SCRAPER BLADE MOUNTING ARRANGEMENT

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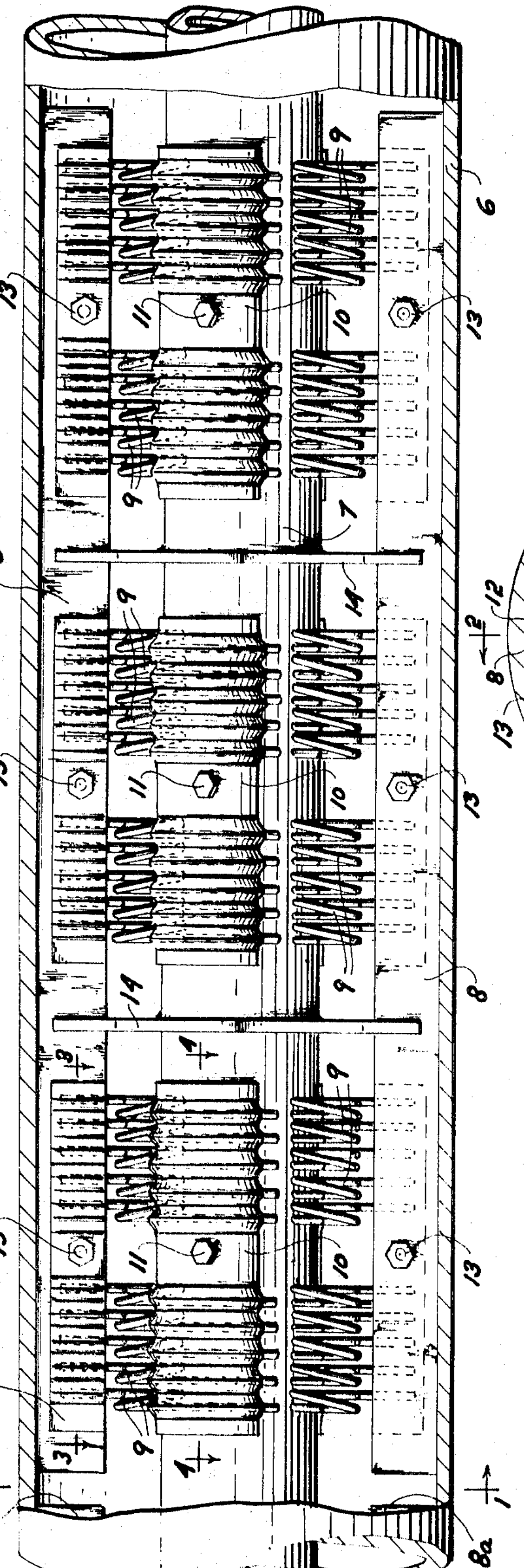

FIG-2

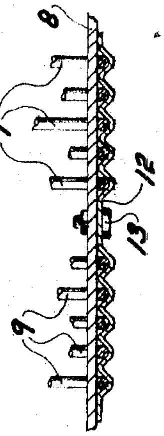

FIG-3

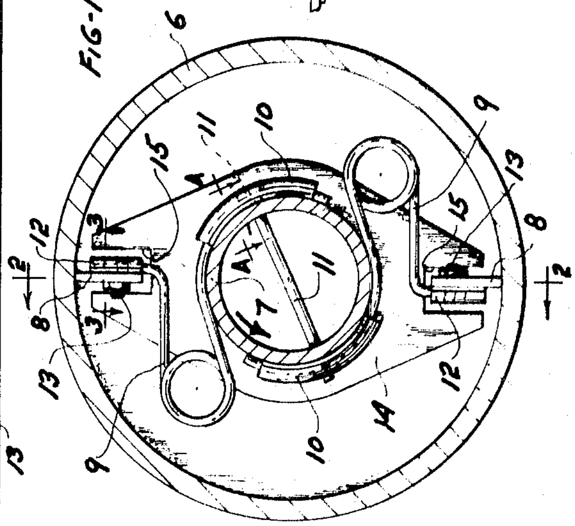

FIG-1

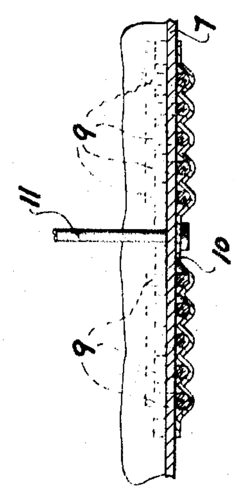

FIG-4

INVENTOR.
RICHARD M. ARMSTRONG
ANDREW J. ARMSTRONG
BY
Synnestvedt & Lechner
ATTORNEY

United States Patent Office

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Richard M. Armstrong, P.O. Box 566, and Andrew J. Armstrong, R.D. 4, both of West Chester, Pa. 19380

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ABSTRACT OF THE DISCLOSURE

Scraper mechanism for use in scraping deposits from the interior surface of a shell including a scraper blade and a plurality of spring assemblies each incorporating a cluster of spring elements for yieldingly holding or suspending the scraper blade in a predetermined position with an edge of the blade in scraping engagement with the shell wall. Provision is also made for limiting motion of the blade from said predetermined position and therefore for limiting spring deflection. Provision is still further made for preventing appreciable movement of the blade from its predetermined spring suspended position.

This invention relates to mechanism for use in scraping deposits from the interior surface of a shell in which materials are treated. There are many industrial applications for equipment comprising a material treatment shell having a scraper mechanism mounted inside the shell and providing for scraping of deposits from the interior surface. Many of these applications are in equipment commonly known as scraped surface heat exchangers. For example, equipment of this general type is known for use in various of the chemical industries, including the treatment of petroleum oil for the purpose of dewaxing the oil. Such equipment is also used in the crystallization of organic chemicals, for example in the separation of para from meta xylene. Such equipment is also used in the selective crystallization of fatty acids or glycerides. Another use for this general kind of equipment is in the cooling or heating of viscous materials, in which it is desired to scrape the boundary layer from the shell wall in order to bring fresh material to the shell wall for more effective heat transfer. Another use is in desublimation condensing where a solid forms on a cooled wall. The scraper removes the solid, thereby improving heat transfer.

Scraper blades within a material treatment shell are customarily yieldingly urged against the shell wall. In most prior arrangements the blades are pivotally mounted or provided with some other structure for guiding the blade motion. Thus, in most of the prior arrangements the blades are supported by a combination of both mechanical means guiding the blade motion, and spring means urging the blade toward the shell wall. In a few prior arrangements no pivot or other guide is provided but the blades are freely, i.e., completely, spring suspended, and the present invention is particularly concerned with improvements in this latter type of arrangement which has a number of distinctive advantages, including the fact that the blade, when freely spring suspended, will follow and conform to the contours of the shell surface with maximum accuracy.

However, problems have been encountered in connection with the spring suspension arrangements heretofore used in the type of equipment in which the blades are freely spring suspended. Thus, failure of the mounting or suspension springs as a result of fatigue has presented a serious problem and has many times resulted in disastrous effects upon the equipment. Failure of mounting springs is not only highly undesirable because of the consequent loss of the desired scraping function, necessitating protracted shutdown of the equipment for repair,

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but in many cases has also resulted in dropping of the unsupported blade into other parts of the equipment with consequent damage to other parts of the apparatus.

In many shell scraper installations, the function performed by the scraper is only one of a series of operations being carried out in a continuous manner in a production or treatment plant, so that failure of the scraper mechanism may result not only in shutdown of the equipment in which the scraper mechanism is used, but also in shutdown of other interconnected parts of the production or treatment system.

It is the major objective of the present invention to provide a spring suspension system for scraper blades which extensively reduces spring failure.

Another major objective of the invention is to provide an arrangement which, even in the event of spring failure, will act to restrict blade movement.

Before considering the specific embodiment of the equipment of the present invention as illustrated in the drawings, it is here further pointed out that in a typical prior art scraped shell device, a cylindrical shell is employed in which a material is subjected to treatment, for instance cooling for the purpose of causing crystal deposits on the interior surface of the shell. A drive shaft is arranged axially and centrally of the shell and one or more scraper blades are mounted on the drive shaft by means of springs. Such springs commonly comprise metal strips of substantial width as compared with the thickness thereof, for instance 2" wide, the strips often having a U-bend intermediate the ends and being connected at one end with the driving shaft and at the other end with the scraper blade. These springs are of course subjected to cyclic stress during operation, and even when meticulously fabricated the cyclic stress is likely to result in fatigue failure. If there is an incipient failure in one of such strip type of springs, under the influence of the cyclic stress, the failure propagates all the way across the spring, so that the whole spring fails relatively promptly after the initial crack develops.

In such prior art arrangements employing strip springs, the individual scraper blades are ordinarily supported by only a few, for instance two or three such springs, and in the event of failure of even one of the springs, a serious condition results because of increased load and asymmetrical or unbalanced forces to which the other springs are consequently subjected. Moreover, with only two or three springs for supporting a given scraper blade, the percentage probability of failure of all of the springs is relatively high, and experience has shown that total failure of the spring support of blades does occur and has resulted in highly disadvantageous equipment shutdowns and damage.

With the foregoing in mind, instead of employing strip type of springs, the present invention contemplates the employment of spring assemblies in which each assembly is preferably made up of the multiplicity of individual spring elements arranged in a group or cluster. The spring elements may take a variety of different forms, but are desirably made in the form of wire which may either be circular or angular in cross section. Although, in a cluster of such small springs, some of the springs may fail, the failure of any one is not propagated to and through others, so that if one or two out of eight or ten spring elements in a cluster fail under the cyclic stress, only a small percentage of the total spring suspension has been impaired.

Moreover, while the failure of one or more elements of a cluster of spring elements will increase the load on the remainder and thereby tend to increase the deflection of the remaining spring elements, the invention further contemplates the provision of an abutment means for limiting the deflection of the elements of the spring cluster, in view of which the load on the springs is limited and cannot increase as the individual elements fail.

How the foregoing objects and advantages of the invention are attained will appear more fully from the following description referring to the accompanying drawings which illustrate a preferred embodiment of the invention, and in which;

FIG. 1 is a cross sectional view through a scraped shell device and illustrating scraper mechanism according to the invention arranged in the shell, this view being taken as indicated by the section line **1**—**1** of FIG. 2;

FIG. 2 is a longitudinal sectional view through the shell taken as indicated by the line **2**—**2** of FIG. 1, but illustrating the scraper mechanism in elevation; and

FIGS. 3 and 4 are views of certain details taken as indicated by the line **3**—**3** and **4**—**4** on FIG. 2.

Referring to the embodiment illustrated in FIGS. 1–4, a cylindrical shell is indicated at **6**, and for the purpose of the present description, it may be assumed that this shell is adapted to be externally cooled as so to promote the formation of deposits on the interior surface of the shell as the materials being treated are passed through the shell.

A drive structure, conveniently in the form of a driving shaft **7** is positioned lengthwise within the shell, preferably axially thereof. This shaft is of course journalled at its ends and desirably provided with gearing or other means for effecting rotation, for instance in the direction indicated by the arrow in FIG. 1.

One or more scraper blades are provided within the shell, in the embodiment shown two such blades being mounted in diametrically opposite positions, as indicated at **8**—**8**. The scraper mechanism may further include additional blades such as indicated at **8***a*—**8***a* at the left hand end of FIG. 2, which may be aligned with the blades **8**—**8** or, if desired, may be angularly offset from the blades **8**—**8**. In typical equipment a series of blades is ordinarily provided axially of the shell, as well as in diametrically opposite positions.

Each of the blades **8** is supported by means of a plurality of spring elements **9**, each element in the embodiment shown being in the form of a wire bent in the midportion through 1½ turns and having one end connected with the driving shaft **7** and the other end connected with one of the blades **8**. Although the spring elements may be of a variety of different cross sectional shapes, such as square or rectangular, the wire shape having circular cross section, as illustrated is preferred. Moreover, the spring elements need not necessarily be bent to provide a 1½-turn loop in the midportion, but may merely be bent to U-shape in the midportion or may be bent in some other fashion providing the desired deflection characteristics. The shape of the spring as illustrated in the drawings is a particularly effective shape because it provides for adequate deflection to accommodate operating conditions without imposing any considerable load in the spring in any portion thereof.

For the purpose of fastening the springs to the driving shaft **7** and also to the blades **8**, it is preferred to arrange the springs in groups or clusters, for example in the pattern plainly shown in FIG. 2. Here it will be seen that two groups of five springs are mounted in common by fastening devices shown in FIGS. 3 and 4. FIG. 4 illustrates a fastening device **10** adapted to cooperate with the inner ends of the springs which are arcuately curved in conformity with the curvature of the outside of the drive shaft **7**, as appears in FIG. 1. The fastening device **10** is similarly arcuately curved and is provided with arcuate corrugations proportioned to receive the inner ends of the respective springs. The device **10** may then be clamped to the drive shaft **7** by means of a through bolt **11**. This bolt is adapted to pass through an aperture provided in the central portion of the fastening device **10**. In fact, as seen in FIG. 1, the bolt **11** serves to connect two diametrically opposite fastening devices **10** for the inner ends of the spring elements employed in supportnig the two diametrically opposite scraper blades **8**. The ends of the springs **9** associated with the fastening device **10** are desirably spot welded in the corrugations or otherwise bonded for secure anchoring of the springs therein.

At their outer ends, the springs are provided with straight end portions adapted to be received in the corrugations provided in the fastening device **12**. This device is also provided with corrugations proportioned to fit the ends of the springs and these ends are also desirably tack welded to the device **12**. Bolts **13** serve to attach the devices **12** to the blades **8**, an aperture being provided for that purpose.

From FIG. 2 it will be seen that the springs for each of the blades **8** are assembled in three general groups for purposes of mounting, one group being positioned toward one end of each blade **8**, another group toward the other end of that blade, with the third group in the midregion. In the embodiment illustrated, each of these groups or clusters of springs are also arranged in two subgroups of five associated with each of the scraper blades **8**.

It will be understood that different numbers of springs may be employed and different grouping and subgrouping may also be employed, but it is preferred to employ clusters of spring elements and it is further preferred that the spring elements of these clusters have common mounting means. While the spring elements may be clustered in various different ways, for instance in overlapping layers, the distribution of the springs along the blade in a single layer, as illustrated in the drawings, is convenient and effective.

Moreover, the spacing of the various springs and groups or clusters thereof may be differently arranged than as shown in FIG. 2, and the springs may even be virtually uniformly distributed throughout the length of the scraper blades. Spacing to some extent between certain groups or clusters is however preferred for convenience in the mounting arrangements and also in order to accommodate certain other devices between groups of springs, including the abutment and retainer devices described just below.

With particular reference to FIGS. 1 and 2, it will be seen that plate-like retainer and abutment devices **14** are mounted upon the drive shaft **7**, as by welding, and have portions projecting in diametrically opposite directions, i.e., in the region of the blade location at opposite sides of the shell. As will be seen in FIG. 1, the end portion of the member **14** projecting upwardly is recessed as indicated at **15** to embrace the upper blade **8**. The lower end is similarly recessed to embrace the lower blade **8**. The side edges of the recesses **15** and also the base of that recess are so positioned as to clear the scraper blade and to permit freedom for limited motion of the scraper blade either forwardly or rearwardly with respect to the direction of rotation, or radially inwardly toward the center of the shell. Because of this spacing of the edges of the recess **15**, each blade **8** is freely spring suspended in a predetermined position with the scraping edge of the blade in engagement with the interior surface of the shell.

One function served by the arrangement just described is a "retainer" function, i.e., the blade **8** will be restrained to a position close to its normal operating position, even in the event of failure or breakage of springs supporting that blade. This may prevent dropping of a blade into other working parts in the event of failure of most or all of the supporting spring elements.

Another important function is served by the devices **14**, i.e., limiting deflection of the springs. Thus, the edges of each recess **15** serve as abutments limiting motion of the associated blade **8** either forwardly or rearwardly or radially inwardly, thereby limiting the deflection of the spring elements **9**. This function is of importance because in providing a limitation upon the spring deflection, it provides also for limiting the load to which the spring can be subjected. With any type of spring the limitation of the deflection, with consequent limitation of the load, will diminish fatigue failure.

In the arrangement of the present invention, however, the function of the recess **15** in limiting spring deflection is of especial importance because of the use of clusters of spring elements. This may be illustrated by considering the possible occurrence of failure of one or two individual spring elements of a cluster. Failure of an individual element of a cluster will result in tendency to deflect the remaining springs in the cluster to a greater extent under the influence of a given force applied to the blade. This greater deflection would result in greater stress and therefore more danger of fatigue failure, but with the limiting stop or abutment present, the load cannot build up in the remaining spring elements.

Attention is now directed to the location of the retainer and abutment members **14**, one adjacent to the spring assembly toward the left of FIG. 2 and the other adjacent to the spring assembly toward the right of that figure. By virtue of these locations, the members **14** cooperate with each other in limiting the motions of the blades both circumferentially and radially of the shell, and in addition, by virtue of these locations, the members **14** will prevent extensive axial motion of a blade, in the event of complete spring failure.

In addition to the arrangement illustrated in the drawings, other arrangements may be employed, but it is contemplated according to the invention that the spring mounting for the scraper blades be of the type providing full or complete spring suspension for the scraper blades. According to the invention, the fatigue failure of the springs is greatly reduced and, even if failure of a few individual spring elements occurs, most of the springs will remain intact and provide adequate blade suspension to continue the normal operating function of the equipment.

We claim:

1. Scraper mechanism for use in scraping deposits from the interior surface of a shell in which materials are treated, comprising a scraper blade having an edge for engagement with the interior surface of the shell throughout an appreciable dimension axially of the shell, blade driving structure rotatable within the shell, means for mounting the blade on the driving structure including a plurality of spring assemblies spaced from each other along said blade and axially of the shell and each assembly comprising a cluster of spring elements reacting between the driving structure and the blade, opposite ends of the spring elements being secured respectively to the driving structure and to the blade to yieldingly suspend the blade in a predetermined position with the edge of the blade in scraping engagement with the interior surface of the shell, and abutment means spaced from the blade when in said predetermined position but located to limit blade motion from said predetermined position and thus limit deflection of the blade mounting spring elements.

2. Scraper mechanism as defined in claim **1** in which the abutment means comprises an abutment member mounted to rotate with the driving structure and having abutment surfaces spaced from the scraper blade at opposite sides thereof circumferentially of the shell.

3. Scraper mechanism as defined in claim **2** in which the abutment member is positioned axially of the shell in a position between spring assemblies.

4. Scraper mechanism as defined in claim **2** and including two abutment members of the kind defined, one of the abutment mmebers being located close to a spring assembly, toward one end of the scraper blade and the other located close to a spring assembly toward the other end of the scraper blade.

5. Scraper mechanism for use in scraping deposits from the interior surface of a shell in which materials are treated, comprising a scraper blade having an edge for engagement with the interior surface of the shell throughout an appreciable dimension axially of the shell, blade driving structure rotatable within the shell, and means for mounting the blade on the driving structure including a plurality of spring assemblies spaced from each other along said blade and axially of the shell and each assembly comprising a cluster of spring elements, the opposite ends of each spring element being secured respectively to the driving structure and to the blade, and the spring elements reacting between the driving structure and the blade to yieldingly suspend the blade with the edge of the blade in scraping engagement with the interior surface of the shell.

6. Scraper mechanism as defined in claim **5** and further including for each spring cluster common means for connecting the spring elements to the blade driving structure.

7. Scraper mechanism as defined in claim **5** and further including for each spring cluster common means for connecting the spring elements to the scraper blade.

8. Scraper mechanism for use in scraping deposits from the interior surface of a shell in which materials are treated, comprising a scraper blade having an edge for engagement with the interior surface of the shell throughout an appreciable dimension axially of the shell, blade driving structure rotatable within the shell, and means for mounting the blade on the driving structure including a plurality of spring asemblies distributed along the blade and each assembly comprising a cluster of wire spring elements, the opposite ends of each spring element being secured respectively to the driving structure and to the blade, and the spring elements reacting between the driving structure and the blade to yieldingly suspend the blade with the edge of the blade in scraping engagement with the interior surface of the shell.

9. Scraper mechanism for use in scraping deposits from the interior surface of a shell in which materials are treated, comprising a scraper blade having an edge for engagement with the interior surface of the shell throughout an appreciable dimension axially of the shell, blade driving structure rotatable within the shell, and means for mounting the blade on the driving structure with the edge of the blade in scraping engagement with the interior surface of the shell and with freedom for movement in a direction circumferentially of the driving structure, the mounting means comprising a plurality of spring assemblies spaced from each other along said blade and axially of said shell and each assembly comprising a cluster of spring elements yieldingly holding the edge of the blade in scraping engagement with the interior surface of the shell, the blade being free for full floating spring suspension on said spring elements in said circumferential direction with the edge of the blade yieldingly held against the interior surface of the shell.

10. Scraper mechanism as defined in claim **9** and further including abutment means spaced from the scraper blade but limiting appreciable blade motion in said circumferential direction and thus limiting deflection of the blade mounting spring elements.

11. Scraper mechanism for use in scraping deposits from the interior surface of a shell in which materials are treated, comprising a scraper blade having an edge for engagement with the interior surface of the shell throughout an appreciable dimension axially of the shell, blade driving structure rotatable within the shell, and means for mounting the blade on the driving structure including a plurality of spring assemblies distributed along the blade and each assembly comprising a cluster of spring elements arranged in close side-by-side relation.

12. Scraper mechanism for use in scraping deposits from the interior surface of a shell in which materials are treated, comprising a scraper blade having an edge for engagement with the interior surface of the shell throughout an appreciable dimension axially of the shell, blade driving structure rotatable within the shell, a blade retainer mounted on and rotatable with the driving structure, the retainer having a pair of opposed abutment surfaces embracing the blade and acting to limit blade movement circumferentially of the driving structure, the abutment surfaces of said pair being circumferentially spaced from each other sufficiently to provide a limited range of blade movement circumferentially of the driving structure, and elongated spring elements for mounting the blade on the driving structure, the spring elements being distributed axially of the shell and including a multiplicity of elements located toward each end of the blade, the opposite ends of each spring being secured respectively to the rotative driving structure and the blade, and the springs providing full floating spring suspension of the blade during rotation thereof with the edge of the blade yieldingly held against the interior surface of the shell and with the blade in a position intermediate the limits of said limited range of movement established by said pair of abutment surfaces so that in normal operation the blade is maintained out of contact with the abutment surfaces of said pair.

13. Scraper mechanism as defined in claim **12** in which groups of the springs are provided with common securing means at least at one end thereof.

14. Scraper mechanism for use in scraping deposits from the interior surface of a shell in which materials are treated, comprising a scraper blade having an edge

for engagement with the interior surface of the shell throughout an appreciable dimension axially of the shell, blade driving structure rotatable within the shell, and elongated spring elements for mounting the blade on the driving structure, the spring elements being distributed axially of the shell and including a multiplicity of side by side parallel elements located toward each end of the blade, the opposite ends of each spring element being secured respectively to the rotative driving structure and the blade, and the springs providing full floating spring suspension of the blade circumferentially of the driving structure during rotation thereof with the edge of the blade yieldingly held against the interior surface of the shell.

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LEON G. MACHLIN, Primary Examiner

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