mounted on the frame, it is in cushioning engagement with the cables, through the pads J^8. The cables themselves, being yieldingly mounted at each end, cannot transmit their vibrations to the frame. In practice, although the screen is undergoing a rapid and ample vibration, the frame does not vibrate and will not vibrate even though it may be supported loosely on the floor of a plant. The rotation of the shaft H^5 imparts no vibration to the frame, because the shaft is provide with proper counter weights. No vibration is imparted to the housing portion H^1, because its sole connection with the vibrated cables in through the flexible housing J^9, which of course transmits no shock or vibration. It is therefore possible to employ a light, open screen frame and to employ light and simple supporting means therefor. The frame is freed from wire or vibratory distortion.

The movement of the cable resembles that of the body of a snake when crawling, the wavelike vibration, however, being in a generally vertical plane. It is true that the cable could be vibrated slowly enough to cause it to vibrate as a violin string, which would give a pronounced movement in the center of the screen, with the amplitude of vibration diminishing from the center toward both ends. But in practice in the structure shown herein, a somewhat more rapid rate of vibration causes the travel of waves lengthwise along the cable and all parts of the screen cloth supported on the cable will be given an upward movement along the full length of the cloth, with every wave set up, and a downward movement, the upward and downward movements corresponding to the difference between the crests and troughs of the waves which travel along the screen. The mechanism is actuated at such speed that the waves follow each other in rapid succession, the crests and troughs extending transversely across the screen from edge to edge, and follow each other lengthwise along the screen. As earlier stated, the screen reproduces the vibratory movement of the cables in a downward as well as in an upward direction, the transverse members B^1 and their clamps rendering this the necessary result of the vibration of the cables.

The material is held on the screen by means of the rubber or flexible strips C C^1, which are fastened securely along each edge of the cushion and which vibrate freely with the cushion and with the cables B^2. The additional stationary sides fit inside the rubber strips but are positioned far enough from the screen cloth to prevent contact or wear. The result is a saving in power and a decrease in the amount of vibration transmitted to the supporting frame. The hinging of the stationary sides permits the screen cloth to be removed with a minimum of work. The rubber strips serve also as clamping means for holding the edges of the individual screen panels.

The tensional mounting of the cables is an important and probably a necessary element in the production of the wavelike movement of the cables, as when the movement is set up in the cables it has a tendency to shorten the distance from one end of the cable to the other. The springs G^7 and D^6 take care of this variation in length, and permit the cable to take this wave movement without adding any undue strain due to the increase in tension. The springs also prevent any tendency to throw back a wave in the opposite direction, and each wave, as it reaches the end of the cable, is killed through the flexibility of the springs. This is important, since if a return wave were set up it would kill the next initial wave traveling in the opposite direction at the point where they meet.

In connection with the wavelike vibration the transverse yoke or equalizer E is of great importance, as unless the tension of one cable is almost exactly the same as the tension of the other there will be a marked difference in the length and height of the waves produced by the eccentric action. The result of the use of the yoke is not only to equalize the tension of the cables, but to equalize the rate and amplitude of vibration throughout the width of the screen. In its action the screen suggests the dusting of a carpet by holding a strip at its two corners and moving it up and down, to cause waves of vibration to travel from end to end of the carpet. In this connection will be understood the impor-

tance of providing a screen which is transversely flexible but longitudinally inflexible. I mean a screen which will flex to permit transverse waves of vibration to move from end to end of the screen, but will not flex to permit waves of vibration to move laterally across the screen. In this sense the screen is flexible transversely, but is held against longitudinal flexure.

While it may be preferable to employ a spring connection between each end of each cable and the frame and yoke respectively, as shown in Figure 1, I find it desirable under some circumstances to eliminate one of the springs and to eliminate the yielding connection for one end of each cable. For example I may omit the spring D^6 and let the abutment D^5 engage the abutment A^{11}. Or any other suitable abutment means may be employed for maintaining the end of the cables B^2 connected to the frame. In such case the springs at the upper end of the cable, the springs G^7, may be employed to take care of the shortening and lengthening of the distance, to permit the wave-like vibration to take place, but the solid connection of the opposite end of the cable may produce a much stronger vibration throughout the lower portion of the screen cloth than would otherwise be produced. In the accompanying claims it will be understood that I do not wish to limit myself to the employment of a yielding connection for each end of the cable unless I specifically so limit myself by the language of the claims. Also I do not wish to be limited, when employing a single yielding connection, to the position of that connection specifically at any given end of the cable, except so far as I specifically so limit myself. In practice a very satisfactory arrangement is to connect the cables yieldingly to the yoke E and unyieldingly, at their opposite ends, to the frame. My tests have indicated that the yielding connection at the vibration transmitting end of the cable, namely between cable and yoke, is effective in preventing return vibration or return waves of vibration along the cable.

I claim:

1. In a screen, a flexible screen member, a plurality of cables, upon which said flexible screen member is mounted, said screen including a plurality of sections of varying mesh spaced along said cables, and means for imparting to said cables and, thereby to the sections of said screen member, a wave-like vibration, of substantially uniform amplitude from end to end of the screen member and means for maintaining said cables under tension.

2. In a screen, a flexible screen member, a plurality of cables, upon which said flexible screen member is mounted, said screen including a plurality of sections of varying mesh spaced along said cables, and means for imparting to said cables and, thereby to the sections of said screen member, a wave-like vibration, of substantially uniform amplitude from end to end of the screen member, and means for maintaining said cables under tension, and means for constraining the screen member to a substantially uniform amplitude of vibration from side to side thereof.

3. In a screen, a flexible screen member, a plurality of cables, upon which said flexible screen member is mounted, said screen including a plurality of sections of varying mesh spaced along said cables, and means for imparting to said cables, and, thereby to the sections of said screen member, a wave-like vibration, of substantially uniform amplitude from end to end of the screen member, means for maintaining said cables under tension, and means for constraining the screen member to a substantially uniform amplitude of vibration, from side to side thereof, including transverse supporting members extending between the cables, and means for holding the screen against movement in relation to said transverse supporting members.

Signed at Hollywood, county of Los Angeles and State of California, this 23rd day of October 1929.

LOREN G. SYMONS.