April 21, 1964 L. J. AUER 3,129,624

CUT-OFF DEVICE FOR TUBE MAKING MACHINE OF CONTINUOUS TYPE

Filed Oct. 24, 1960 7 Sheets-Sheet 1

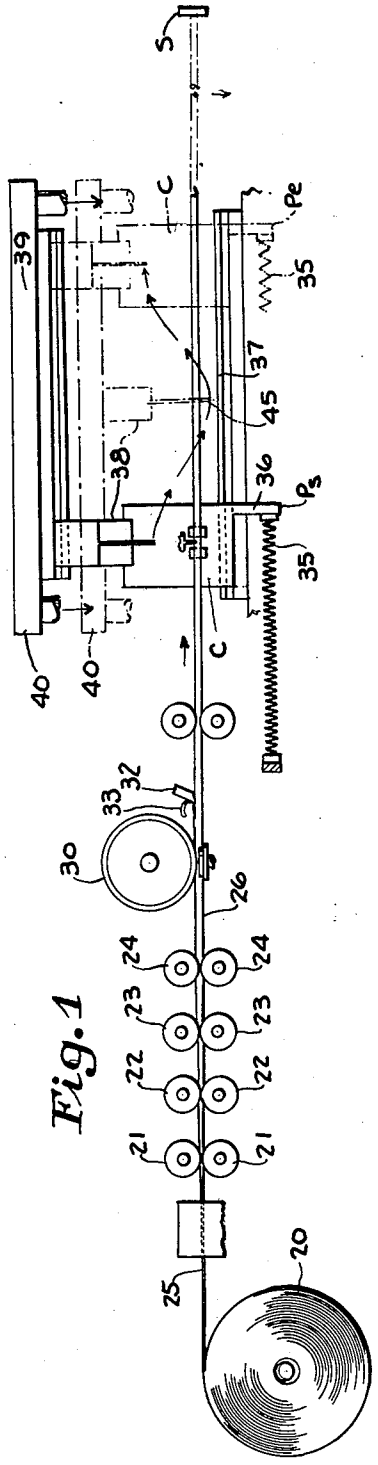


Fig. 1

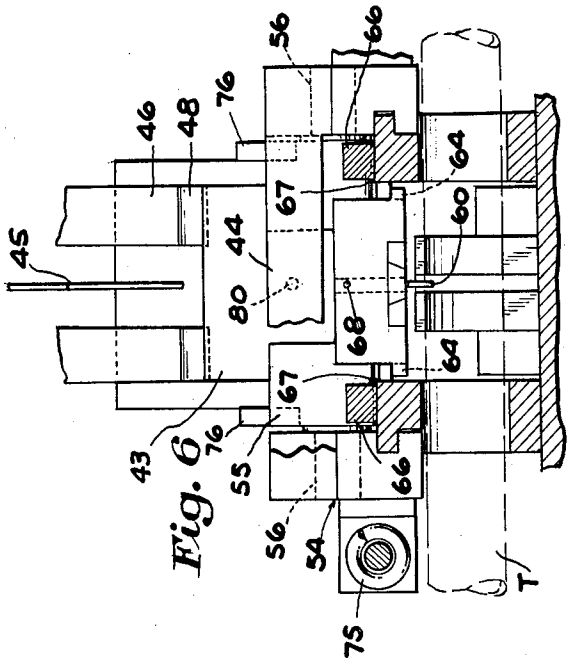


Fig. 6

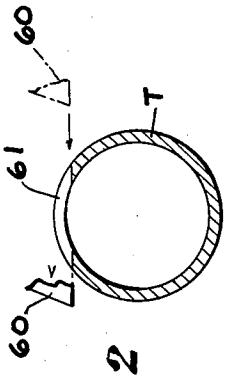


Fig. 2

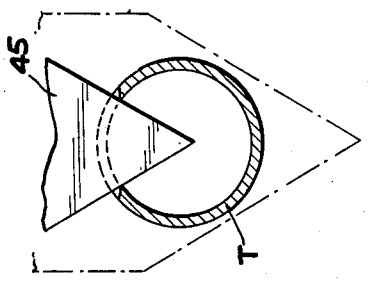


Fig. 3

INVENTOR.
LOUIS J. AUER
BY
Gregory S. Dolgorukov
ATTORNEY

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CUT-OFF DEVICE FOR TUBE MAKING MACHINE OF CONTINUOUS TYPE

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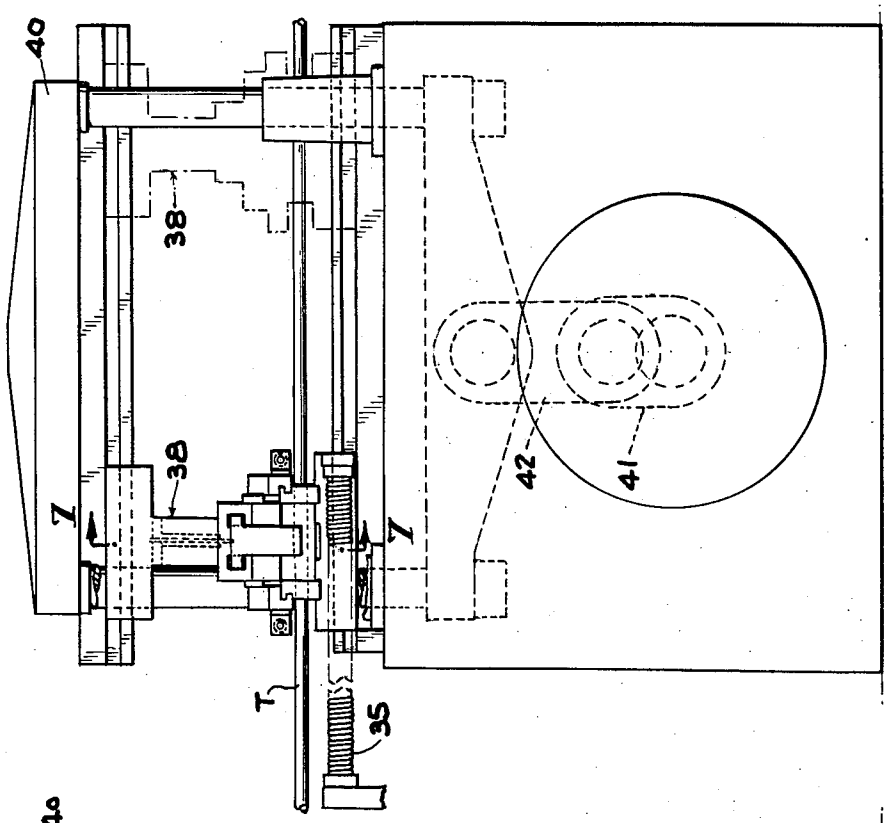


Fig. 5

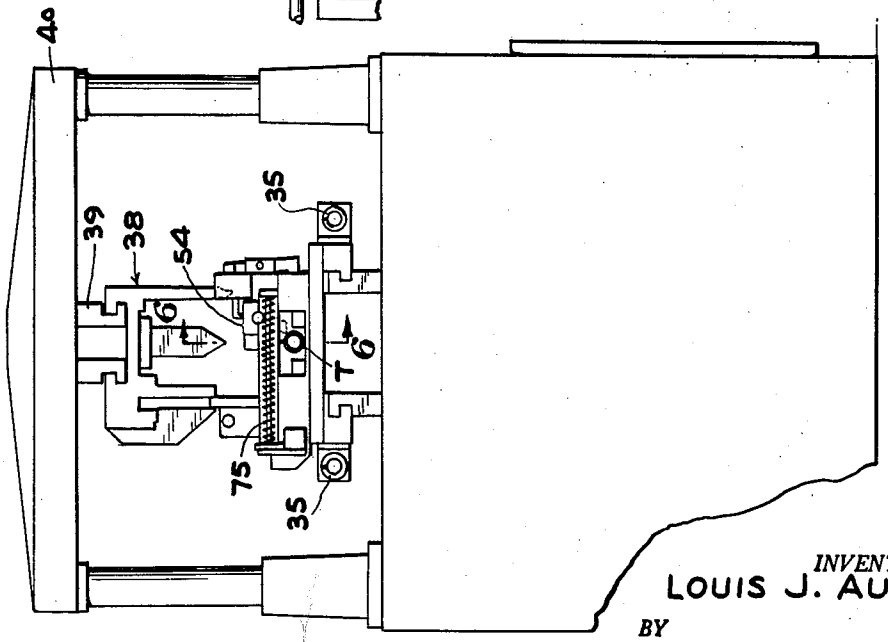


Fig. 4

INVENTOR.
LOUIS J. AUER
BY
Gregory S. Dalgorusso
ATTORNEY

April 21, 1964 L. J. AUER 3,129,624

CUT-OFF DEVICE FOR TUBE MAKING MACHINE OF CONTINUOUS TYPE

Filed Oct. 24, 1960 7 Sheets-Sheet 3

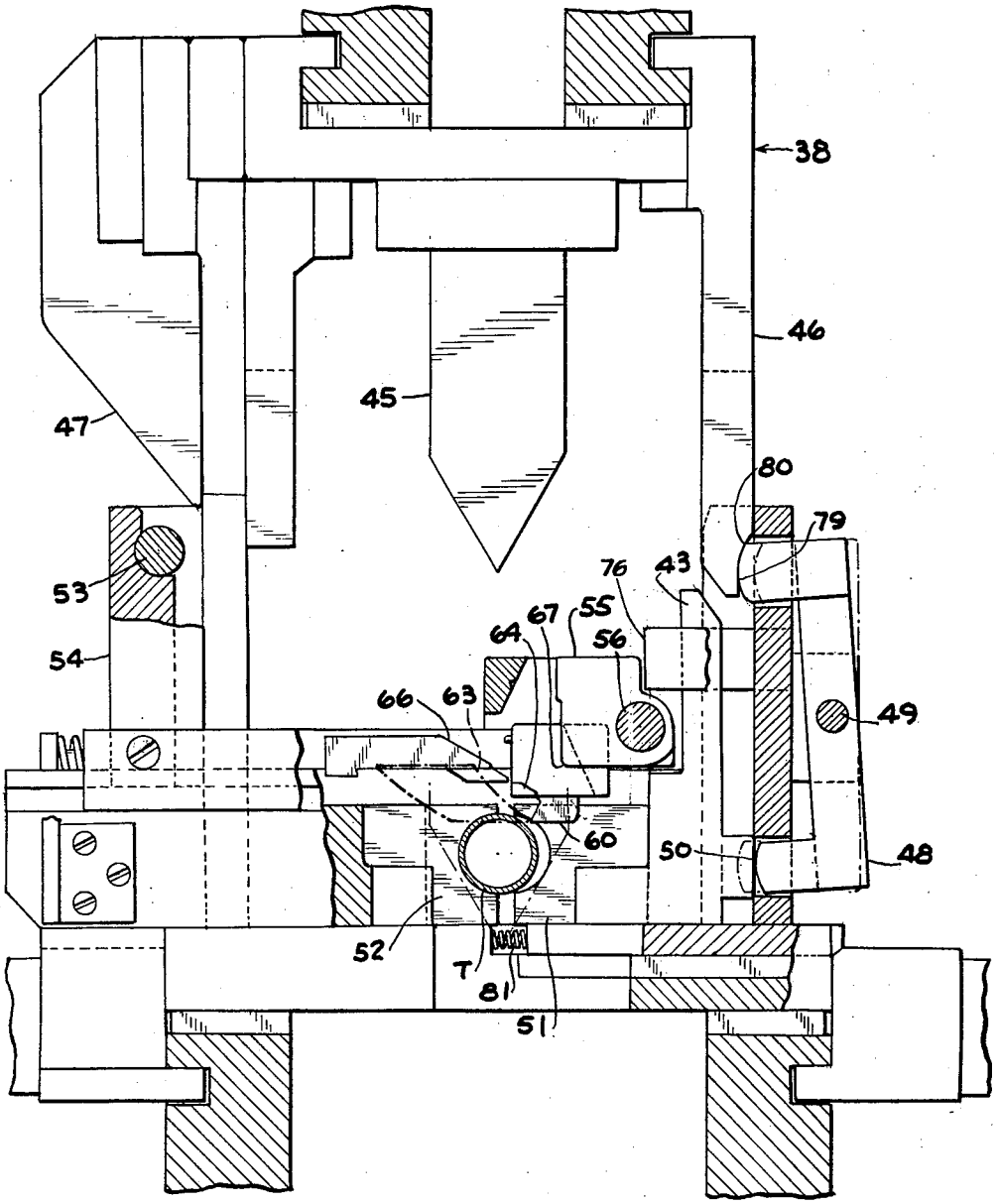


Fig. 7

INVENTOR.
LOUIS J. AUER
BY
Gregory S. Dolgorukov
ATTORNEY

April 21, 1964 L. J. AUER 3,129,624

CUT-OFF DEVICE FOR TUBE MAKING MACHINE OF CONTINUOUS TYPE

Filed Oct. 24, 1960 7 Sheets-Sheet 4

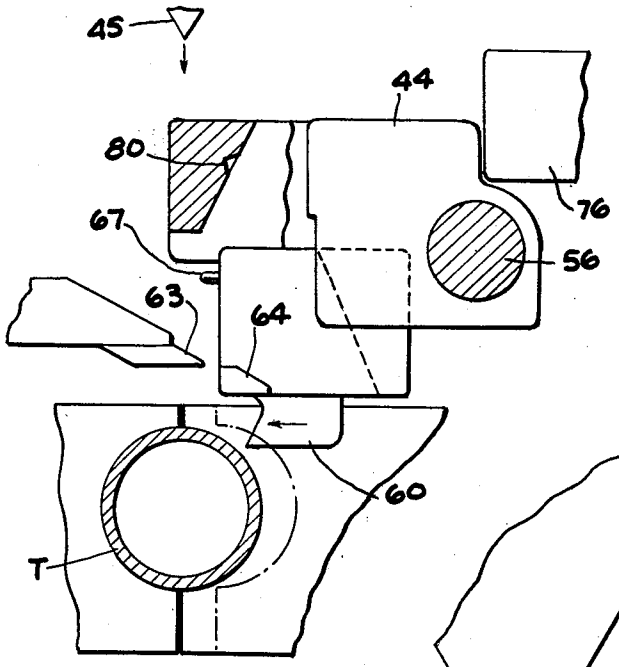


Fig. 8

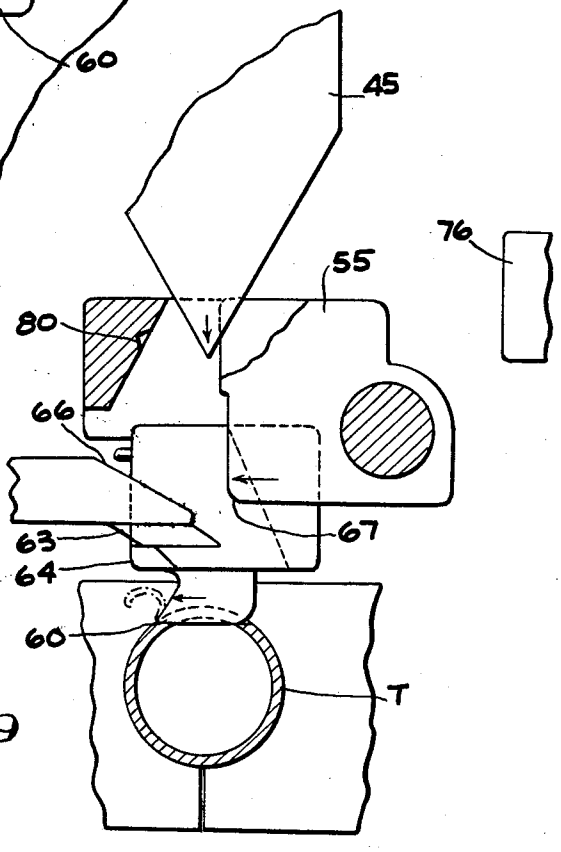


Fig. 9

INVENTOR.
LOUIS J. AUER
BY
Gregory J. Dolgorukov
ATTORNEY

April 21, 1964 L. J. AUER 3,129,624

CUT-OFF DEVICE FOR TUBE MAKING MACHINE OF CONTINUOUS TYPE

Filed Oct. 24, 1960 7 Sheets-Sheet 5

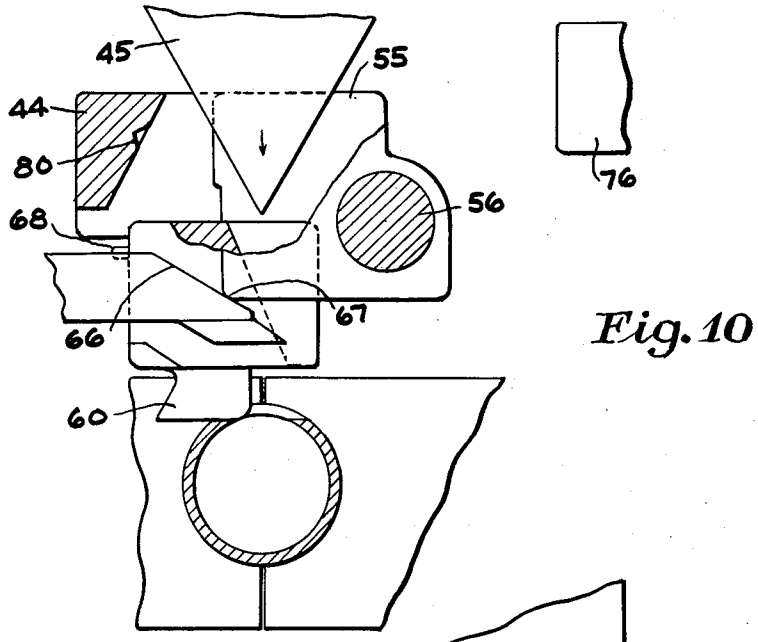


Fig. 10

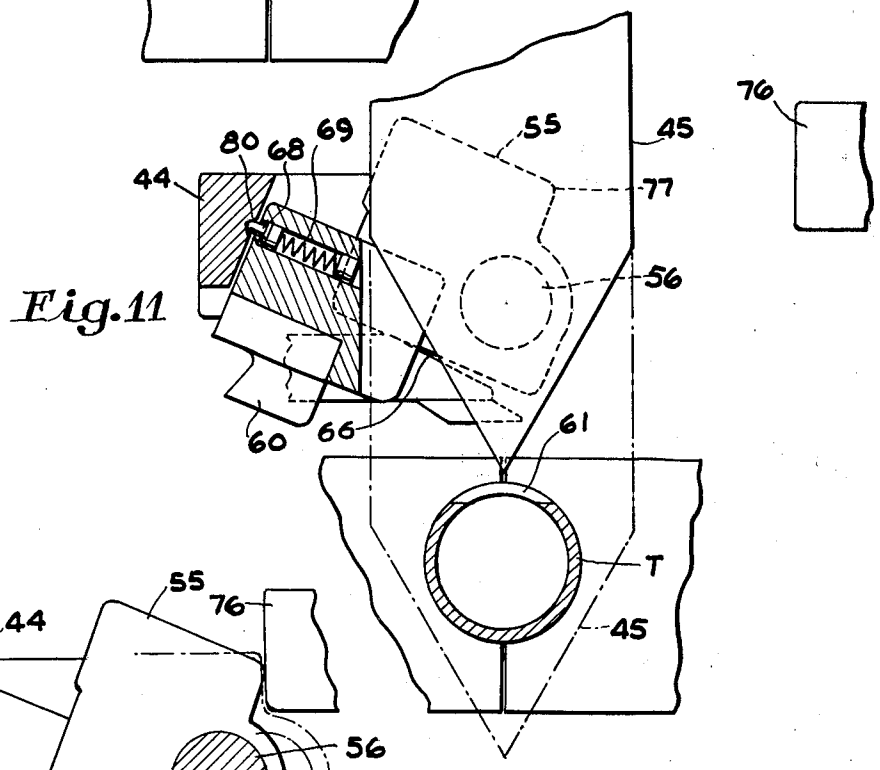


Fig. 11

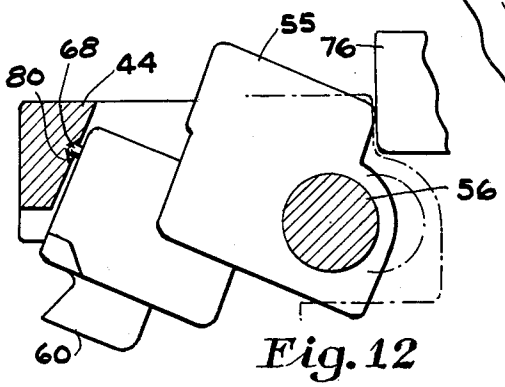


Fig. 12

INVENTOR.
LOUIS J. AUER
BY Gregory L. Dolgorukov
ATTORNEY

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CUT-OFF DEVICE FOR TUBE MAKING MACHINE OF CONTINUOUS TYPE

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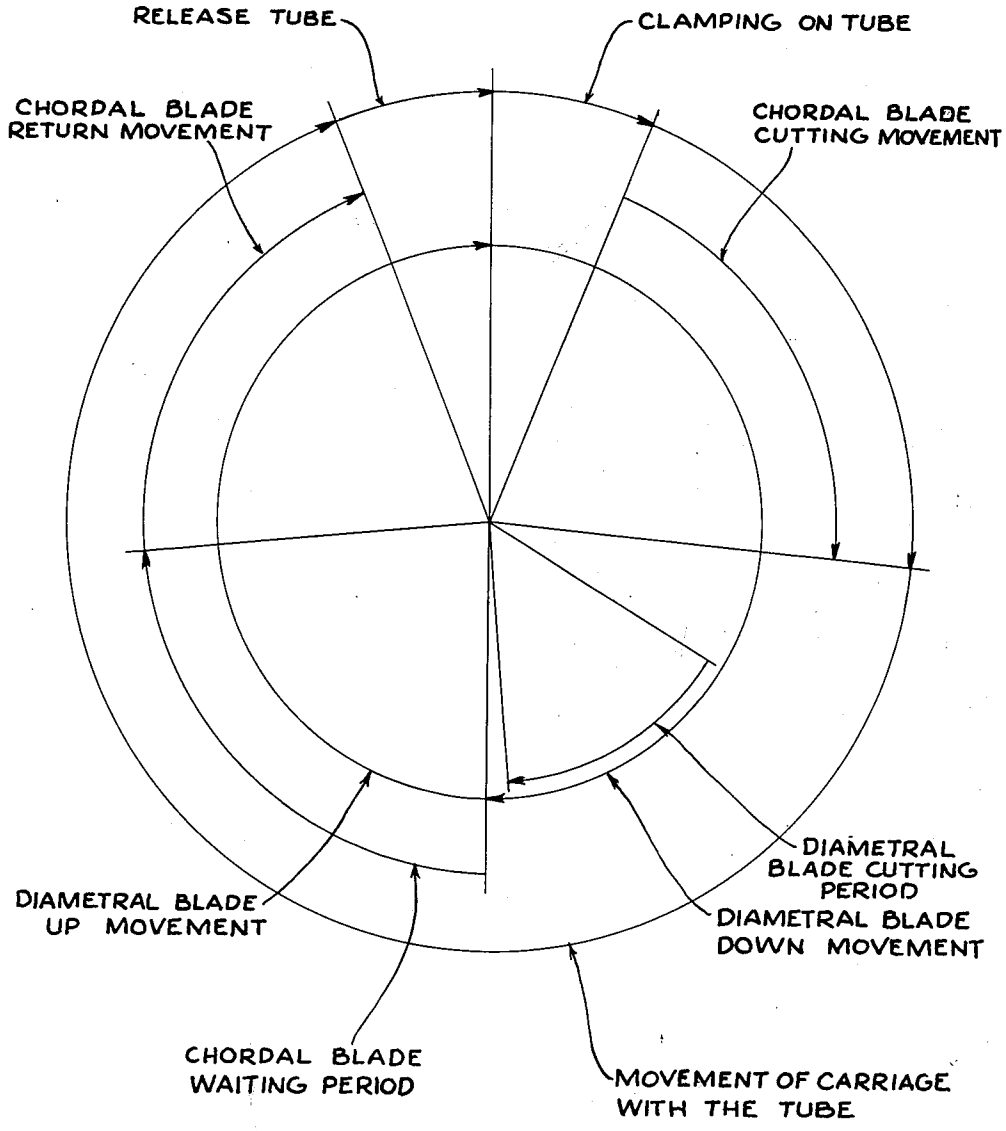


Fig. 13

INVENTOR.
LOUIS J. AUER
BY
Gregory J. Dolgorukov
ATTORNEY

April 21, 1964 L. J. AUER 3,129,624

CUT-OFF DEVICE FOR TUBE MAKING MACHINE OF CONTINUOUS TYPE

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Fig. 15

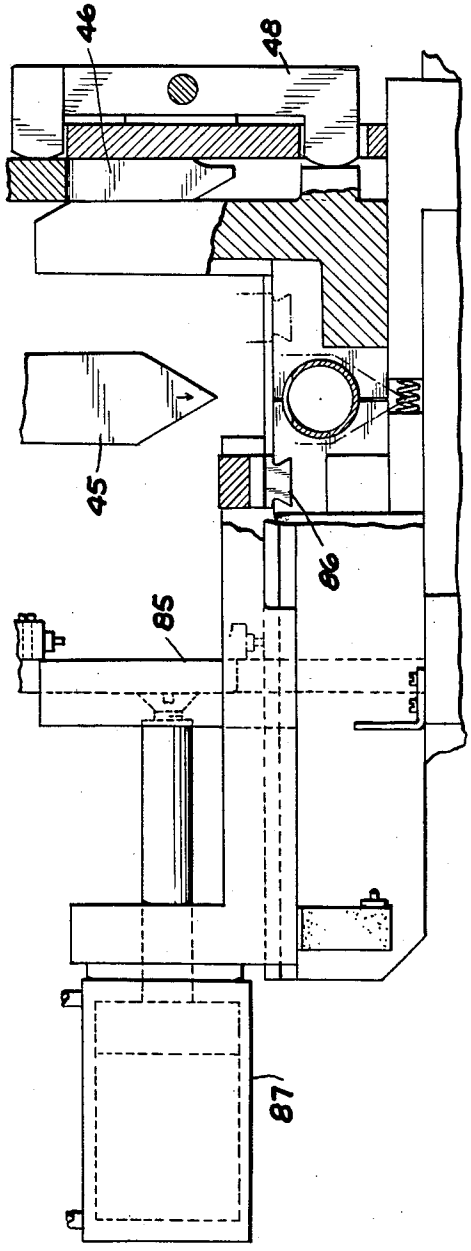


Fig. 16

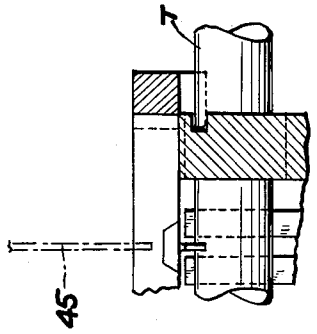
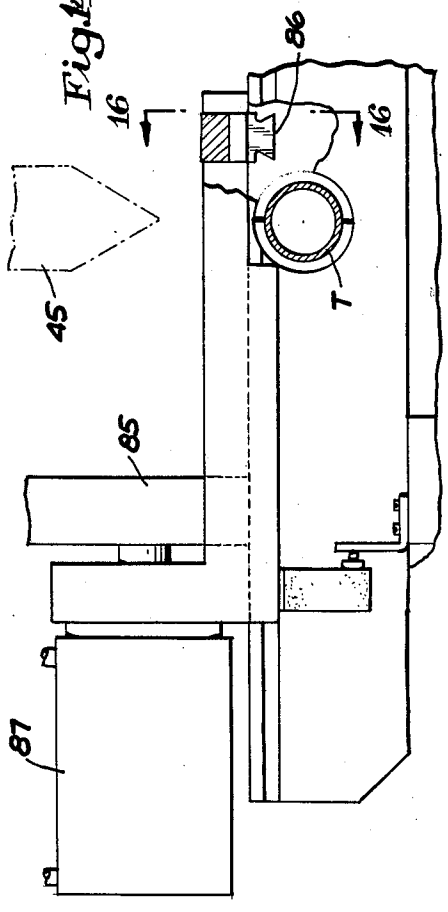


Fig. 14



INVENTOR.
LOUIS J. AUER
BY
Gregory S. Dalgorutsos
ATTORNEY

United States Patent Office 3,129,624 Patented Apr. 21, 1964

3,129,624

CUT-OFF DEVICE FOR TUBE MAKING MACHINE OF CONTINUOUS TYPE

Louis J. Auer, 1200 E. Square Lake Road, Birmingham, Mich.

Filed Oct. 24, 1960, Ser. No. 64,431
7 Claims. (Cl. 83—300)

This invention relates to tube-making machines and more particularly to such machine having an improved cut-off device. In one of its aspects the the present invention also relates to an improved cut-off device made as an attachment and used in connection with a machine having a tube or tubular member in continuous longitudinal motion for the purpose of cutting such tube or tubular member.

With the advent of tube-making machines producing tubes from a strip of sheet metal by a continuous process, the use of such tubes in industry has greatly increased. With the use of such machines, tubes are made by having a sheet metal strip continuously fed into the forming rolls wherein the strip is folded longitudinally into a cylindrical shape and fed on further toward the welding electrodes which are adapted to produce a continuous welded seam connecting the two edges of the strip together. The continued movement of the tube brings the welded seam past a stationary shaving cutter which takes a continuous chip from such welded seam. Thus, a smooth cylindrical tube is formed, which tube moves continuously toward the delivery side of the machine at a relatively high speed, such as approximately 100 feet per minute, to be cut into pieces of desired length. One construction of such machines known in the trade as "Yoder" is used very extensively in industry.

Difficulties have been experienced, however, in providing means for cutting the continuously moving tube into pieces of predetermined length and producing square and smooth cuts.

The difficulties result primarily from two factors. The first such factor is the continuous motion of the tube, which condition requires that cutting means travel with the tube from the time they commence the cutting operation at least until the time when the cut is completed, and it is no longer necessary for the cutting tool to be in contact with the tube. Since any prolonged cutting operation would require cutting means to travel for a considerable distance in the machine, it was found imperative to utilize means producing very fast cuts, such as cut-off die blades. Cut-off devices used almost universally with the tube-making machine of the continuous type utilize a V-shaped blade mounted in a carriage operating on slide rails, with the carriage including means adapted to engage the tube and to travel therewith for a distance giving sufficient time for the blade to move down, cut the tube transversely and to return to its starting position, whereupon the engagement of the carriage with the tube terminates and the carriage is returned to its starting position with the aid of suitable springs. In the present day tube-making machines such cut is usually accomplished within approximately 24" of carriage travel. The V-shaped cutter is made to move on its cutting stroke along the center line of the cross section of the tube. Thus, in cases of tubes of round cross section, such blade travels along the diameter of the tube cross section.

It was found, however, that while such cutting means operate successfully to separate the tubes into pieces of desired length, the quality of the cut produced thereby is not fully satisfactory. As the point of the blade strikes the tube, it first produces an indentation extending toward the center of the cross section of the tube. It is only after this indentation reaches a certain size that the cutting process begins. As a result, the end of the tube so cut is

not cylindrical, but has a portion of its edge bent inwardly, with some metal extending in a tongue-like manner toward the center of the tube cross section. The tubes having such ends have to be trimmed with the use of special machines.

For the purposes of trimming the ends of such tubes, machines including cut-off devices with two blades have been developed. Such machines accomplish a cut in two steps or operations. A tube to be trimmed is fed into the machine wherein it advances longitudinally to a stop. Thereupon, a so-called "horizontal" cutter blade moves along a path representing, in effect, a chord of the cross section of the tube, crossing both the outer and the inner periphery of the tube and thus producing an "initial" cut, as a result of which a small opening is formed at the top of the tube. The horizontal blade then returns to its original position, whereupon a "vertical" blade of the V-type, such as described above, moves down, with its point passing through the opening provided by the initial cut, and cutting with its sides completes the cut without producing an indentation or bending the wall of the tube.

Cut-off devices of this type produce cuts satisfactory for general purposes. However, not only is there loss of material due to cutting off pieces of the tube from both of its ends, but the entire process, including intermittent rather than continuous movement of the tube to be cut, is relatively slow. Furthermore, provision of special machines and the necessity of additional handling of long tubular members in the plant complicates manufacturing and requires additional space.

Many years of practicing such methods has established in the art a process usable on intermittently movable tubular members and incompatible, due to its plurality of operations, with machines wherein the tubular members are in continuous longitudinal motion.

One of the objects of the present invention is to produce a tube-making machine of the continuous type, including improved cut-off means whereby the above difficulties and disadvantages are overcome and virtually eliminated without introducing new problems and without increasing in an appreciable degree the cost involved.

Another object of the present invention is to provide a tube-making machine of the continuous type having improved cut-off means operating automatically to cut the moving tube into pieces of predetermined length squarely and smoothly without forming an inwardly protruding tongue and thus, in effect, producing a cut requiring no further trimming, thus saving both the material as well as the expense of subsequent trimming operations.

A further object of the present invention is to provide a tube-making machine of the continuous type having improved cut-off means of the character specified in the preceding paragraph, which means are operative to produce such improved cuts within the space limitations of such machines as they are now constructed and particularly without increasing the length thereof.

A further object of the present invention is to provide an improved tube-making machine of the continuous type having improved cut-off means with the aid of which the tube may be automatically cut into much shorter pieces than was possible heretofore, the cut-off ends of such pieces requiring no further trimming and, therefore, affording possibilities of cutting the tube produced by the machine into short pieces as may be required by a specific order rather than produce it first in a standard length of much greater dimension and thereupon cutting it into shorter pieces on a separate machine.

A still further object of the present invention is to provide an improved tube-making machine of the continuous type having improved cutting means including a carriage traveling with the tube in the process of cutting which means complete the two-step cutting within the time and

space limitations which do not increase the impact of the carriage on its return stroke.

A still further object of the present invention is to provide a cut-off device which may be produced as a separate item or article of manufacture and used as an attachment in connection with any machine or device in which a tubular member is maintained in continuous longitudinal motion either in the process of making the tubular member or otherwise.

It is an added object of the present invention to provide an improved cutting device of the foregoing character which is simple and rugged in construction, dependable in use and is relatively inexpensive to manufacture and to service.

Further objects and advantages of this invention will be apparent from the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification, wherein like reference characters designate corresponding parts in the several views.

FIG. 1 is a diagrammatic elevational view illustrating a complete installation, i.e. a tube-making machine employing continuous method and including a cut-off device embodying the present invention.

FIGS. 2 and 3 are sectional views illustrating in a diagrammatic manner the general concept of cutting a thin wall tube that would normally collapse under pressure of a cutter, with FIG. 2 illustrating making a cut in a chordal direction to produce an initial opening without the danger of the tube collapsing, and FIG. 3 illustrating completing the cut with the aid of a V-shaped cutter entering the opening produced by the chordal cutter and completing the cut by movement through the center line or diameter of the tube cross section perpendicularly to the chord along which the initial cut was made by the chordal cutter.

FIG. 4 is an end view of the machine generally illustrated in FIG. 1 and showing details of the cut-off device.

FIG. 5 is a side view of the construction of FIG. 4.

FIG. 6 is a side view, partly in section, illustrating on a larger scale the cut-off device, with said view being taken in the direction of the arrows on the section plane passing through the section line 6—6 of FIG. 4.

FIG. 7 is an end view illustrating in elevation the cut-off device, the observer being presumed to look in the direction of the arrows on the section plane passing through the section line 7—7 of FIG. 5, with the parts of the cut-off device being shown at the moment of the beginning of the operation cycle, with the jaws about to engage the moving tube, with phantom lines indicating the extreme downward position of the V-shaped diametral cutter and also the path of the cutting edge of the chordal cutter throughout the entire cycle of its operation.

FIG. 8 is a fragmentary view similar in part to FIG. 7 but showing the jaws having clamped tube for movement of the carriage therewith, the chordal cutter starting on its movement to produce the initial opening in the tube.

FIG. 9 is a view similar in part to FIG. 8 with the chordal cutter having completed its cut through the tube.

FIG. 10 is a view similar in part to FIGS. 8 and 9 and showing the chordal cutter reaching the position where it begins to clear the way for the diametral cutter and climb up to a position for return through the upper portion of its path in order not to interfere with movement of the tube.

FIG. 11 is a view similar in part to FIGS. 8–10 and showing the chordal cutter having climbed, because of the operation of the cam means, to its elevated position and out of the way of the diametral cutter, the latter now reaching the position at which it is about to enter the initial opening produced in the tube by the chordal cutter, with phantom lines showing the lowermost position of said diametral cutter after completing the cut through the entire cross section of the tube.

FIG. 12 illustrates the chordal cutter in the position at which it is about to be released from its suspended position.

FIG. 13 is a circular diagrammatic view illustrating with reference to a complete cycle representing the cycle of the forward movement of the carriage and of the cutters therein, and the time relationship of such movements.

FIG. 14 is a view similar in part to FIG. 7 but showing the cut-off device including hydraulic means for operating the chordal cutter with the operative parts of the device being shown at the beginning of the operation cycle.

FIG. 15 is a view similar in part to FIG. 14 and showing the chordal cutter having completed its forward stroke in producing the initial cut in the tube.

FIG. 16 is a view partly in section taken in the direction of the arrows on the section plane passing through the line 16—16 of FIG. 14.

It is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein is for the purpose of description and not of limitation.

Although the invention is hereinafter illustrated and described with reference to a tube of a circular cross section, it will be understood that the invention is applicable to tubes of other cross sections such as square, rectangular, hexagonal, triangular and the like.

In accordance with the invention, cutting the tube, in spite of its movement at high velocity, is done in two operations such as was previously considered to be possible only with a tube remaining stationary. Such a method includes providing an initial opening in the tube by means of a "chordal cutter" having its blade moving in the chordal direction as shown in FIG. 2, and thereupon completing the cutting-off operation with the aid of a V-shaped "diametral cutter" having a pointed blade with its vertex or point moving along the center line or diameter of the cross section of the tube perpendicularly to the chord along which the initial cut was made. The second operation, i.e. the operation performed by the diametral cutter is illustrated in FIG. 3. In accordance with the invention such cutting-off is made without decreasing the speed of the movement of the tube and, therefore, the rate of its continuous production and without increasing the length of the travel of the cut-off carriage and of the length of the machine. Such results are attained by so devising the cycle of the movement of the chordal and diametral cutters that their movements are, in their large portions, simultaneous rather than successive, thus saving considerable time and, therefore, decreasing the necessary length of the carriage travel. It is only the actual cutting of the tube that is done successively, while the operative movements preparatory to such actual cutting are simultaneous and not successive as in prior constructions.

In the drawings there are shown, by way of example, two embodiments of the invention, one including a carriage with its operative parts being actuated by mechanical means and another in which some of such parts are actuated by hydraulic means.

FIG. 1 illustrates an entire installation forming a tube-making and cutting-off machine. FIG. 1 represents diagrammatically such an installation utilizing either mechanical or hydraulic means for actuating parts of the carriage. Referring to said FIG. 1, the installation illustrated therein comprises means to support on a suitable shaft a roll 20 of a strip material, preferably steel, from which roll such strip is unwound by the pull exerted thereon by several sets of forming rolls 21–24, which also gradually bend the tube and change its form from a flat strip as at 25 into a tube as at 26. With the edges of the strip being thus brought together, circular electrodes 30 rotating in the process of their operation operate to produce an electric weld or a continuous welded seam along the tube, fusing its meeting edges together. A shaving cutter 32 fixed in a suitable position shaves off the excess

welding flash as indicated at 33 and thus smoothens the rough weld and provides a smooth weld requiring no further finishing. The process so far described is a conventional one. Such process is continuous, the tube being so produced at the rate of approximately 90 feet per minute unitl all the strip on the roll 20 is used up.

The roll 20 may have as much as 10,000 feet and even more of strip and, therefore, it is necessary as the tube is produced to cut it into pieces of desired length which may be either a standard length for a tube representing a staple item of the trade, or into pieces of some special length specified by an order. Considerable saving in material and labor may be attained by ordering tube cut into pieces of desired length in the process of its manufacturing, in accordance with the present invention, and without the necessity of its trimming or further cutting.

As mentioned above, the conventional tube-making machines of this general type are limited, in effect, to cutting the tubes in a preliminary manner merely to make its continuous production possible, because of the inability of the conventional cutting-off devices of such machines to produce a smooth cut-off which could be considered as the final or finished cut-off. With conventional cut-off devices, the ends of the tubes coming from the tube-making machine had to be trimmed in machines capable of operating only on pieces of tubing remaining at rest during the cutting-off operation.

In accordance with the present invention the final or finished cutting of the tube is produced in two operations illustrated in FIGS. 2 and 3 but in the process of the forward stroke of the cutting carriage generally designated by the character C, i.e. movement of the carriage C from its position indicated in FIG. 1 in full lines and designated by the character P_s to the position designated by the character P_e and shown in said FIG. 1 by phantom lines. During the cutting operation the carriage is locked with the aid of locking jaws to the tube and travels therewith. After a piece of the tube is cut off, the jaws are released, and springs, such as those indicated at 35, return the carriage to its original position P_s. The cut-off piece continues to travel, partly by inertia and partly by being pushed by the tube behind it, until it reaches the stop S, whereupon it rolls down through a suitable trough into a box or similar container for removal to another station for shipment or for further operations.

The carriage C comprises a lower unit 36 traveling along the slides 37, hereinafter described in detail, and an upper unit designated in FIG. 1 by the numeral 38 and carrying the diametral or V-shaped cutter and cams actuating the parts of the lower unit. The upper unit 38 moves along the slides 39 carried by the ram 40 which is actuated with the aid of a crank 41, see FIG. 5, connected to a connecting rod 42 and adapted to pull the ram 40, and the upper unit carried thereby, down for the purpose of actuating the cut-off device as explained in detail below and to return it to its uppermost position at the end of the forward travel or stroke of the carriage C, whereupon said carriage is returned to its original position P_s by the action of the springs 35, as mentioned.

Thus, the operative bodily movement of the carriage C during the operation cycle consists of movement of the carriage forward from its starting position P_s to its forward position P_e and thereupon returning to its starting position P_s, i.e. or of its forward and return strokes. The operative movements of the upper unit 38 and of the ram 40 actuating the same consist of downward movement to the position indicated in phantom lines in FIG. 1 during the 180° rotation of the crank 41, return or upward movement to the starting or upper position, during the next 180° rotation of the crank 41, or rotation of the latter from 180° to 360° angle, and thereupon remaining at rest in said uppermost position, during which period the carriage C returns to its original position, with the crank 41 also remaining at rest.

The movements of the parts of the lower units are described below and their occurrence is illustrated in FIG. 13. It should be appreciated that FIG. 13 illustrates the cycle or sequence of movements occurring during rotation of the crank 41 through 360° angle, and therefore, during the forward stroke of the carriage C, i.e. its movement from position P_s to position P_e, and does not include the return of said carriage C to its original position, which return takes place while the crank 41 remains stationary in its original position. In other words, rotation of the crank 41 is intermittent and not continuous.

Operative parts of the lower unit including the chordal and diametral blades are actuated by the downward and upward movement of the unit generally designated in FIG. 1 by the numeral 36 and shown separately and on a large scale in FIG. 7. FIGS. 8–12 illustrate positions of said parts during various portions of the operation cycle. The upper unit 38 carries a V-shaped diametral cutter or blade 45, a jaw-locking cam 46 and a chordal cutter actuating cam 47. The jaw-locking cam 46 operates the sliding block 43 which, in turn, locks the jaws on the moving tube T causing the carriage to move with the tube and unlocking the jaw at the end of the forward movement of the carriage. Downward movement of the cam 46 operates also the bell crank 48 hinged as at 49 causing the lower end 50 of said crank to move to the left and exert pressure on the block 43 at the lower portion thereof to produce a balanced operation and prevent jamming. The block 43, in turn, presses on the right or movable jaw 51 bringing it into contact with the tube T pressing the same against the stationary jaw 52. As the grip of the locking jaws on the tube T is effected, the entire carriage begins to travel forward.

Simultaneous with the downward movement of the jaw-locking cam 46, cam 47 pressing on the pin 53 secured to the sliding frame 54 causes said frame to move to the left carrying with it the chordal blade bracket 55 hinged on said frame 54 at 56 and carrying the chordal cutter blade 60. Movement of the blade 60 takes place along the chord of the tube cross section as shown in FIG. 2 and causes cutting in the wall of the tube T of a slit 61 passing through the entire thickness of the wall of the tube at the top thereof. In order to prevent the cutter 60 from being deflected by the wall of the tube because of a relatively small angle at which it contacts the same, means are provided to hold the blade 60 down and to prevent it from riding over the top of the tube. In the present embodiment said means are exemplified by a hold-down cam 63 under which a lug 64 of the chordal cutter bracket 55 rides in the process of cutting the slit 61 in the tube T. However, because of the form of said hold-down cam 63 and the limited length thereof, this cam becomes ineffective as soon as cutting is completed in order to permit the chordal cutter 60 to rise. Because of its rising, the chordal cutter becomes prepared to return to its original position through a path above the tube and, therefore, independently of the tube or in such a manner as not to interfere with the movement of the tube. Such an expedient eliminates the necessity of the carriage moving with the tube during the return of said cutter 60 to its original position.

Raising the cutter 60 is attained with the aid of a cam 66 which is contacted by the rounded edge 67 of the bracket 55, causing said bracket 55 to rotate on its hinge 56 and come into the position illustrated in FIG. 11. At this position a pin 68 pressed outwardly by the spring 69 gets into an indentation 70 provided on a cross bar 44 of the frame 54 and retains the cutter 60 in its raised position. FIG. 8 illustrates positions of the operative parts when the cutter 60 is just about to contact the tube T and with the lug 64 of the bracket 55 not yet under the hold-down cam 63.

FIG. 9 shows the blade 60 about to complete its cut through the tube T and with the lug 64 about to come out from under the hold-down cam 63 but with the rounded edge 67 of the bracket 55 not yet in contact with the raising cam 66. FIG. 10 shows the operative parts at the

moment of contact of said rounded edge 67 with the raising cam 66 and with the bracket 55 about to begin its climb to cause the pin 68 to enter the indentation 70 for the purpose of retaining the cutter bracket 55 and the cutter 60 in their position illustrated in FIG. 11 as mentioned. It will be understood that pin 68 and its associated elements may be eliminated by the provision of a cam having an articulated path so developed as to impart desired movements to the bracket 55.

It will be understood that during such movement of the chordal blade 60, the diametral cutter or blade 45 continues its downward movement from its uppermost position and by the time the blade 60 and its bracket 55 are brought into the raised position illustrated in FIG. 11, the blade 45 is about to enter the slit 61 in the tube T and to complete the cut. Such cutting movement of the blade 45 occurs within the next few degrees of the rotation of the crank 41 as illustrated in FIG. 13 and, therefore, considerably before the cutter 60 completes its return movement. In other words, in accordance with the invention, the cutter 45 does not need to wait for the cutter 60 to return to its original position before starting on its cutting movement, and actual cutting operations of the cutters 60 and 45 follow each other in exceedingly rapid succession in the process of actual cutting. Thereupon, the return movements of the cutter 45 and blade 60 occur as explained below.

When the cutters 45 and 60 are in their positions illustrated in FIG. 11, with the cutter 45 being in its lowermost position, carriage C of the machine is in a position intermediate its position P_s and P_e and with the cutter 45 and the ram 40 being in their lowermost positions. Thereupon, with the ram 40 rising because of the operation of the crank 41, the return springs 75, which are compression springs, cause the sliding frame 54 to move to the right as permitted by the rising cam 47, thus carrying the chordal cutter bracket 55 also to the right. It will also be understood that during the first few degrees of such movement, the blade 45 is withdrawn from the tube T and with the cutter 60 returning to its original position above the tube T, there is no need to have the main carriage C move with the tube. Therefore, unlocking the jaws can take place much sooner than would otherwise be possible.

In its movement to the right, the bracket 55 reaches the stop 76, contacting the same with its rounded edge 77 as shown in FIG. 12. Further movement of the bracket 55 to the right causes its rotation in the counter-clockwise direction as illustrated in FIG. 12 and release of the pin 68 from the indentation 70 and, therefore, release of the bracket 55 and the cutter 60 and their return to the original position. By that time the cam 46 reaches its uppermost position as indicated in FIG. 7, in consequence whereof the jaw block and the movable jaw 51 are permitted to move to the right, bringing the bell crank 48 into its position shown in FIG. 7, with its upper end 79 entering into the recess 80 provided at the lower end of the unlocking cam 46. Such movement of the jaw 51, block 43, and of the bell crank 48 is produced mainly by operation of the compression springs 75, with the small spring 81 provided merely to keep the jaws apart. The locking movement of the cam 46 takes place in opposition to said spring 81.

As explained above, at this time the carriage is at the end of its forward stroke and is substantially in the position P_e with the crank 41 being in its position shown in FIG. 5, and the ram 40 being in its uppermost position as shown in full lines in FIG. 1. As soon as the grip of the jaws on the tube T is released, the springs 35 return the carriage C into its starting position P_s and the device is ready for another cycle of operation.

FIGS. 14–16 illustrate a machine in which the chordal cutter makes only one stroke for each cycle of operation, and such stroke, which may be either a forward stroke or a return stroke, is also a cutting stroke. In other words, the chordal cutter cuts both on its forward stroke and its return stroke. In addition, the movement of the frame 85 operating the chordal cutter 86 is produced not by mechanical means, such as cam 47 of the construction of FIGS. 2–12, but by hydraulic means and particularly by a hydraulic cylinder-and-piston assembly generally designated by the numeral 87. It will be noted, however, that the device of FIGS. 14–16 still includes the diametral cutter 45 and the unlocking cam 46 constructed and operating substantially in the same manner as in the construction of FIGS. 2–12. Provision of hydraulic means, such as the cylinder-and-piston assembly 87, affords an opportunity to adapt the operation of such hydraulic means for a more advantageous movement with respect to movements of other parts, and particularly of the ram 40, and in a much easier manner, such as with the aid of hydraulic valves, than making a corresponding change with the use of mechanical means. However, it will be understood that the movements of the chordal cutter in the construction of FIGS. 14–16 may also be attained with the aid of mechanical, pneumatic, or other means capable of producing a desired force. In the embodiment of the invention illustrated in FIGS. 14–16, the movement of the chordal cutter 86 is made such that it moves through one stroke during each cycle of operation, as mentioned. The blade 86 is made to cut on both of its sides. Therefore, it cuts on its forward stroke during one cycle of operation of the device, and cuts with its other side on its return stroke during the succeeding cycle. Consequently, the blade 86 need not be raised for its return during the same cycle of operation. After completing its forward stroke, the chordal blade 86 simply waits for the diametral blade to complete its operation and for the carriage C to return to its original position, and its return movement is thus made a cutting movement also.

By virtue of the constructions disclosed above, the objects of the present invention listed above and numerous additional advantages are attained.

I claim:

1. In a cut-off device for a tube in continuous longitudinal motion, a carriage having said tube threaded through it and movable in a straight reciprocal path of a predetermined length substantially parallel to the tube, the movement of said carriage from its starting position to the forwardmost position and its return to the starting position forming one cutting cycle of the device, locking means carried by said carriage and operable to lock said carriage to the tube at the beginning of the cycle for having the carriage move with the tube to the forward terminal point of said path and to release the carriage from the tube at said terminal point, spring means returning the carriage to its original position upon release of the tube by said locking means; two cutters, each carried by said carriage and separately movable therein transversely of the tube through a cutting stroke and a return stroke, means to move the first of said cutters through its cutting stroke to cut a notch through the thickness of the tube wall and to proceed further in the forward direction toward a position completely out of the way of the second cutter and to remain stationary in such position while the second cutter moves at least until said second cutter entered said notch; and means to move said second cutter through said notch and the remaining portion of the tube cross section to cut off the tube and to return said second cutter to its original position in the carriage.

2. In a cut-off device for a tube in continuous longitudinal motion, a frame, a carriage having said tube threaded through it and movable in said frame along a straight reciprocal path of a predetermined length, locking means carried by said carriage and operable to lock said carriage to the tube to move the carriage from its starting position to the end of its forward movement and to release the tube from the carriage at said end, means returning the carriage to its original position upon its re-

lease from the tube, two cutters carried by said carriage and movable therein transversely of the tube to perform the cutting-off operation, the first of said cutters movable on its cutting stroke along a path intersecting the cross section of the tube to cut a notch through the thickness of the tube and thereupon proceeding further into a position out of the way of the second cutter, the second of said cutters thereupon moving to enter said notch and to move transversely of the tube cross section to complete the cutting-off operation, cam means for actuating said cutters, and means adapted to retain the first cutter in said position at least until the second cutter completes the cutting-off operation and moves out of the tube cross section.

3. In a cut-off device for a tube in continuous longitudinal motion, a frame, a carriage having said tube threaded through it and movable in said frame along a straight reciprocal path of a predetermined length, locking means carried by said carriage and operable to lock said carriage to the tube to move the carriage from its starting position to the end of its forward movement and to release the tube from the carriage at said end, means returning the carriage to its original position upon its release from the tube, two cutters carried by said carriage and movable therein transversely of the tube to perform the cutting-off operation, the first of said cutters moving on its cutting stroke along a path intersecting the cross section of the tube to cut a notch through the thickness of the tube and thereupon proceeding further into a position out of the way of the second cutter, cam means to actuate thereupon the second of said cutters to enter said notch and to move transversely of the tube cross section to complete the cutting-off operation, and cam means adapted to actuate said first cutter through the cross section of said tube on its cutting stroke and to return said first cutter to its starting position through a path by-passing the cross section of the tube.

4. In a cut-off device for a tube in continuous longitudinal motion, a frame, a carriage having said tube threaded through it and movable in said frame along a straight reciprocal path of a predetermined length, locking means carried by said carriage and operable to lock said carriage to the tube to move the carriage from its starting position to the end of its forward movement and to release the tube from the carriage at said end, means returning the carriage to its original position upon its release from the tube, two cutters carried by said carriage and movable therein transversely of the tube to perform the cutting-off operation, cam means to move the first of said cutters through its cutting stroke along a path intersecting the cross section of the tube to cut a notch through the thickness of the tube and thereupon to proceed further into a position out of the way of the second cutter, cam means to move thereupon the second of said cutters to enter said notch and to move transversely of the tube cross section to complete the cutting-off operation, cam means adapted to raise the first cutter at the end of its cutting movement into a position above the cross section of the tube, to retain it in said position, and to return said first cutter to its starting position through a path above the cross section of the tube.

5. In a cut-off device for a tube in continuous longitudinal motion, two cutters each separately movable

transversely of the tube through a cutting stroke and a return stroke, with the first one of said cutters movable along a chord of the cross section of the tube to cut a chordal notch through the thickness of the tube and the second of said cutters movable on its cutting stroke to enter the notch produced by the first cutter, slide means carrying said first cutter and adapted to bring the same at the end of its cutting stroke into a position completely out of the cross sectoin of the tube and out of the way of said second cutter and to retain it stationary in said position without holding sationary said second cutter, and slide means carrying said second cutter to move the same on its cutting stroke through the cross section of the tube before the first cutter starts on its return stroke.

6. In a cut-off device for a tube in continuous longitudinal motion, a frame, a carriage movable forward and back in said frame through a straight path of predetermined length parallel to said tube, clamping means mounted on said carriage and adapted to lock said carriage to the tube for moving therewith, cam means actuating said clamp means to lock the carriage to the tube at the starting position thereof and to unlock the same at the forward end of said path, means returning the carriage to its original position upon unlocking of the clamp means, a chordal cutter and diametral cutter carried by said carriage and slidably mounted therein for movements transversely of the tube, hydraulic means actuating said chordal cutter to cut a notch through the thickness of the tube by moving across a portion of the cross section of the tube and to move murther into a position on the other side of the tube and out of the way of the diametral cutter, cam means actuating said diametral cutter to enter the notch so produced to complete the cutting operation and to return to its original position, said hydraulic means operating to move said chordal cutter back to cut a notch on its return stroke and thus to provide such notch for the next cutting-off operation of the diametral cutter.

7. In a cut-off device for a tube in continuous longitudinal motion, a frame, a carriage movable forward and back in said frame through a straight path of predetermined length parallel to said tube, clamping means mounted on said carriage and adapted to lock said carriage to the tube for moving therewith, cam means actuating said clamp means to lock the carriage to the tube at the starting position thereof and to unlock the same at the forward end of said path, means returning the carriage to its original position upon unlocking of the clamp means, a chordal cutter and diametral cutter carried by said carriage and slidably mounted therein for movements transversely of the tube, said chordal cutter being adapted to cut on its forward stroke and to move on the other side of the tube and out of the way of the diametral cutter for the latter to complete the cutting-off operation, and on the return stroke to cut another notch and thereupon to return into its starting position after cutting said another notch for the diametral cutter to complete the second cutting-off operation.

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