Nov. 1, 1960 N. L. KNOPH ET AL 2,958,323

STONE CUTTING APPARATUS

Filed Jan. 29, 1958 3 Sheets-Sheet 1

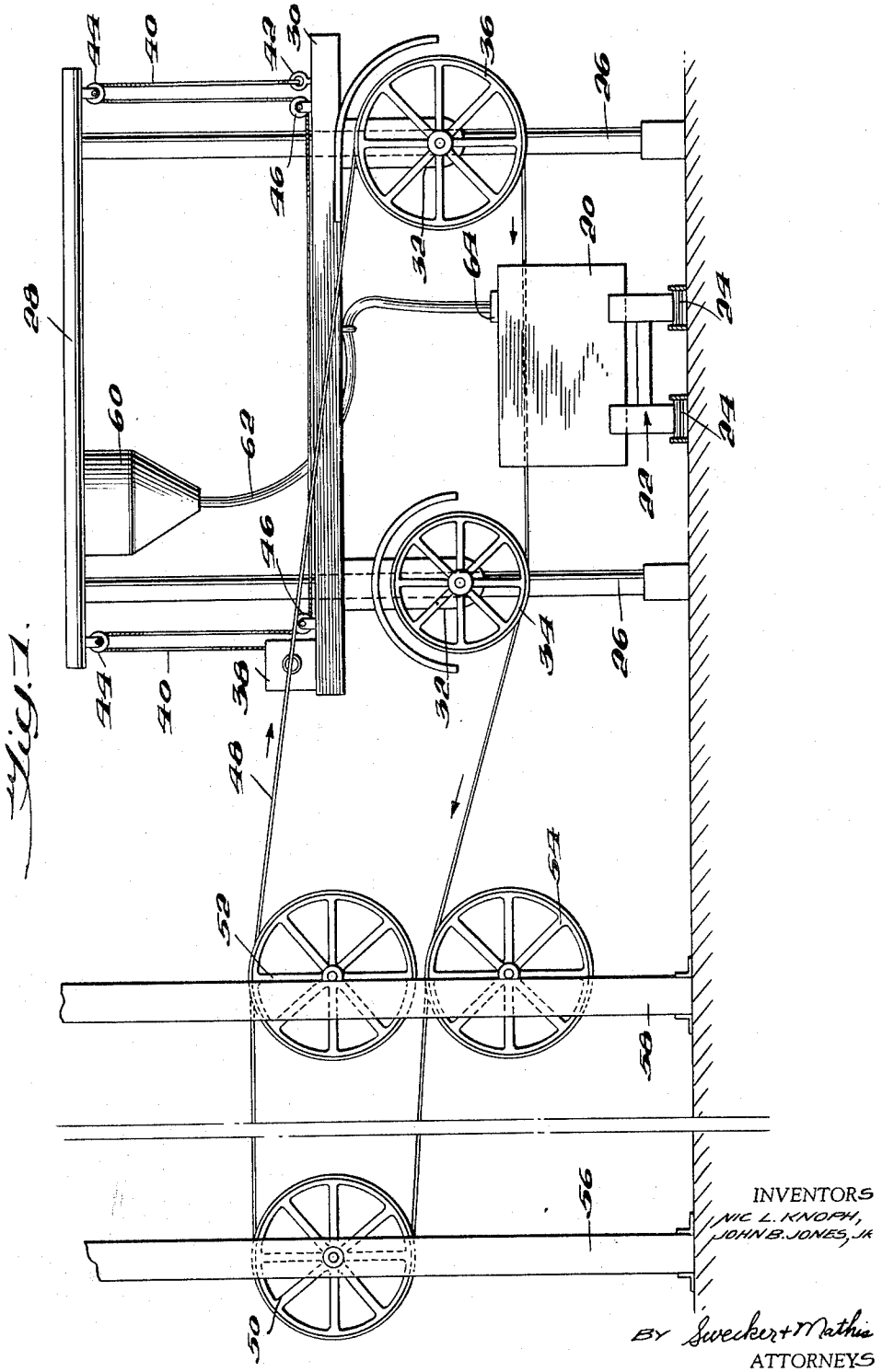

Fig. 1.

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STONE CUTTING APPARATUS

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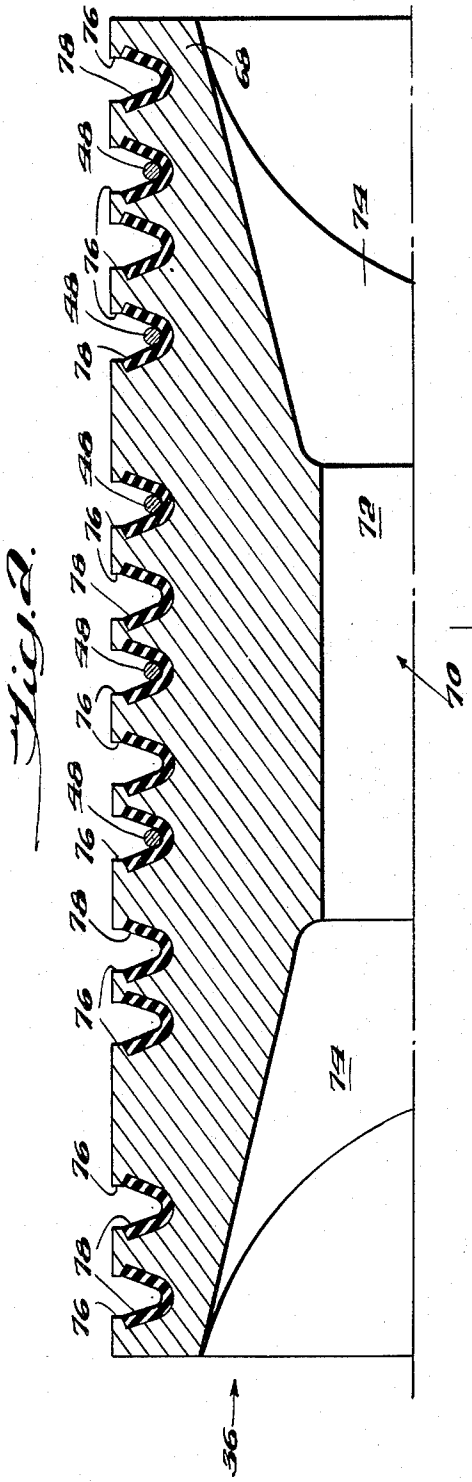

Fig. 2.

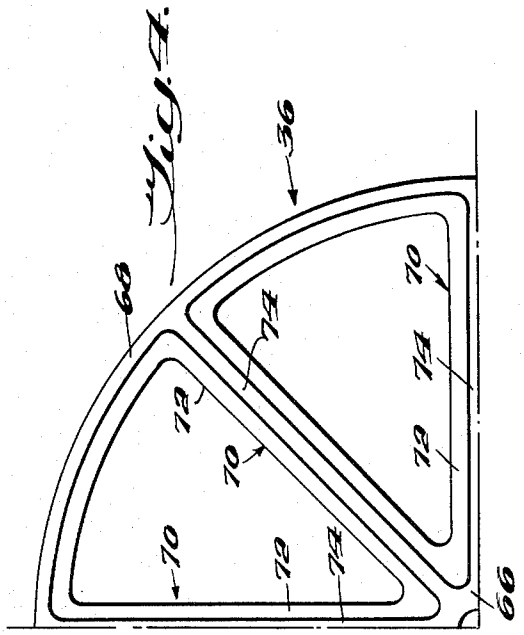

Fig. 4.

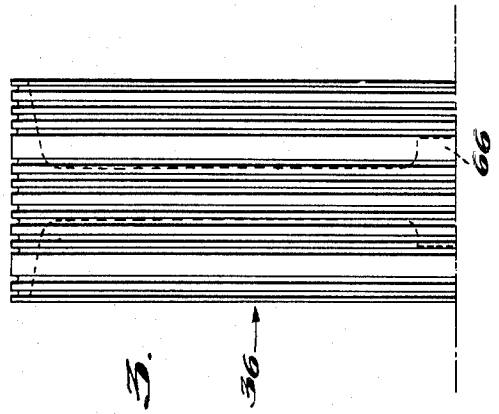

Fig. 3.

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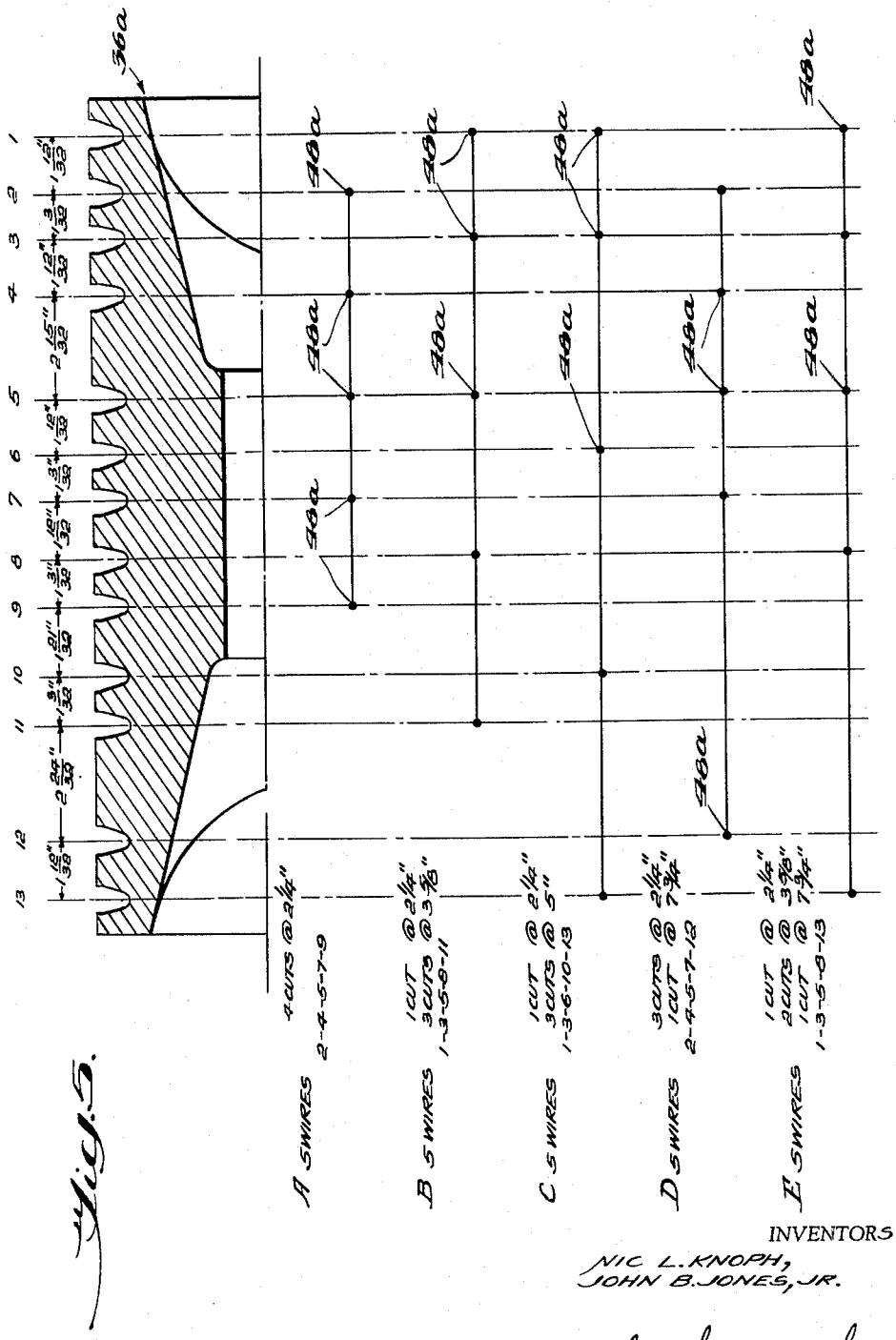

Fig. 5.

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STONE CUTTING APPARATUS

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5 Claims. (Cl. 125—21)

This invention relates to stone cutting apparatus, and more particularly to wire-guiding wheels for stone saws of the type in which a plurality of moving lengths of wire are caused to pass through a stone in order to subdivide it into a plurality of slabs.

Stone usually is removed from a quarry in large blocks which are too massive for ordinary uses. These blocks then are subdivided into a plurality of smaller slabs and used in buildings, ornamental structures, and the like. At the present time, the stone requirements of the building industry are restricted almost entirely to slabs of brick-course heights or widths, i.e., slabs of widths which correspond to the heights of the various types of bricks and cement blocks in general use for building purposes. These are standards in the trade, and are well known. By way of example, it may be mentioned that two and one-quarter inches, three and five-eighths inches, five inches, and seven and three-quarters inches are representative brick-course heights.

The subdivision of the large blocks of stone received from a quarry into smaller slabs usually is accomplished through the use of a wire saw. In such saws, a mixture of water and abrasive material is fed to the stone, and a plurality of parallel running lengths of wire move the abrasive along in contact with the stone to produce cuts extending parallel to the paths of the wires. In addition to their linear motions, the wires move bodily in a direction approximately at right angles to their lengths, so that, after a time, the cuts will extend entirely through the stone in parallel planes.

Prior to the present invention, the running lengths of wire employed in wire saws were guided by two groups of coaxially mounted wheels disposed upon opposite sides of the stone to be cut, with the cutting path of each wire being established by one wheel from each of the two groups. The several wheels of each group were mounted upon a common shaft for axial adjustment relative to each other, so that the spacing between adjacent wheels might be changed when it became necessary to alter the distances between the paths of the several wires. Such adjustments were necessary whenever different sizes of stone slabs were required.

The task of adjusting the individual wheels was a very time consuming one. Even when the equipment was in good condition, it frequently took from three to four hours to reset the wire-guiding wheels. Moreover, the wheels and their shafts were continuously subjected to contact with water and abrasive material during the operation of the apparatus, so that rust and corrosion was a very serious problem. After a relatively short period of use, it was not unusual to find that a wheel-supporting shaft had corroded so badly that axial adjustment of the wheels was virtually impossible. In such situations, the resetting of the wire paths often took the saws out of production for a period of one or more days.

Another difficulty encountered in setting up groups of coaxial wire-guiding wheels for the production of

standard brick-course heights of stone was that the distance between each pair of adjacent wheels had to be measured accurately every time an adjustment was to be made. This tedious procedure not only was time consuming but also required considerable skill.

It is an object of this invention to overcome the objections and disadvantages noted above and to provide stone cutting apparatus which can be adjusted quickly and easily so as to produce cuts of a variety of predetermined widths.

Another object of this invention is to provide wire saws with improved wire-guiding means which will obviate the necessity for using groups of axially adjustable wheels for guiding the running lengths of wire.

Another object of this invention is to provide improved wire-guiding means for wire saws which will enable the spacing of the wires to be changed from one standard position to another without the necessity for accurate measurements on the part of the operator of the saw.

Yet another object of this invention is to provide improved wire-guiding means which will be relatively inexpensive to manufacture and which will be durable under the corrosive service conditions encountered in wire saws for cutting stone.

The foregoing objects may be accomplished, according to one embodiment of the invention, by utilizing novel multiple-groove wheels to establish the cutting paths of the running lengths of wire in a wire saw. One of the multiple-groove wheels may be positioned on each side of the stone to be cut and rotatably mounted upon a movable frame which can be moved so as to cause the wires carried by the wheels to pass through the stone.

The number of grooves in each wheel preferably exceeds the number of cuts to be made by the machine, and the spacing of the several grooves preferably is such that, by positioning the wires in different groups of grooves, it is possible to produce cuts of a variety of different standard widths. This arrangement greatly simplifies the problem of adjustment of the machine. Whenever slabs of different widths are required, all that need be done by the operator is to shift the wires from one set of grooves to another set. The wheels themselves require no adjustment at all and they may be mounted permanently upon their shafts.

In order to combat corrosion, the multiple-groove wheels of this invention preferably are of aluminum. Such structures are relatively inexpensive to manufacture, and they are not subject to corrosion in any material degree. Abrasion of the walls of the grooves in the wheels may be eliminated by providing each of the grooves with a replaceable rubber liner.

A more complete understanding of the invention and its many advanaages will be gained from a consideration of the following detailed description of the embodiment illustrated in the accompanying drawings, in which:

Fig. 1 is a diagrammatic elevational view of a typical stone cutting machine in which the present invention may be utilized;

Fig. 2 is a cross sectional view of a peripheral portion of one of the wire-guiding wheels in the machine shown in Fig. 1;

Fig. 3 is a partial side elevational view of the wheel of Fig. 2;

Fig. 4 is a partial end elevational view of the wheel of Fig. 2; and

Fig. 5 is a diagram suggesting several possible dispositions of the saw wires in the grooves of the wire-guiding wheels.

Machines of the type illustrated in Fig. 1 are well known, and it will not be necessary to describe the various components in detail. However, a general explanation of the machine and its mode of operation will be

helpful to a complete understanding of the present invention.

In Fig. 1, a block 20 of stone or other material being cut is shown in position upon a carriage 22 which may be moved along tracks or guides 24 extending transversely of the machine. The carriage 22 normally is held stationary during cutting operations, but it may be moved along the tracks 24 before or after the cutting operation to facilitate the handling and positioning of the block 20.

Disposed on opposite sides of the carriage 22 are rigid uprights 26 which extend upwardly substantial distances above the block of stone 20 and are connected together at their upper ends by a beam 28 to form a stationary machine frame. This stationary frame serves both to support and to guide a vertically movable frame comprising a horizontal platform 30. Depending from the platform 30 at locations on opposite sides of the carriage 22 are brackets 32 upon which rotatable wire-carrying wheels 34 and 36 are mounted. The movable frame also carries a motor (not illustrated) for driving the wheel 36 and suitable feed means for controlling the vertical movements of the movable frame.

As illustrated, the feed means includes a cable winding device 38 which cooperates with a cable 40 fixed at one end to the platform 30 by a fitting 42 and passing over guides 44 and 46 attached, respectively, to the cross beam 28 of the stationary frame and to the platform 30. When the device 38 is actuated in one direction, the cable 40 is wound onto the cable winding device. This results in a decrease in the length of the portion of the cable 40 extending from the device 38 to the fitting 42 so that the movable frame must move upwardly. Similarly, when the device 38 is reversed, the cable 40 is unwound, and the movable frame moves downwardly under the influence of gravity.

One or more long saw wires 48 pass around the wheels 34 and 36 and are guided thereby along horizontal, cutting runs over the carriage 22 supporting the block of stone. Although these wires need be no longer than would be required for them to pass in closed loops around the two wheels 34 and 36 on the vertically movable frame of the machine, sometimes it is desirable that they be extended over additional guide wheels 50, 52, and 54 spaced from the actual cutting portion of the machine.

The wheel 50 may be spaced from the carriage a distance of a hundred feet or more and may be mounted for rotation upon a suitable framework 56 which ordinarily is of such construction as to permit bodily movement of the wheel 50 when it is necessary to adjust the tension in the wires 48. The wheels 52 and 54 also are mounted upon a suitable frame 58, but this frame should be in the immediate vicinity of the main frame of the machine so that the wheels 52 and 54 may serve effectively to control the directions of movement of the wires 48 to the wheel 36 and from the wheel 34.

The apparatus shown in Fig. 1 commonly is referred to in the trade as a "long wire" machine, because of the very substantial lengths of the wires 48. Such machines are preferred by many operators. Since only a very small portion of each wire 48 is subject to abrasion at any particular moment, the wear on the wires is spread out along the lengths of the wires in such a manner that it is not necessary to replace the wires at frequent intervals.

Although reference has been made to a plurality of wires 48, it will be evident to persons skilled in the art that a single endless strand might be used in lieu of a plurality of separate wires. When this is done, the single strand may be guided in a plurality of convolutions about the various guide wheels so that the necessary number of running lengths will extend between the guide wheels 34 and 36 on opposite sides of the block of stone 20. Insofar as the present invention is concerned, these two arrangements may be considered to be equivalents.

The invention also is applicable to the so-called "short wire" machines in which the wires are looped directly about the two wheels carried by the movable frame of the machine. This type of saw is especially suitable for use in environments where space restrictions make the use of remote wire-guiding means, such as the wheel 50 illustrated in Fig. 1, inadvisable.

In all of the wire saws in use today, the actual cutting of the stone is accomplished by feeding a mixture of water and particulate abrasive to the cutting runs of the wires 48. The wires themselves are twisted structures having a number of inclined surfaces that engage the particulate abrasive and rub it against the stone to effect the cutting. As the depths of the cuts in the stone 20 increase, the movable frame carrying the wire-guiding wheels 34 and 36 moves downwardly so that the cutting runs of the wires 48 remain in contact with the bottoms of the cuts until the stone 20 has been severed completely.

In Fig. 1, the abrasive mixture is fed from a suitable supply chamber 60 through a flexible conduit 62 to a distribution block 64 attached to the upper face of the stone 20 being cut. In this connection it will be understood that there may be as many conduits 62 and distribution blocks 64 as there are cutting runs of the wires 48. Each block 64 is positioned immediately adjacent to the plane of movement of the cutting run of a wire 48, and feeds abrasive directly into the cut being formed thereby.

The construction of the novel wire-guiding wheels of this invention is best illustrated in Figs. 2, 3, and 4. Although these views represent the wheel 36 of Fig. 1, the configuration of the wheel 34 is similar and the remotely located wheels 50, 52 and 54 also may conform to the wheel 36, if desired.

The wheel 36 includes a hub portion 66, a generally cylindrical rim portion 68, and a plurality of radial spokes 70 extending betwen the hub 66 and the rim 68. The hub 66 is adapted to be permanently mounted upon a transversely extending shaft carried by the movable frame of the machine. In the case of the wheel 36, which normally serves as a drive wheel for moving the wires 48, the hub 66 is keyed or otherwise fixed against rotation relative to its shaft. However, the wheel 34, which serves as an idler in the wire-guiding system, may be rotatably mounted upon a fixed shaft or it may be keyed to a rotatable shaft.

The spokes 70 are shaped to give the wheel good strength and rigidity characteristics and to minimize the overall mass of the wheel. To this end, each of the spokes 70 is generally cruciform in cross sectional shape. An arcuately elongated central portion 72 of each spoke 70 extends from the central portion of the rim 68 of the wheel, and laterally extending flanges 74 give the structure transverse rigidity.

The rim portion 68 of the wheel is provided with a large number of circumferential grooves 76. The number of grooves 76 exceeds the number of running lengths of wire 48 used in the stone cutting operation, and the grooves 76 are spaced apart along the length of the rim 68 of the wheel so that the spacing of the wires 48 may be changed by shifting them from one set of grooves 76 to another.

In order to protect the walls of the grooves 76 against abrasion by the wires 48, each groove 76 is provided with a liner 78. These liners preferably are of rubber, but it will be apparent to persons skilled in the art that any other suitable material may be used for this purpose. It is contemplated that, when a liner 78 becomes worn, it may be removed from its groove 76 and replaced with a new liner.

It is preferred that the wheel 36 be of cast aluminum. Aluminum is a particularly desirable material for this purpose, because its corrosion resisting properties minimize the deteriorating effects produced by the water and abrasive to which the wheel is subjected during use.

The significance of the spacing of the grooves **76** in the wheel **36** can best be explained by referring to the diagram shown in Fig. 5. At the top of this view there is a schematic representation of the rim portion of a wheel **36***a*, and below the wheel, five different arrangements of the wires **48***a* are suggested.

Although the wheel **36***a* may be identical to the wheel **36** of Fig. 2 an attempt has been made to simplify Fig. 5 by omitting the liners **78** disposed within the circumferential grooves and by illustrating the outlines of the grooves as they would appear with the liners **78** in place. The several grooves in the wheel **36***a* have been numbered **1** through **13** from right to left, to facilitate reference to them.

The uppermost wire arrangement pattern suggested in Fig. 5 is designated by the letter A. In this pattern, the five wires **48***a* are disposed in grooves **2**, **4**, **5**, **7**, and **9**. As indicated by the legend at the top of Fig. 5, the spacing between the axes of adjacent ones of these grooves is a $2\frac{15}{32}$ inches. Since the width of a cut produced by a wire normally is about $\frac{7}{32}$ of an inch, the use of pattern A will result in the production of four slabs or cuts of stone, each having a width of 2¼ inches. This width is a standard in the building industry in that it conforms to a standard brick-course height.

It will be observed that pattern A is the arrangement illustrated in Fig. 2 of the drawings. Slabs of 2¼ inch width constitute the bulk of the output of many producers, and pattern A results in maximum production of this width. However, the present invention is not limited to the production of slabs of a single width. When other widths are required, the wires **48***a* may be shifted to a different group of grooves in the wheel **36***a*.

Several alternative wire disposition patterns are suggested by the letters B, C, D, and E in Fig. 5. These patterns are largely self-explanatory. It will suffice to point out, as an example, that in pattern E, the five wires **48***a* produce one 2¼ inch slab, two 3⅝ inch slabs, and one 7¾ inch slab. All of the slab widths mentioned in Fig. 5 correspond to standard brick-course heights, and it can be anticipated that most producers of stone slabs will have occasion to make slabs of these widths from time to time.

It now will be evident that the present invention greatly simplifies the problem of resetting the spacing of the wires of a wire saw. Instead of adjusting the spacing between a number of individually movable wheels, the operator of the machine need only shift the wires **48** from one set of grooves **76** to another set. Since the multiple-groove wheels of this invention need never be shifted axially along the shafts upon which they are mounted, the resetting operations can be carried out quickly and easily even though the surfaces of the shafts themselves are corroded. This has not been possible heretofore.

An indication of the practical importance of the multiple-groove wheels of this invention is that the task of resetting the spacing of the wires of a wire saw now can be accomplished in a fraction of an hour. This remarkable result can best be appreciated by contrasting it with the three to four hours formerly required even under the most favorable circumstances.

In addition to reducing the down time to a small fraction of what has heretofore been required, the present invention enables the operator of the machine to make more accurate settings. Since no measurements are required in resetting the wires, the operations may be carried out by relatively unskilled labor without danger of costly errors.

Although the illustrated multiple-groove wheel **36** is particularly adapted for use on a machine having five wires **48**, it will be apparent that it is not restricted to such use. If desired, the wheel **36** may be used to guide a larger or smaller number of wires. Also, the spacing of the circumferential grooves **76** in the wheel may be varied as necessary in order to meet particular requirements without departing from the principles of the invention.

Still other variations and modifications will suggest themselves to persons skilled in the art. It is intended therefore that the foregoing detailed description of the illustrated embodiment of the invention be considered as exemplary only, and that the scope of the invention be ascertained from the following claims.

We claim:

1. A wheel for guiding the wires of stone sawing apparatus of the type in which moving lengths of wire are caused to pass through the stone to be cut, comprising a cast aluminum member having a hub portion, a rim portion and a plurality of spokes extending between said hub and rim portions, said rim portion having an elongated cylindrical external surface provided with a plurality of axially spaced apart, circumferentiatlly extending, wire-receiving grooves therein, said grooves being spaced irregularly along the length of said external surface, the spacing between said grooves being such that different combinations of brick-course height slabs may be cut from the stone by disposing the moving lengths of wire in different sets of grooves, and an annular rubber liner disposed within each of said grooves in position to prevent the wires from contacting the walls of said grooves.

2. Stone sawing apparatus comprising stationary frame means, means for supporting a stone to be cut, movable frame means mounted on said stationary frame means for movement toward and away from the stone to be cut, a pair of wheels carried by said movable frame means on opposite sides of the stone, and a plurality of running lengths of wire guided by said wheels along spaced apart paths so that upon movement of said movable frame means said wires may cut the stone, each of said wheels including an axially elongated unitary rim portion having a plurality of spaced circumferential wire-receiving grooves formed directly therein, the number of said grooves being in excess of the number of said running lengths of wire so that the spacing between the wire paths may be varied by utilizing different sets of grooves to guide the lengths of wire.

3. Stone sawing apparatus comprising stationary frame means, means for supporting a stone to be cut, movable frame means mounted on said stationary frame means for movement toward and away from the stone to be cut, a pair of wheels carried by said movable frame means on opposite sides of the stone, and a plurality of running lengths of wire guided by said wheels along spaced apart paths so that upon movement of said movable frame means said wires may cut the stone, each of said wheels including an axially elongated unitary rim portion having a plurality of irregularly spaced circumferential wire-receiving grooves formed directly therein, the number of said grooves being in excess of the number of said running lengths of wire so that the spacing between the wire paths may be varied by utilizing different sets of grooves to guide the lengths of wire, and the spacing between said grooves being such that different combinations of brick-course height slabs may be cut from the stone by disposing the lengths of wire in different sets of grooves.

4. A wheel for guiding the wires of sawing apparatus of the type in which moving lengths of wire are caused to pass through the material to be cut, comprising a metal member having a hub portion, a rim portion and connecting means extending between said hub and rim portions, said rim portion having an elongated cylindrical external surface provided with a plurality of axially spaced apart, circumferentially extending, wire-receiving grooves therein, said grooves being spaced irregularly along the length of said external surface, the spacing between said grooves being such that different widths of material may be cut by disposing the moving lengths of wire in different sets of grooves.

5. A wheel for guiding the wires of sawing apparatus of the type in which moving lengths of generally round wire are caused to pass through the material to be cut, comprising a metal member having a hub portion, a rim portion and a plurality of spokes extending between said hub and rim portions, said rim portion having an elongated cylindrical external surface provided with a plurality of axially spaced apart, circumferentially extending, wire-receiving grooves therein, each of said grooves having a curved bottom upon which said round wire may bear and having sloping side walls converging toward said curved bottom to guide the wire into position, said grooves being irregularly spaced along the length of said external surface, the spacing between said grooves being such that different widths of material may be cut by depositing the moving lengths of wire in different sets of grooves, and an annular rubber liner

disposed within each of said grooves in position to prevent the wires from contacting directly the walls of the grooves.

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