Jan. 24, 1967 W. J. SCHUMACHER ET AL 3,299,757

APPARATUS FOR THE OPERATION OF FLYING CUT-OFF DEVICES

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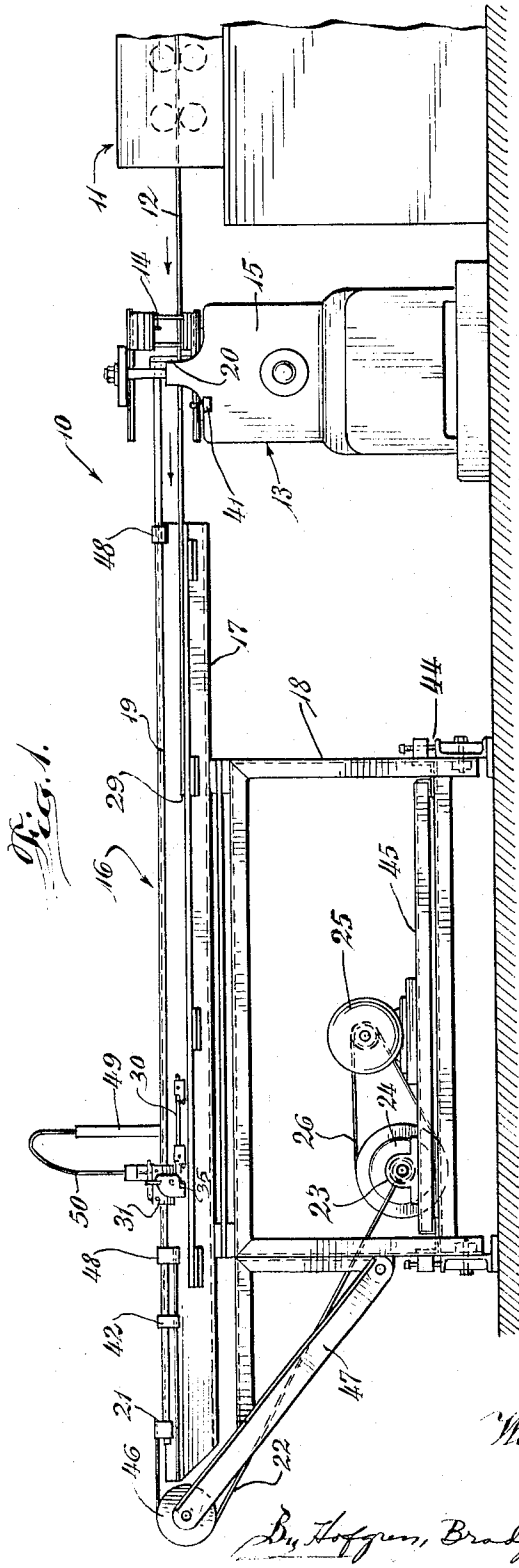


Fig. 1.

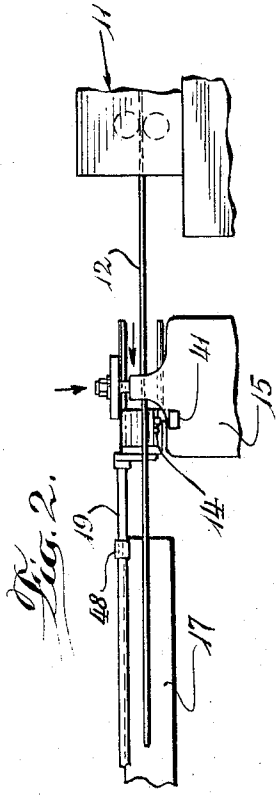


Fig. 2.

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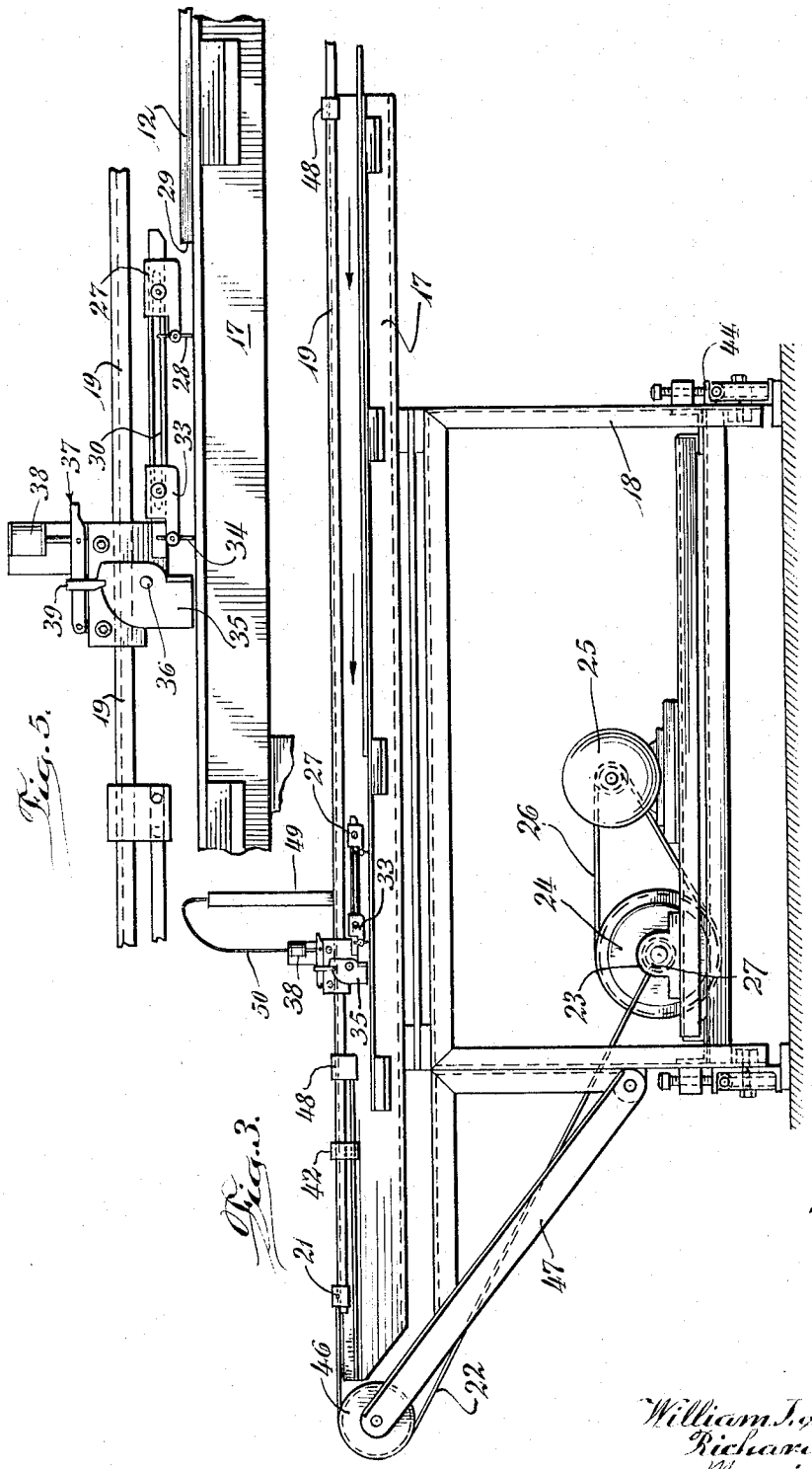


Fig. 5.

Fig. 3.



Fig. 12.

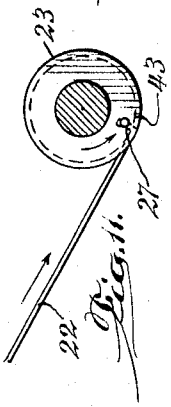


Fig. 11.



Fig. 10.

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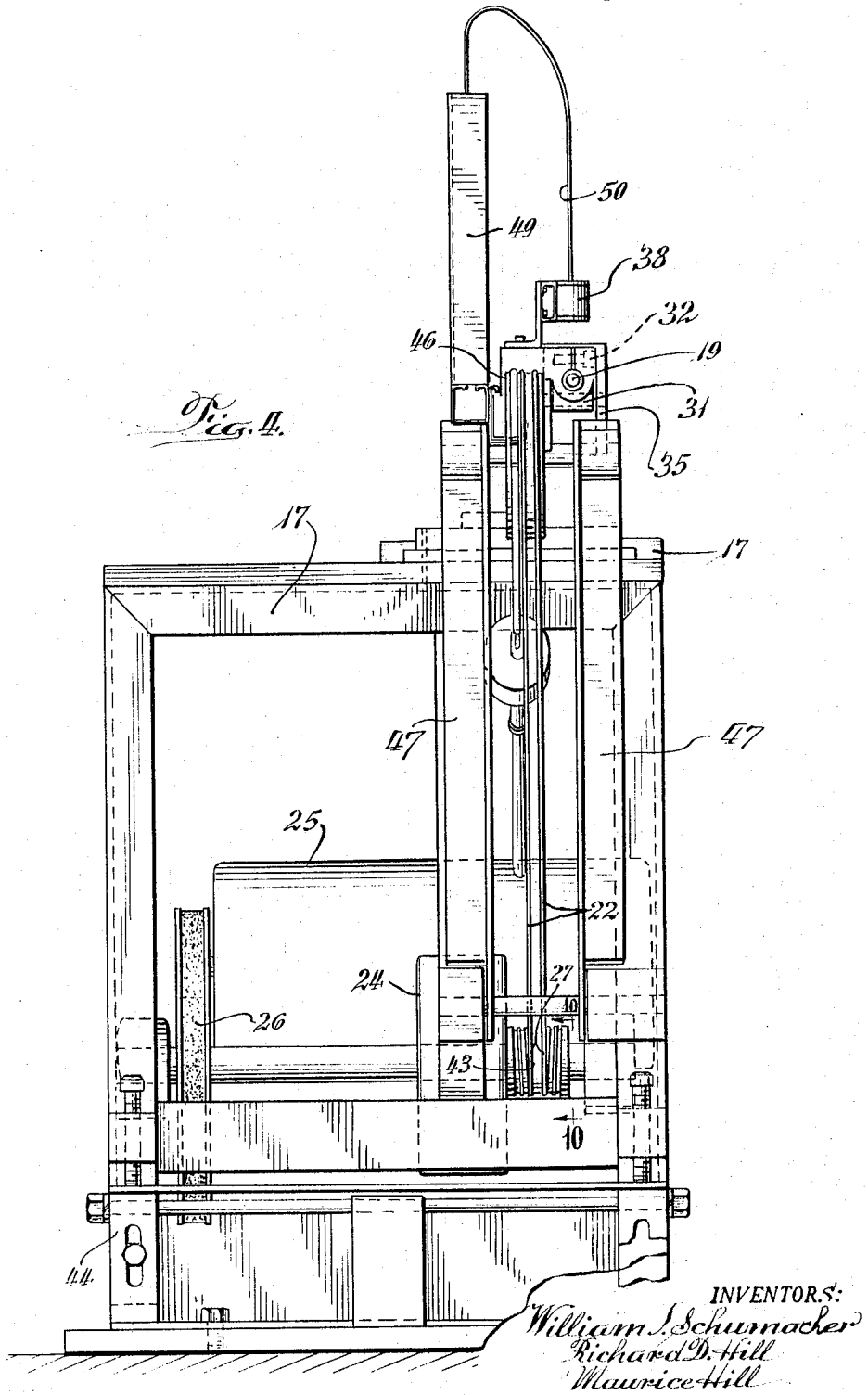
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APPARATUS FOR THE OPERATION OF FLYING CUT-OFF DEVICES

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Fig. 4.



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Fig. 6.

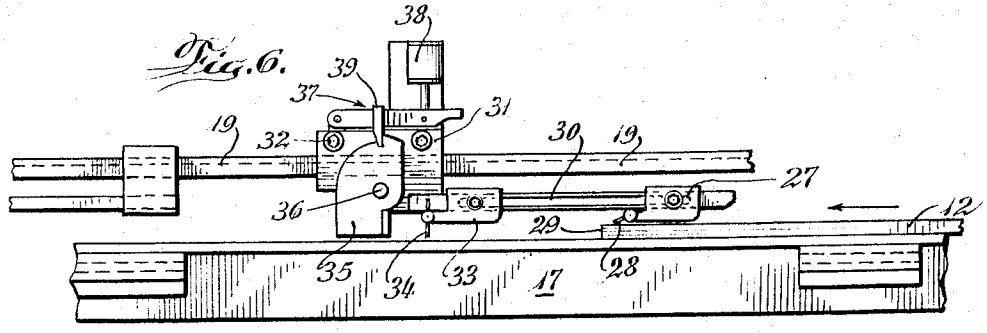


Fig. 7.

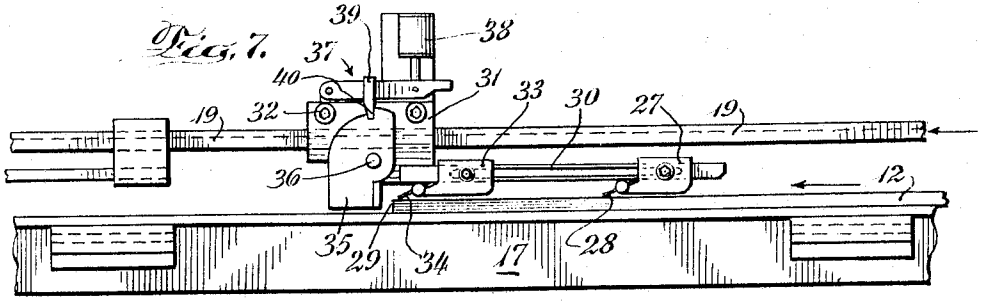


Fig. 8.

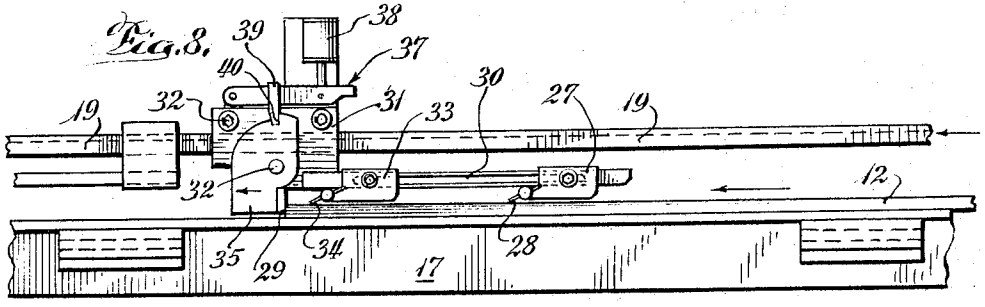
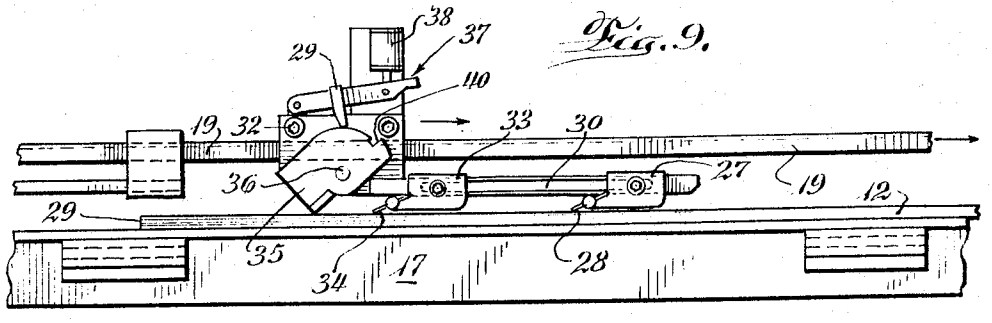


Fig. 9.



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APPARATUS FOR THE OPERATION OF FLYING CUT-OFF DEVICES

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Filed Dec. 24, 1959, Ser. No. 861,793
2 Claims. (Cl. 83—293)

This invention relates to cut-off devices and in particular to flying cut-off devices.

Cold roll forming machines have been developed for forming a wide variety of shapes including rounded and straight sections. A well-known example of such a roll formed product is electric welded tubing which may be formed substantially more economically by the roll forming process than by the extruding process. Modern roll forming machines have been developed which are capable of producing such products at substantial linear speeds such as up to 250 feet per minute.

While such increased speeds permit substantial reductions in the cost of the roll formed product, they have introduced a problem which has not heretofore been satisfactorily solved. More specifically, conventionally as the roll formed product is delivered from the forming machinery, it is cut into predetermined lengths by an associated cut-off device. It is desirable to limit the tolerances of the cut-off lengths to no greater than 1/64 inch. Control devices such as flying trip switches have been found to produce errors of up to 1/4 inch at such high speeds and, thus, are unsatisfactory in such applications.

A substantially more accurate method of controlling the cut-off is to provide a length stop which is physically engaged by the end of the roll formed element, or work, at a preselected point in its travel and which is connected to the cut-off die to move the die directly with the work so that, when the die cuts transversely through the work, it is moving directly therewith and at an accurately predetermined distance from the leading end.

The use of the length stop, however, has also been found to be unsatisfactory at the desirable higher speeds of operation. It has been found that the work tends to buckle and, thus, destroys the accuracy of the cut-off during such operations, particularly where the weight of the cut-off die appreciably exceeds 50 pounds. The use of two or more dies for performing concurrent operations such as notching and cut-off has been effectively precluded by this inability of the work to accelerate the substantial weight thereof without buckling. Further, the substantial shock delivered to the die by the striking of the work end against the stop has required the use of substantial, rigid dies aggravating the weight problem.

The instant invention comprehends a new and improved method and apparatus for effecting cut-off of such roll formed work capable of operating at high speeds and with cut-off dies having substantial weight while maintaining desired low tolerances in length of the cut-off portions. It is, therefore, a principal feature of the instant invention to provide a new and improved cut-off apparatus.

Another feature of the invention is the provision of such a cut-off apparatus including means for moving the cut-off die in the direction of travel of the work at a speed slightly less than the speed of travel of the work, means engageable by the work at a preselected point in its travel arranged to move the moving die directly with the work, and means operating the die to cut through the work during such movement of the die directly with the work.

A further feature of the invention is the provision of such a cut-off apparatus including a cut-off die juxtaposed to the path of travel of the work and movable parallel to that path between a starting position and a final position, powered means for moving the die from the starting position to a transfer position short of the final position, the powered means accelerating the die to a speed at the transfer position slightly less than the speed of travel of the work, means arranged to be positively associated with the work at a preselected point in its travel to move the die from the transfer position to the final position directly with the work, and means operating the die to cut through the work during movement from the transfer position to the final position.

Still another feature of the invention is the provision of such a cut-off apparatus having new and improved means for accelerating the die smoothly away from the starting position to have the desired speed at the transfer position slightly less than the speed of travel of the work.

Yet another feature of the invention is the provision of such a cut-off apparatus having new and improved means for permitting free lateral translation of the length of work subsequent to the cut-off operation.

Other features and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawing wherein:

FIG. 1 is a side elevation of an apparatus embodying the invention for cutting off lengths of roll formed work, a roll forming machine associated therewith being shown fragmentarily;

FIG. 2 is a fragmentary side elevation thereof illustrating the position of the cut-off die at the end of the cut-off operation;

FIG. 3 is a fragmentary enlarged side elevation illustrating a portion of the apparatus in greater detail;

FIG. 4 is an enlarged end elevation thereof looking from the left-hand end as seen in FIG. 3, a portion thereof being broken away for convenience of illustration;

FIG. 5 is a fragmentary, more greatly enlarged side elevation of the portion of the apparatus coacting with the end of the work;

FIG. 6 is a view similar to that of FIG. 5 illustrating a first step in the cut-off operation;

FIG. 7 is a view similar to that of FIG. 5 illustrating a second step in a cut-off operation;

FIG. 8 is a view similar to that of FIG. 5 illustrating a third step in a cut-off operation;

FIG. 9 is a view similar to that of FIG. 5 illustrating a fourth step in a cut-off operation;

FIG. 10 is a section taken substantially along the line **10—10** of FIG. 4 illustrating the arrangement of the winding drum and cable at the beginning of the die moving operation;

FIG. 11 is a view similar to that of FIG. 10 illustrating a subsequent arrangement thereof; and

FIG. 12 is a view similar to that of FIG. 10 illustrating a further subsequent arrangement thereof.

In the exemplary embodiment of the invention as disclosed in the drawing, a cut-off apparatus generally designated **10** is associated with a roll forming machine of conventional construction, generally designated **11**, to cut-off, in preselected lengths, elongate work **12** delivered continuously at a substantial speed from machinery **11**. Work **12** herein comprises roll formed electric welded tubing although it may comprise other elongate work such as any of the substantially unlimited number of different roll formed elements capable of being produced in such roll forming machines. Cut-off apparatus **10** includes a cut-off machine **13** which may be of conventional construction and which includes a die **14** carried on a support **15** to move with work **12** during the time die **14** is cutting through the work. This type of flying cut-off is conventional in the art and the present invention is concerned with means for controlling the movement of the support **15** and die **14** to provide an improved, accurate cut-of of the work with such cut-off means.

More specifically, cut-off apparatus **10** includes a control generally designated **16** including a table **17** carried on a frame **18** and supporting the outboard end of the work during the cut-off operation. Cut-off control **16** includes a pull rod **19** connected at one end **20** to die **14** and at its opposite end **21** to a flexible moving means comprising a pair of cables **22**. The cables are connected to a winding cylinder, or drum, **23** selectively driven by a magnetic clutch **24** from a drive motor **25** through a belt drive **26**. Motor **25** and belt drive **26** operate continuously so that when magnetic clutch **24** is energized, rotation of drum **23**, in a counterclockwise direction as seen in FIG. 1, is effected in approximately .07 second to initiate winding of cable end **27** about the drum. The resultant pull on cables **22** urges rod **19** to the left as seen in FIG. 1, initiating movement of die **14** from the position of FIG. 1 toward the position of FIG. 2. The energization of clutch **24** is effected by a control switch **27** having a sensing element **28** engaged by the outboard end **29** of work **12**. Switch **27** is carried on a support bar **30** extending horizontally toward cut-off machine **13** from a support block **31** fixedly clamped to pull rod **19** by means such as bolts **32**.

Thus, in the first phase of operation of control **16**, die **14** is accelerated from a starting position of rest, as shown in FIG. 1, toward a final position as shown in FIG. 2. If, however, the entire control of the die movement were thusly effected by switch **27**, errors up to ¼ inch at high speeds of travel of work **12** might occur in the cut-off effected by die **14**. To eliminate such errors, control **16** further includes means for causing die **14** to move directly with the work **12** and accurately at a preselected distance from work end **29**. More specifically, control **16** further includes a second control switch **33** having a sensing device **34** engaged by work end **29** subsequent to its engagement of sensing device **28** of switch **27**. Switch **33** is fixed on support bar **30** to the left of switch **27** as seen in FIG. 7. The relatively higher speed of work **12** causes work end **29** to move beyond sensing element **28** to sensing element **34** notwithstanding the concurrent leftward movement of pull rod **19** at this time. The operation of switch **33** actuates cut-off machine **13** to initiate the downward movement of die **14**.

At this point in the operation of cut-off apparatus **10**, the die **14** is moving parallel to work **12** at a speed slightly less than the speed of the work. The slightly greater speed of the work **12** causes end **29** to advance relative to pull rod **19** and abut a length stop **35** carried on support block **31**. The length stop is movably carried on block **31** by means of a pivot **36**, being normally held against pivotal movement by a latch **37** operated by a solenoid **38**. Latch **37** includes a finger **39** selectively engaging a shoulder **40** on length stop **35** to retain the length stop in the position of FIG. 5 while the solenoid **38** is de-energized, and move from engagement with shoulder **40** to permit clockwise pivoting of the length stop **35**, as shown in FIG. 9, when solenoid **38** is energized. When work end **29** abuts length stop **35**, as seen in FIG. 8, a slight additional acceleration of pull rod **19** results causing the pull rod and die **14** secured thereto to move directly with work **12**. As only a small additional force need be imparted to pull rod **19** to cause the die to move directly with the work **12**, buckling of work **12** is substantially eliminated while yet a substantial weight of the cut-off die or the use of a plurality of cut-off dies is permitted. Conversely a substantially higher speed may be attained with a given die weight.

The point at which the work end **29** engages stop **35** may be considered a transfer position in the operation of cut-off apparatus **10** as it comprises the position where movement of the die **14** is changed from a power acceleration to a positive work-effected acceleration. During movement of the die between the transfer position and the final position, the die, which had previously begun its downward movement, engages and cuts through the work **12** to complete the cut-off of the preselected length.

As the subsequent portion of work **12** being delivered from roll forming machine **11** continues to move forwardly directly behind the cut-off length, it is desirable to permit a continued forward movement of the cut-off length on table **17** subsequent to the completion of the cut-off operation, during which movement a lateral translation of the cut-off length may be effected to remove it from the table. This is accomplished by the energization of solenoid **38** through a control switch **41** carried on cut-off machine **13** and operated by die **14** at a preselected point in the forward travel thereof. Thus, as seen in FIG. 9, the energization of solenoid **38** removes finger **39** from engagement with shoulder **40** of length stop **35** and permits work end **29** to pivot the length stop and move thereunder to the position of FIG. 9. If desired, a switch **42** may be secured to pull rod **19** to the left of support block **31**, as seen in FIG. 1, to be engaged by work end **29** and effect a table dumping operation by suitable conventional mechanism, not shown. When the cut length moves from under the sensing elements **28** and **29** and the length stop **35**, the sensing elements and length stop automatically return to the starting position of FIG. 5. Die **14** is spring biased back to the starting position of FIG. 1 and is automatically retracted. The cut-off apparatus is now ready for a subsequent similar operation in effecting a cut-off of the subsequent length of work **12**.

To reduce the shock in initiating the movement of die **14** from the starting position, cables **22** are connected to winding drum **23** at the portion **43** of the winding drum which is closest to the die as measured along the cables and pull rod **19** when the die is in the starting position of FIG. 1. Thus, as the drum rotates in a counterclockwise direction as seen in FIG. 11, the end **27** of the cables has a movement substantially more laterally than longitudinally, thereby effecting an extremely smooth and gradual acceleration. When the drum portion **43** moves to the position of FIG. 11 wherein the cables **22** are substantially tangent to the drum, the longitudinal movement of the cables is maximum and remains at this maximum speed as the drum rotates from the position of FIG. 11 to the position of FIG. 12. As discussed above, this maximum speed is slightly less than the speed of the travelling work; illustratively, where the work is travelling at a speed of 250 feet per minute, the maximum longitudinal movement of the cables and pull rod **19** may be approximately 230 feet per minute.

As the die is smoothly accelerated to the transfer position without slippage of the clutch, the transfer point is accurately fixed permitting the length stop to be positioned to be contacted by the work substantially at the instant that the maximum speed effected by the motor drive is reached. As the total travel of the die is, thus, effectively minimized, more rapid cycling may be effected while yet high accuracy in the cut may be maintained.

To facilitate operation of control **16**, the level of frame **18** may be adjusted by suitable adjustable supports **44**. The motor, drive, and winding drum apparatus may be carried on a suitable shelf **45** in frame **18**. A pulley **46** may be secured at the end of a support arm **47** to guide cables **22** into alignment with pull rod **19** at end connection **21** and table **17** may be provided with suitable slide supports **48** for facilitated longitudinal movement of the pull rod **19**. A standard **49** may be secured to table **17** for bringing wires **50** to solenoid **38** for electrical control thereof.

In recapitulation, work end **29** in moving along the table **17** first strikes the sensing element **28** of switch **27** which initiates operation of the winding drum **23** to effect a powered acceleration of the die parallel to the travelling work. The work end next engages sensing element **34** of switch **33** to initiate downward movement of die **14**. The work end **29** next abuts length stop **35**

which is accurately positioned on pull rod **19** by means of support block **31** to effect a positive acceleration of the die for direct movement with the work. The die continues its downward movement while moving directly with the work to cut through the work and assure a highly accurate cut-off of the work length. The moving die next operates switch **41** to energize solenoid **38** and release the length stop permitting the cut length to continue its forward movement as the subsequent portion of work **12** continues to advance from the roll forming machine **11**. The cut length then moves laterally from table **17**, the control switches and length stop are restored to the position of FIG. 1 and the cut-off apparatus is aranged for a subsequent similar cycle.

While we have shown and described one embodiment of our invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as defined in the appended claims.

We claim:

1. Apparatus for cutting-off travelling work, comprising: a cut-off die juxtaposed to the path of travel of the work and movable parallel to said path between a starting position and a final position; powered means for moving the die from the starting position to a transfer position short of the final position, said powered means comprising a cylinder, flexible means connecting the die to a portion of the cylinder, and means for rotating the cylinder to wind the flexible means onto the cylinder and draw the die in the direction of travel of the work for accelerating the die slowly away from the starting position to have a speed at the transfer position slightly different from the speed of travel of the work; means for moving the die from the transfer position to the final position directly with the work; and means for operating the die to cut through the work substantially only during the movement from the transfer position to the final position.

2. The apparatus of claim **1** wherein the means for rotating the cylinder includes a constant speed drive and means for substantially instantaneously clutching the cylinder to the drive to initiate the winding of the flexible means thereonto.

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