

[54] WIRE LENGTH MEASURING AND CUTTING APPARATUS

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[22] Filed: March 17, 1971

[21] Appl. No.: 125,164

[52] U.S. Cl.83/151, 83/578, 83/277

[51] Int. Cl.B26v 7/06

[58] Field of Search.....83/151, 222, 277, 578, 580

[56] References Cited

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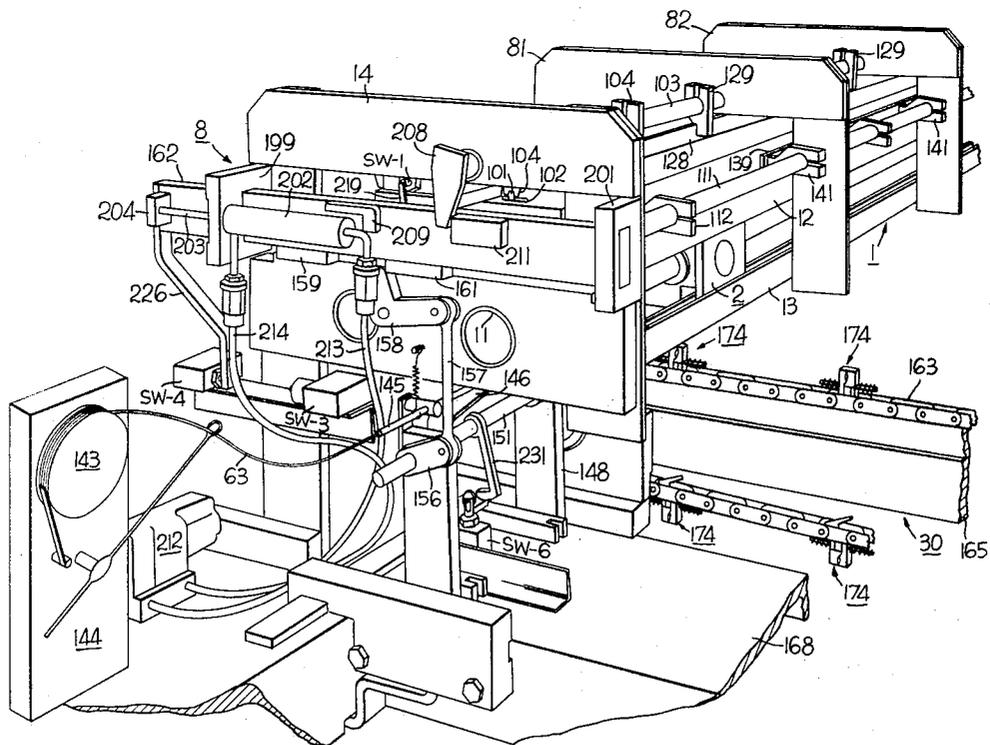
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[57] ABSTRACT

An apparatus for producing electrical wire leads has two feeding clamps which are counter reciprocated between a fixed control station and an adjustable control station whose spacing from the fixed control station determines the length of the produced wire lead. Varying the spacing between the control stations automatically varies the cycling of the apparatus as required for the increased or decreased length of the produced wire lead.

15 Claims, 33 Drawing Figures



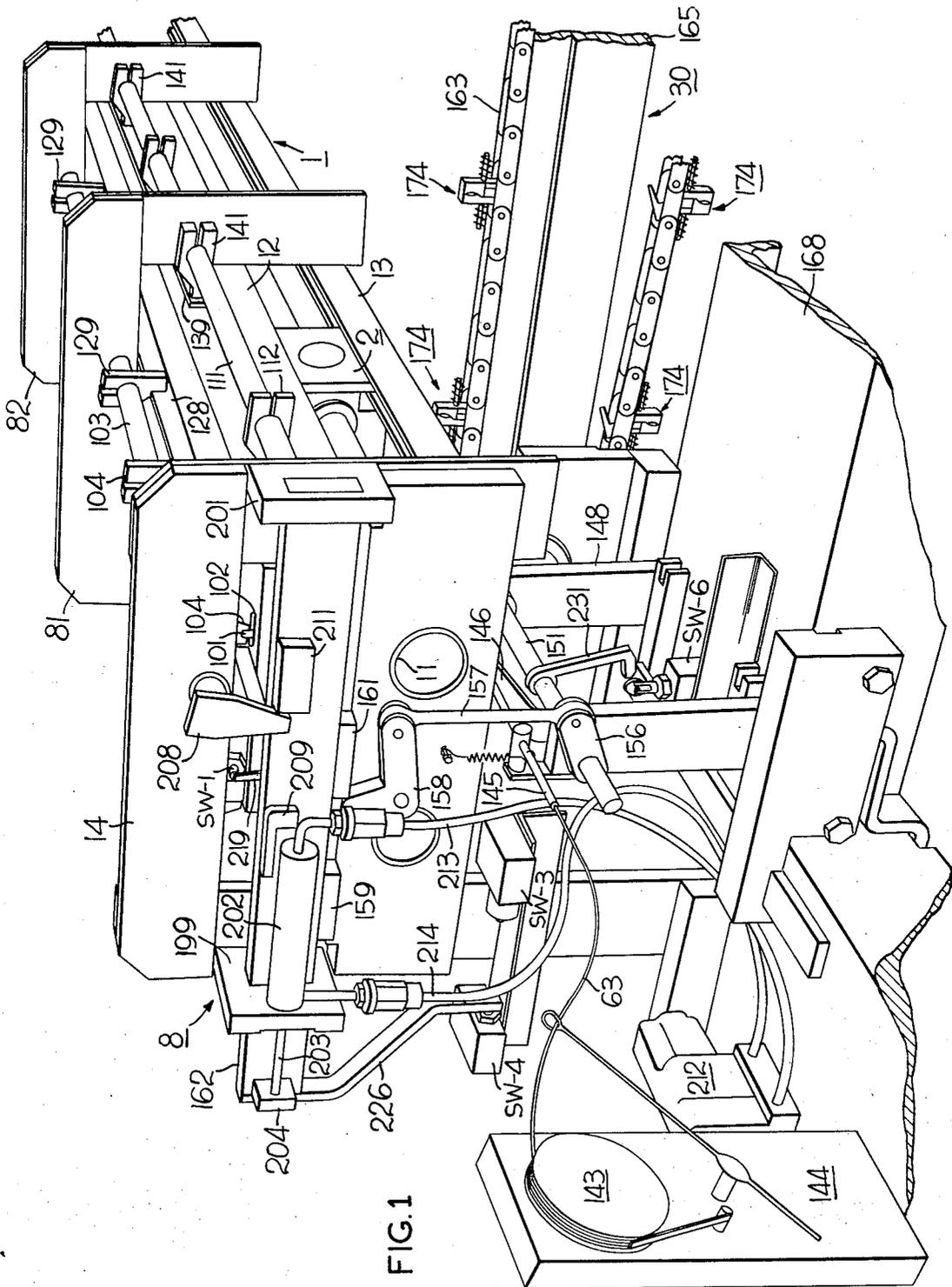


FIG. 1

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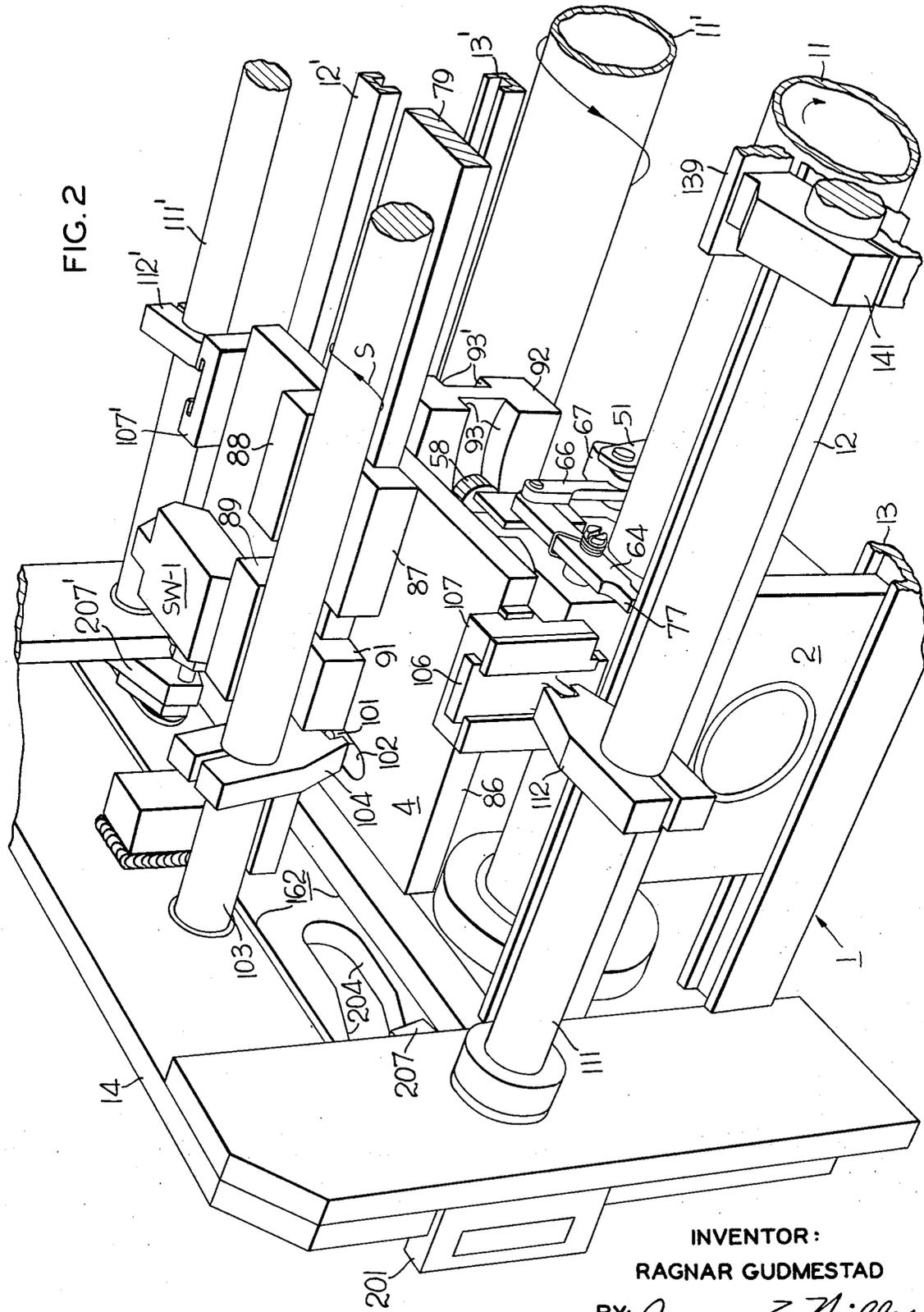


FIG. 2

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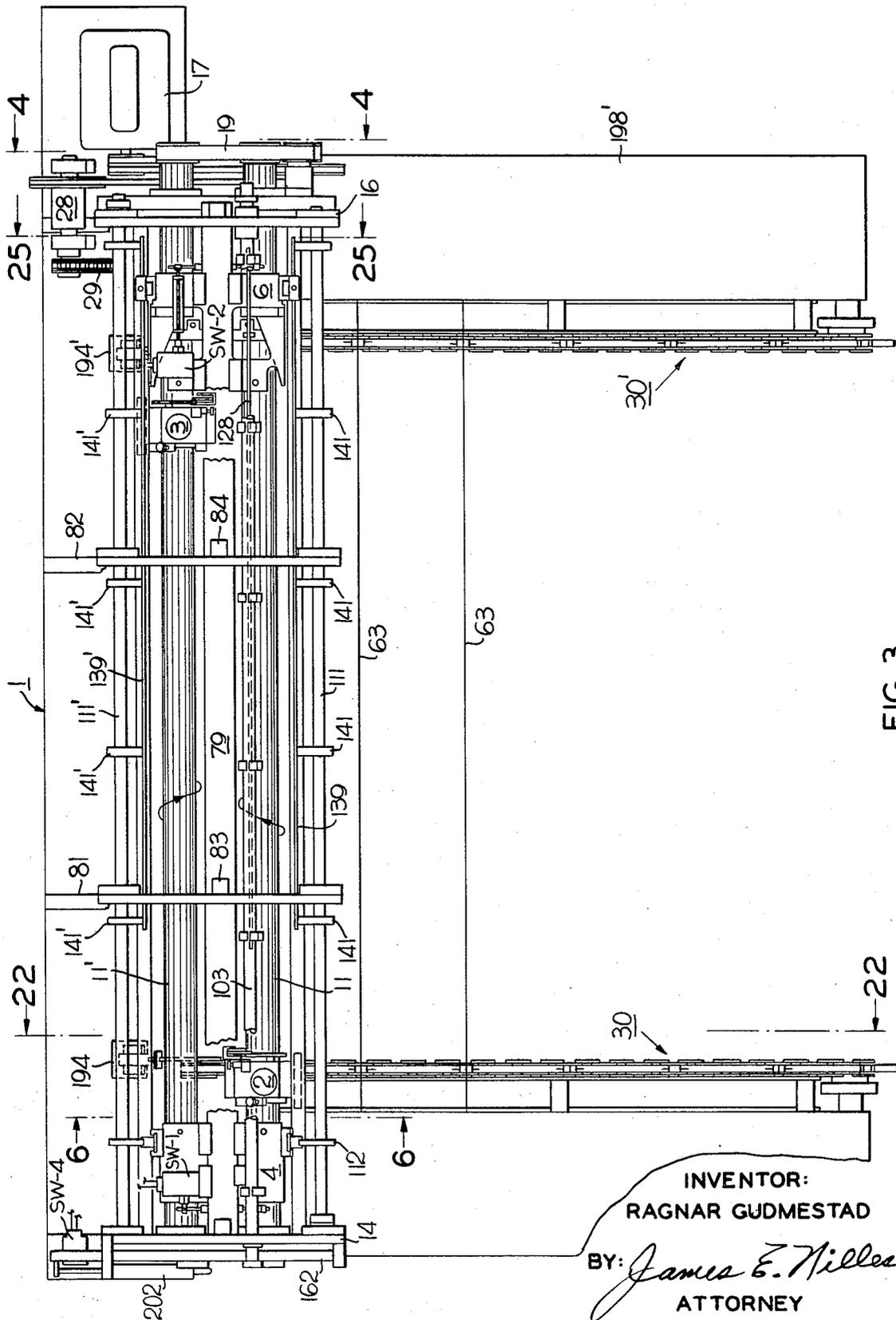


FIG. 3

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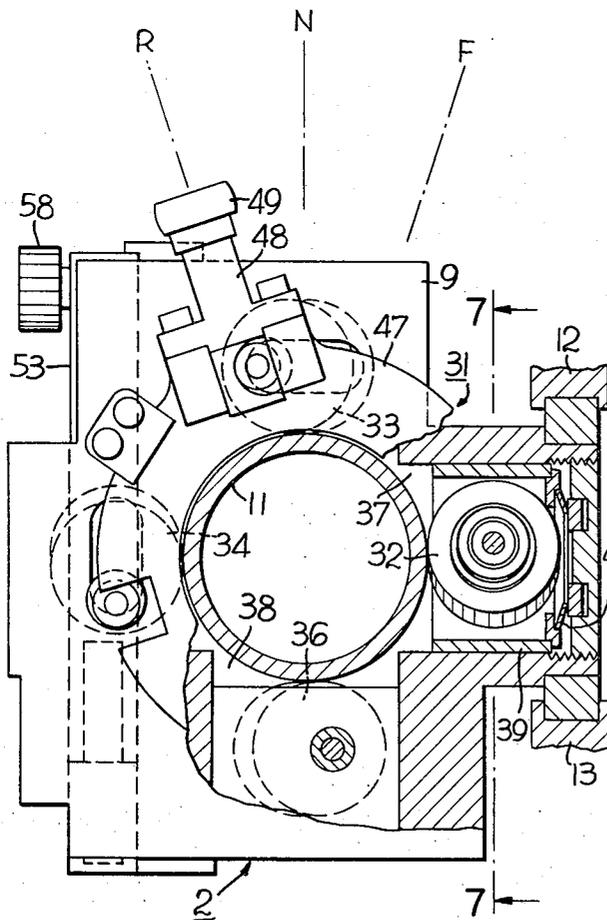
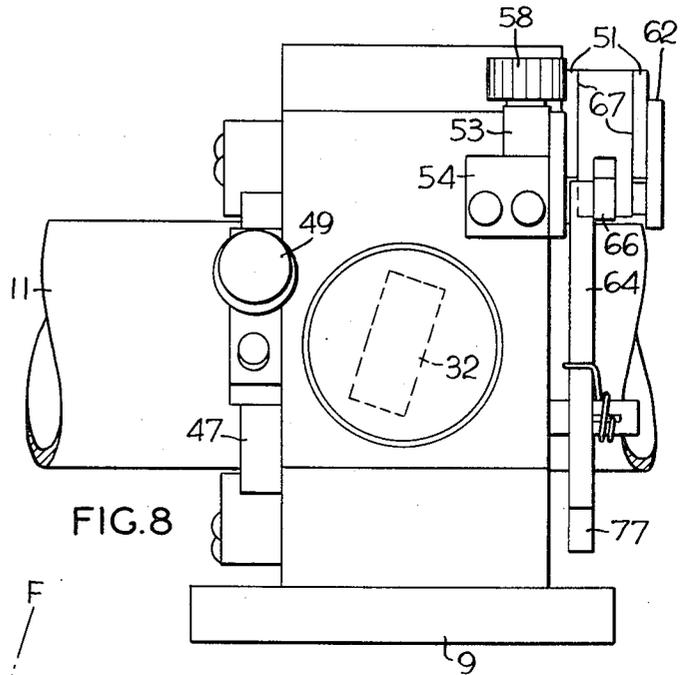


FIG. 6

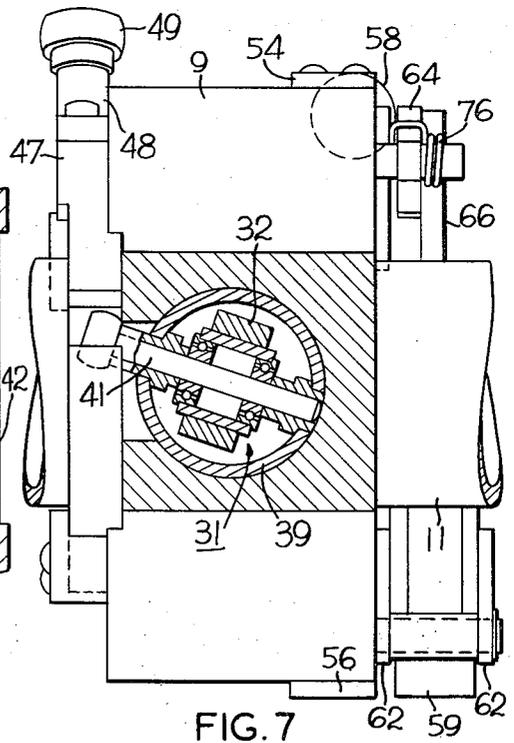
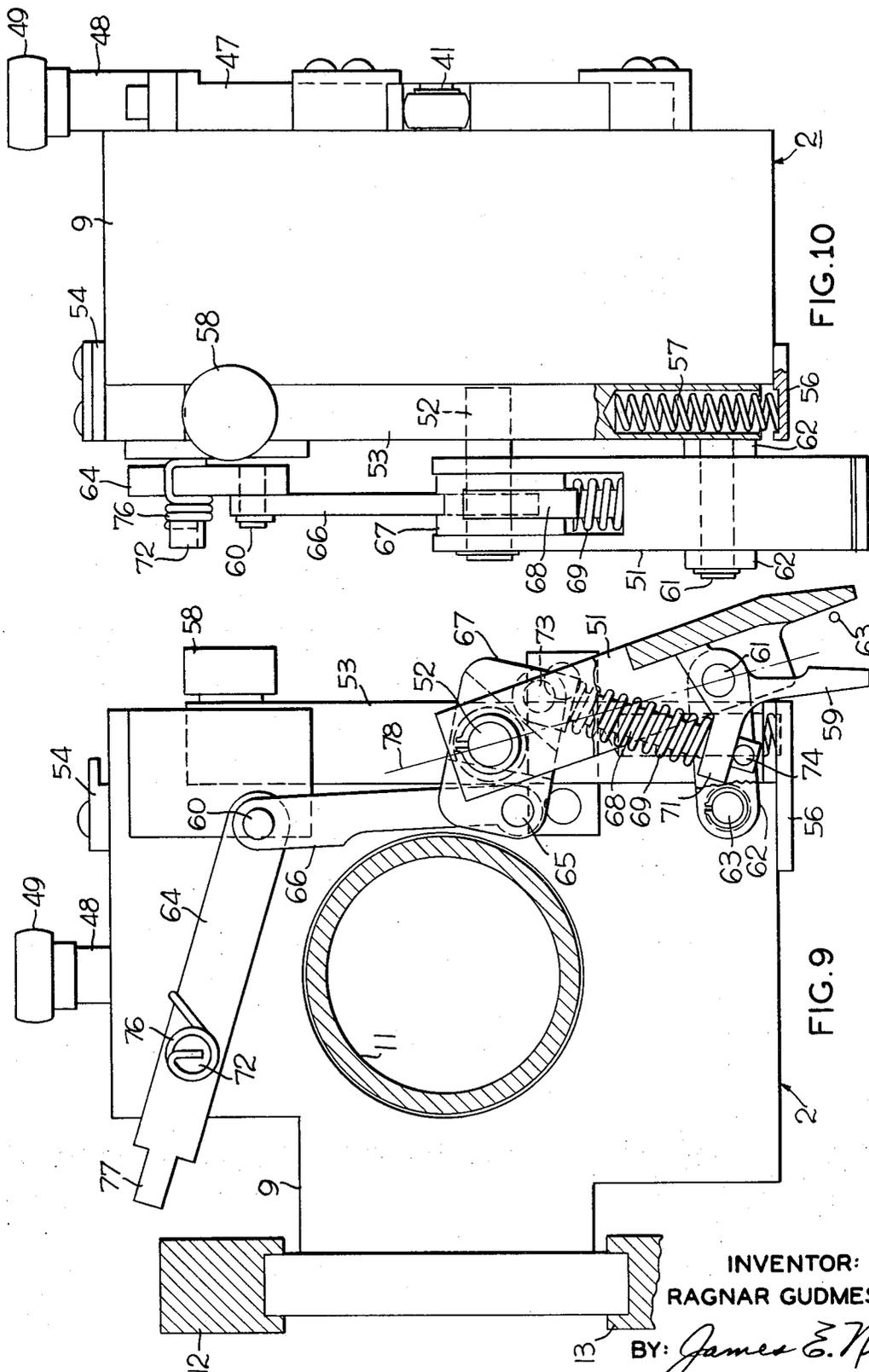


FIG. 7

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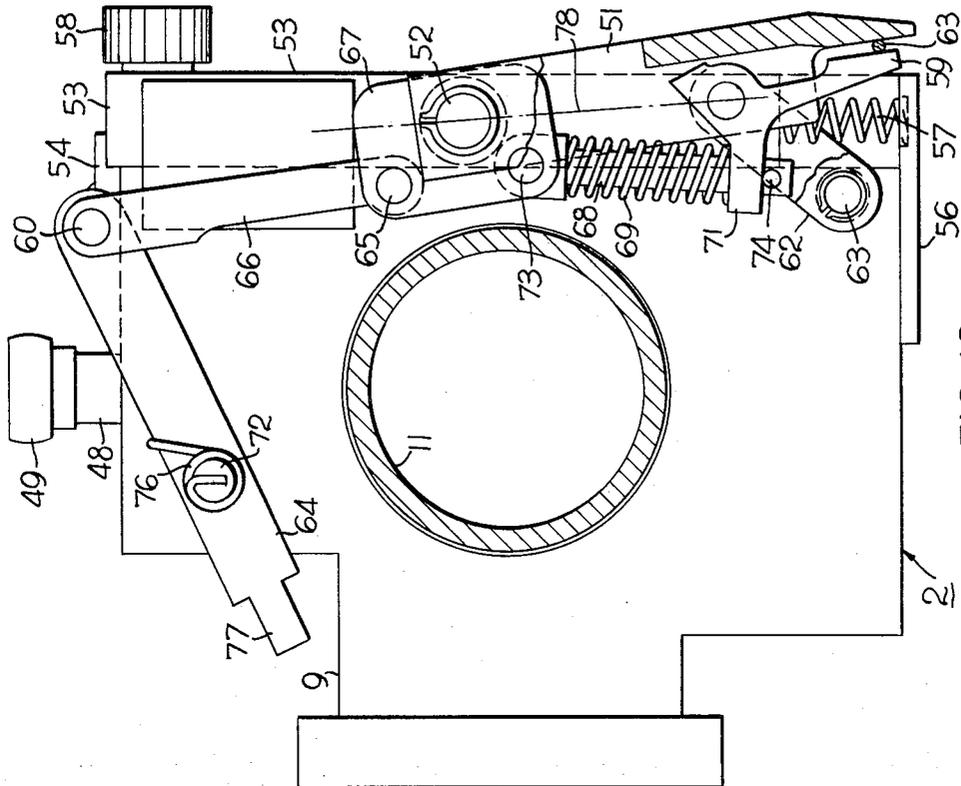


FIG. 11

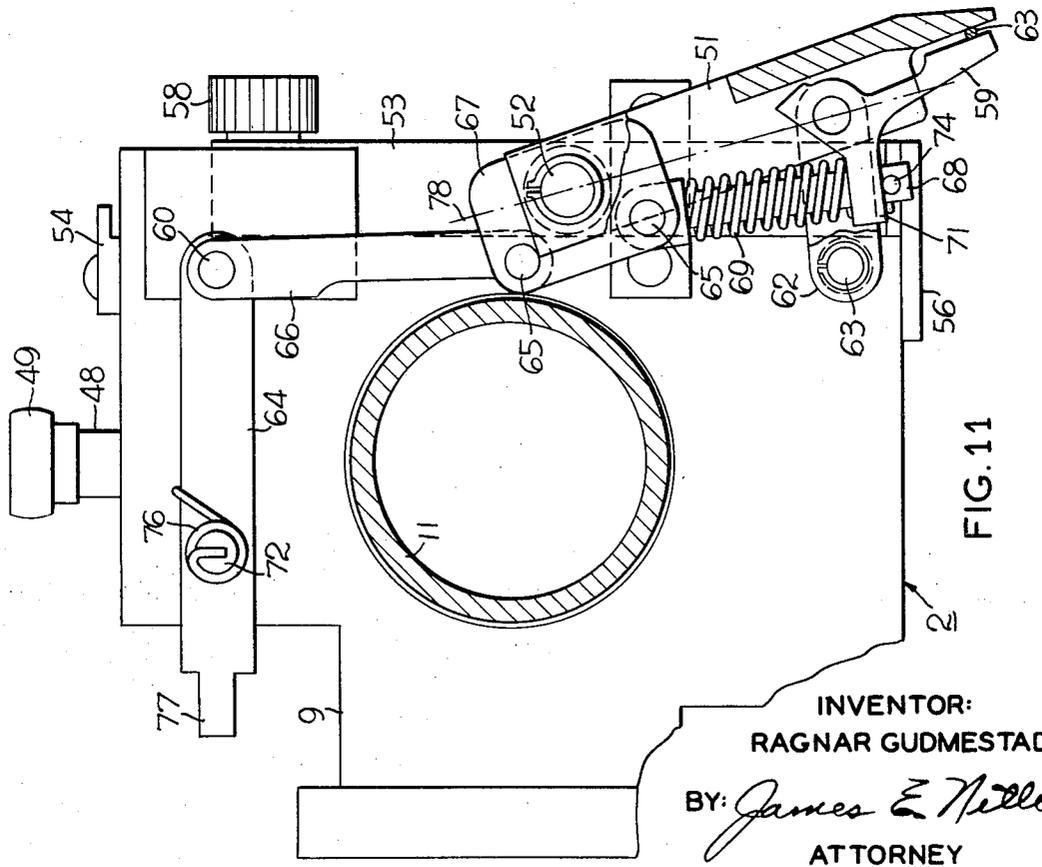


FIG. 12

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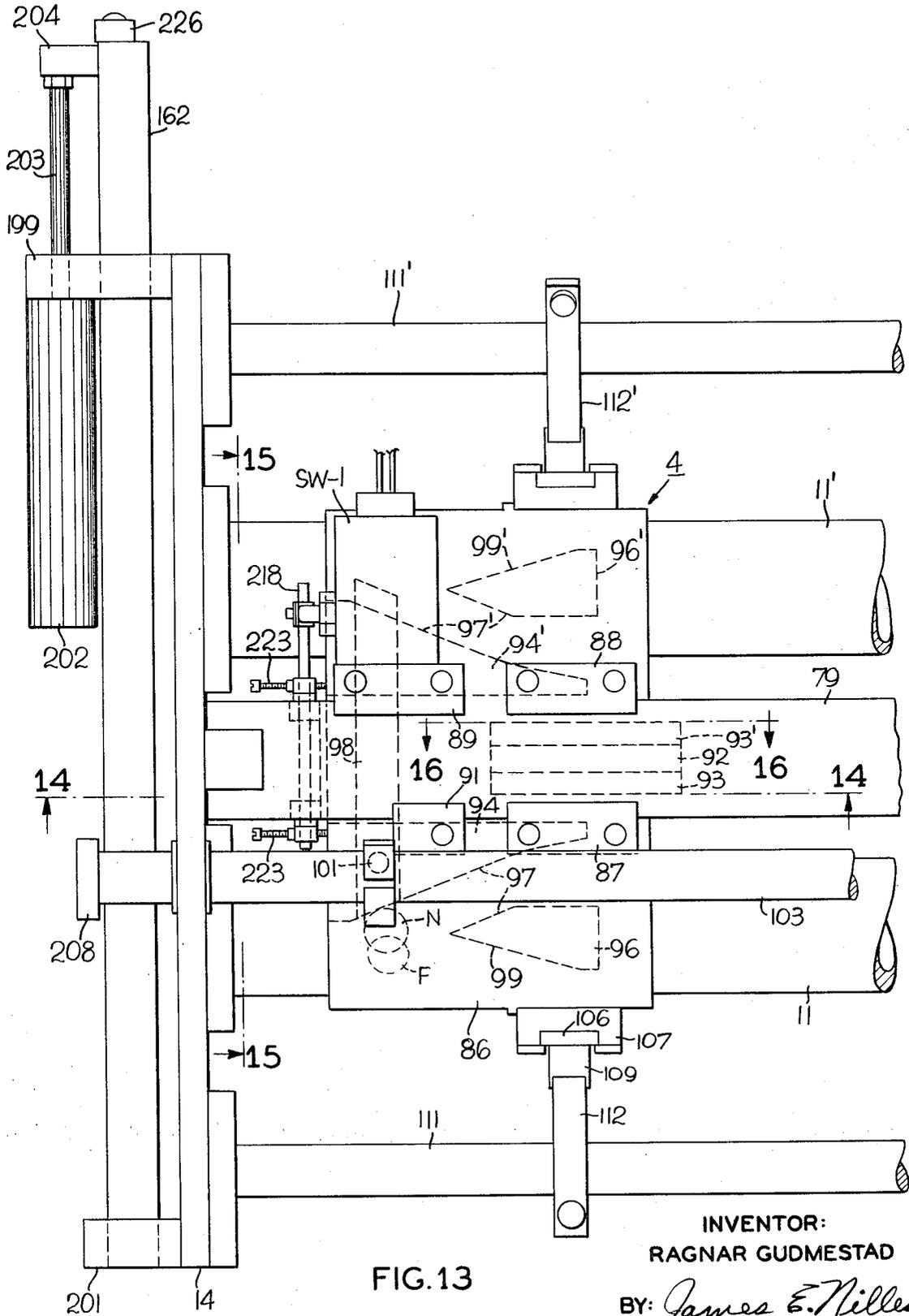


FIG. 13

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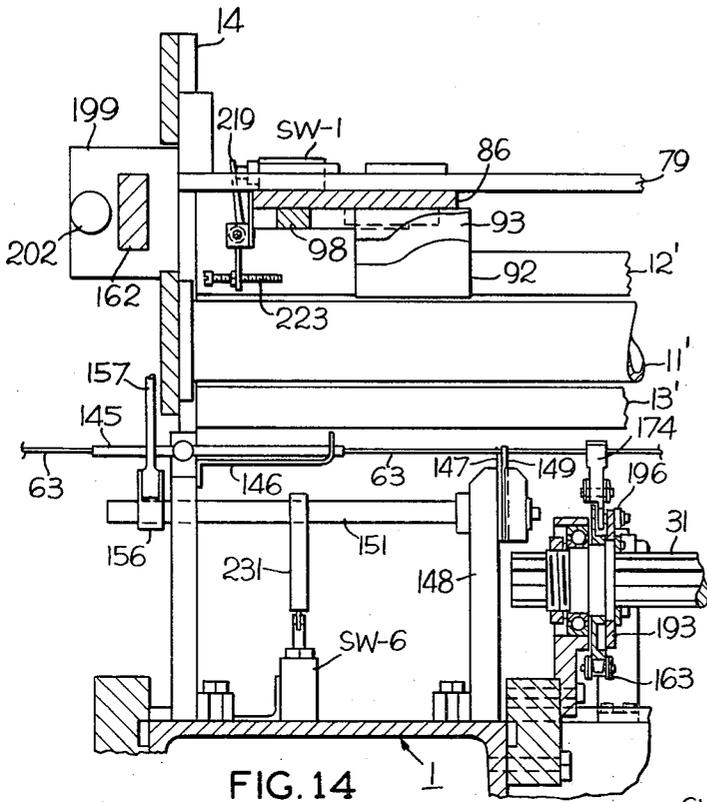


FIG. 14

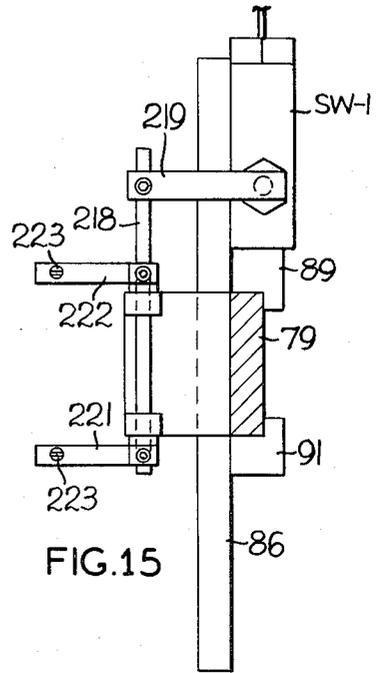


FIG. 15

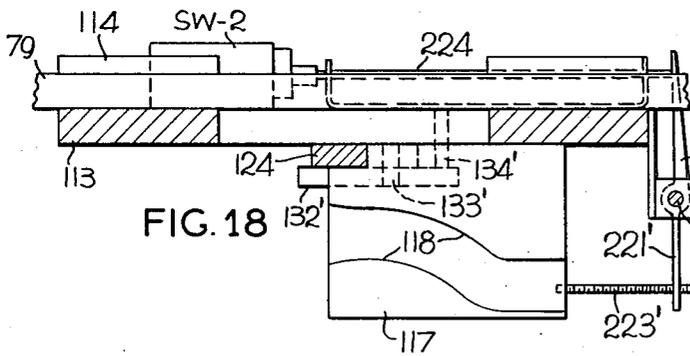


FIG. 18

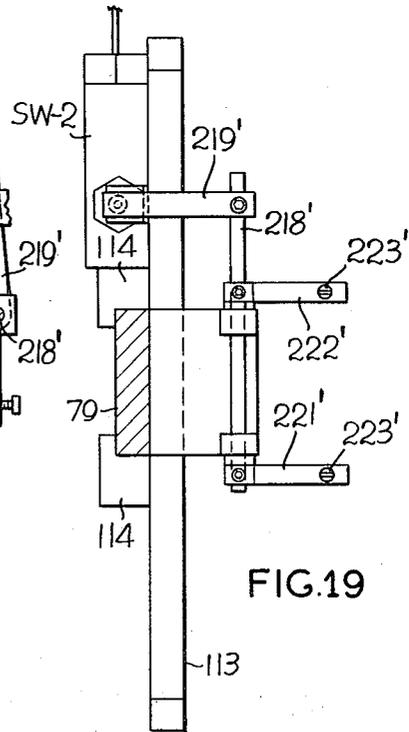


FIG. 19

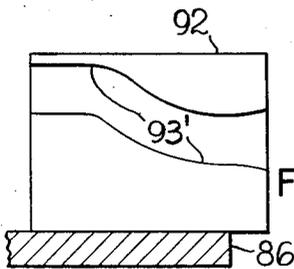


FIG. 16

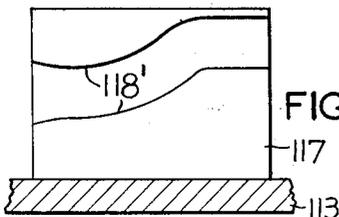


FIG. 20

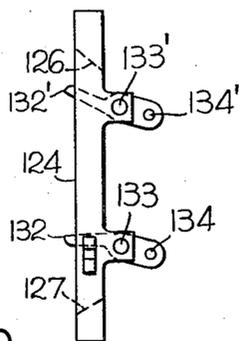
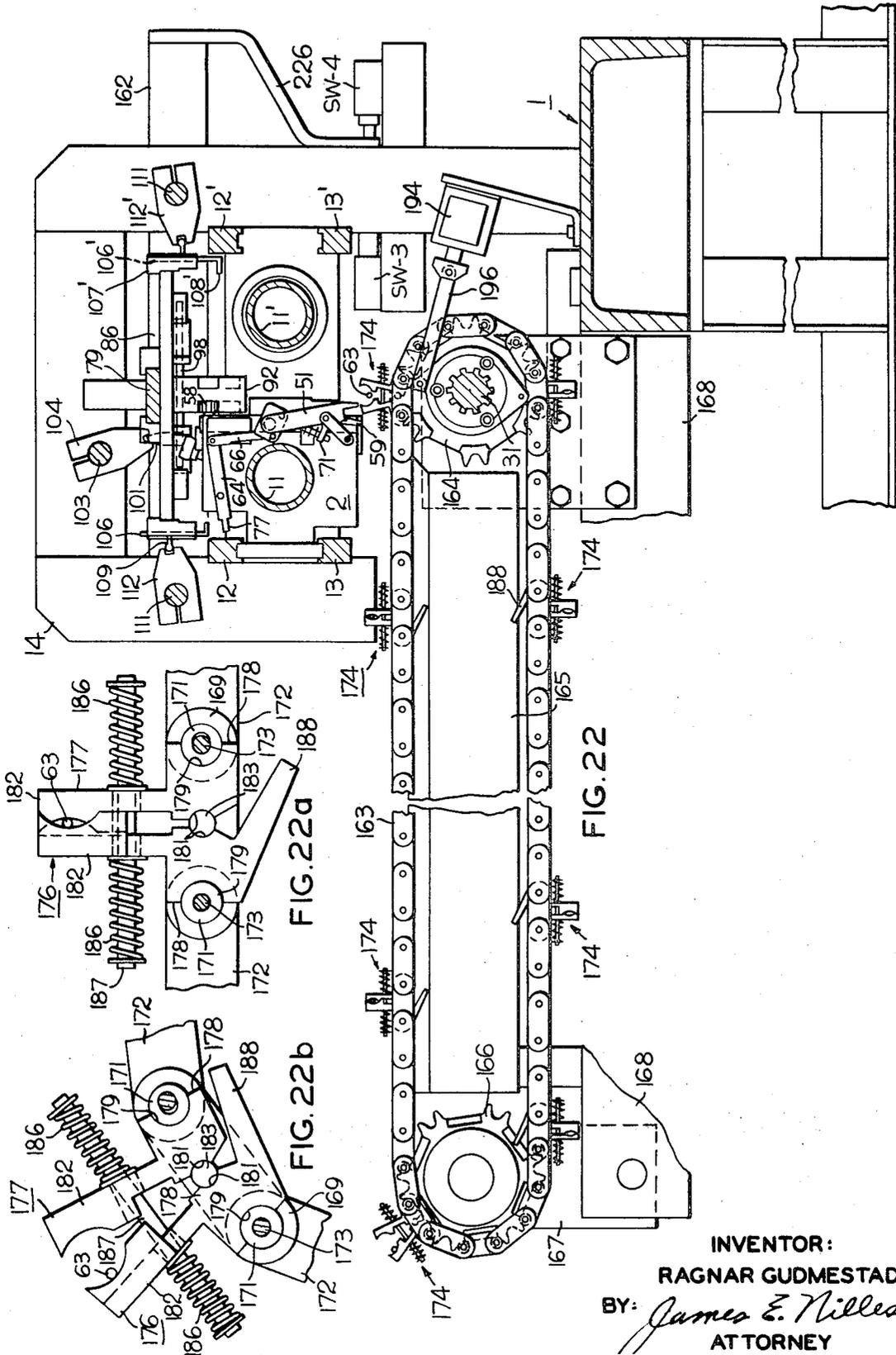


FIG. 21

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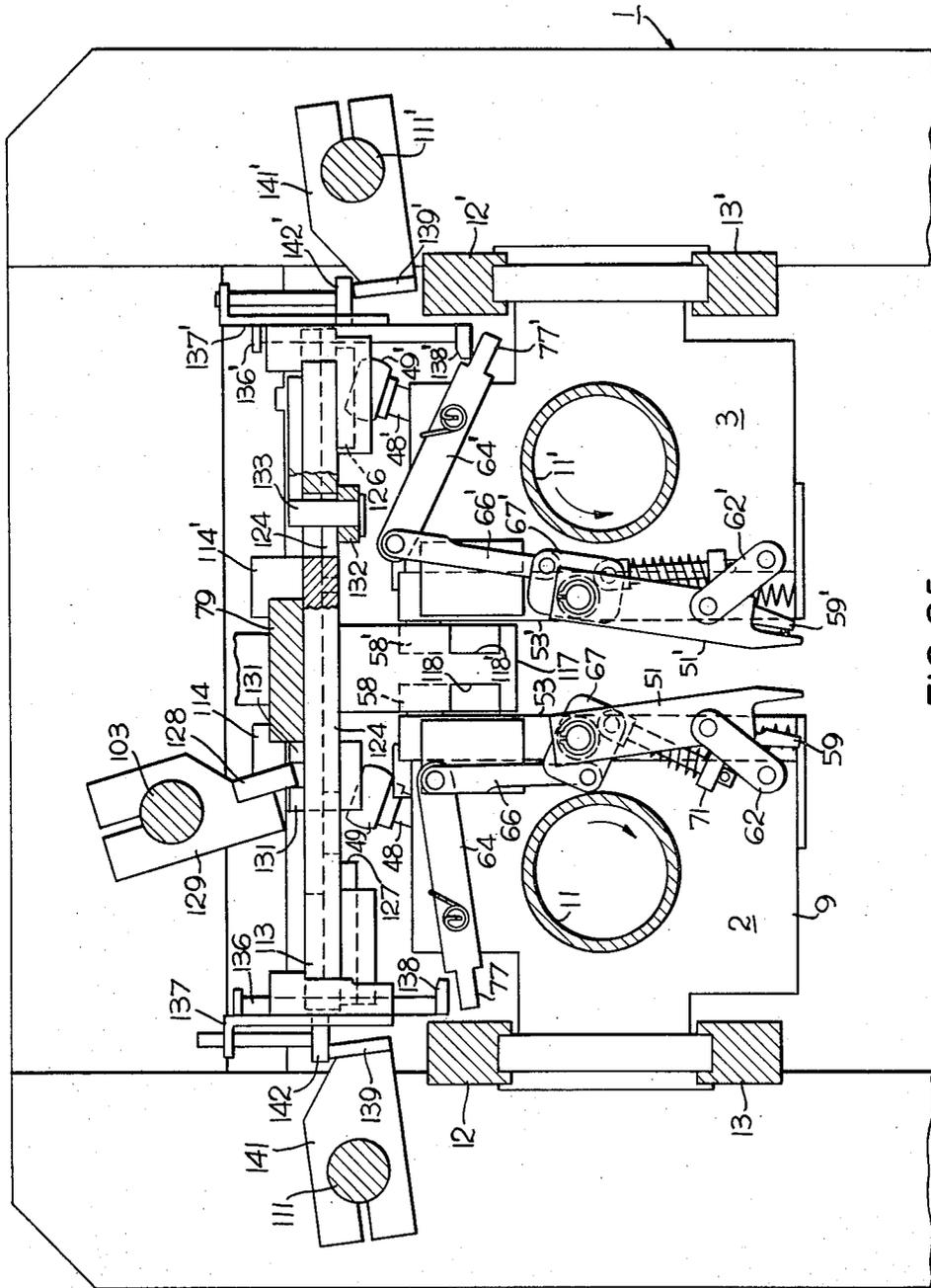


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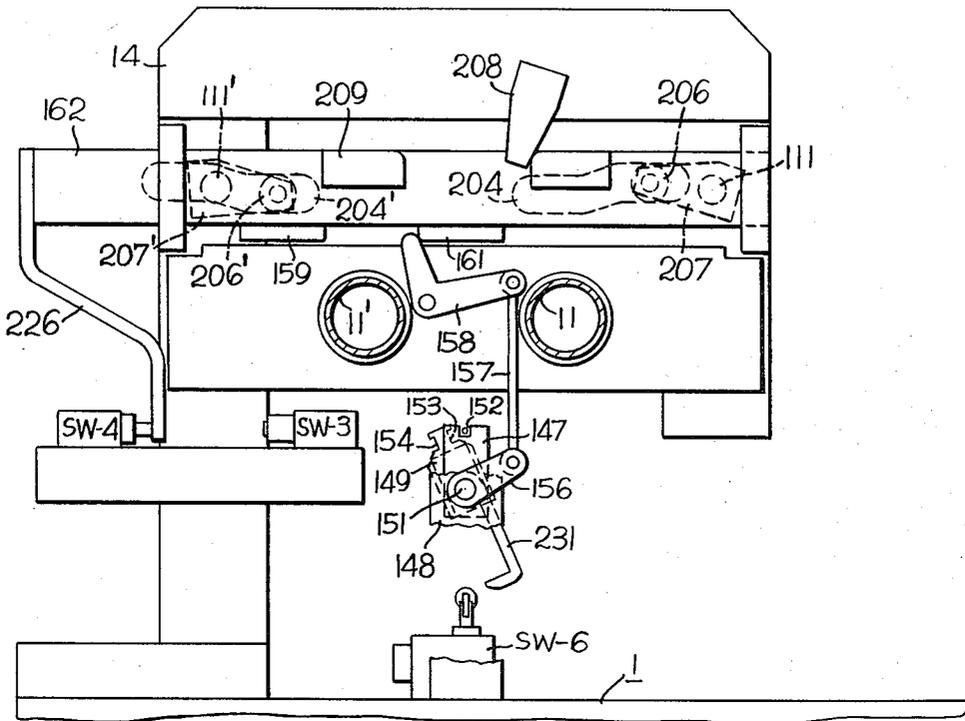


FIG. 26

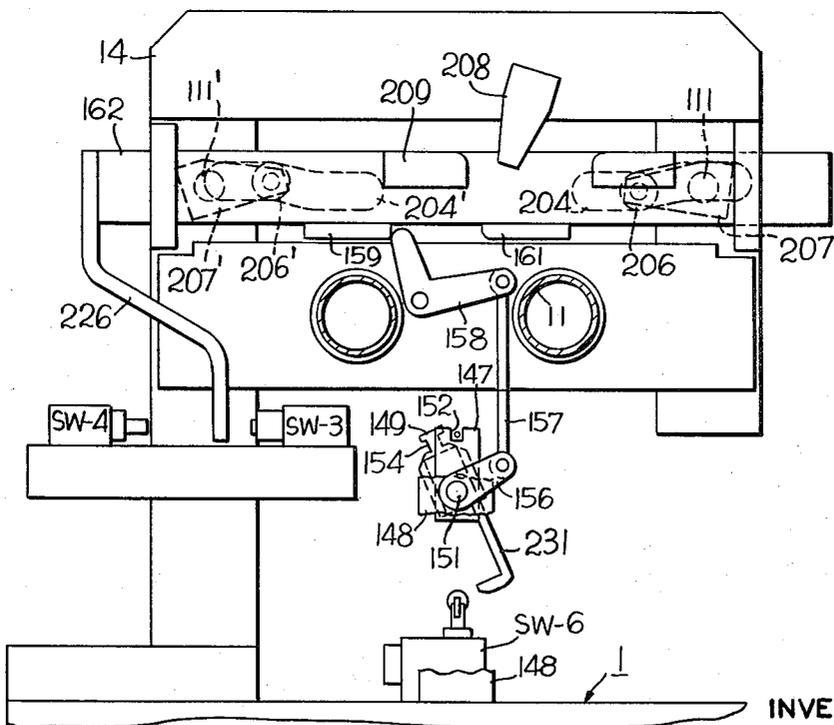


FIG. 27

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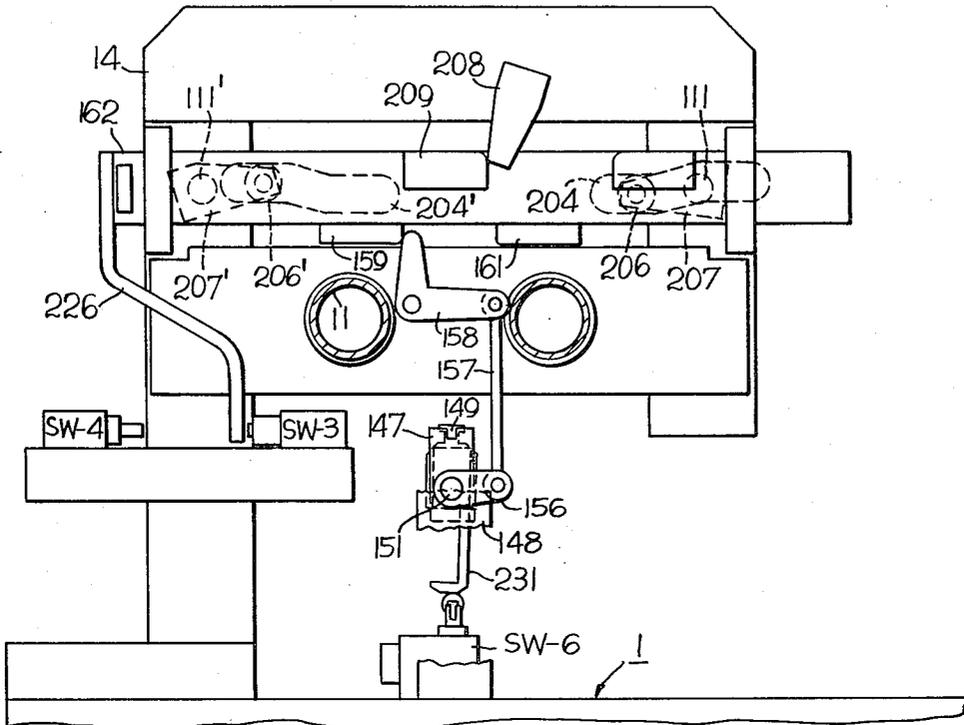


FIG. 28

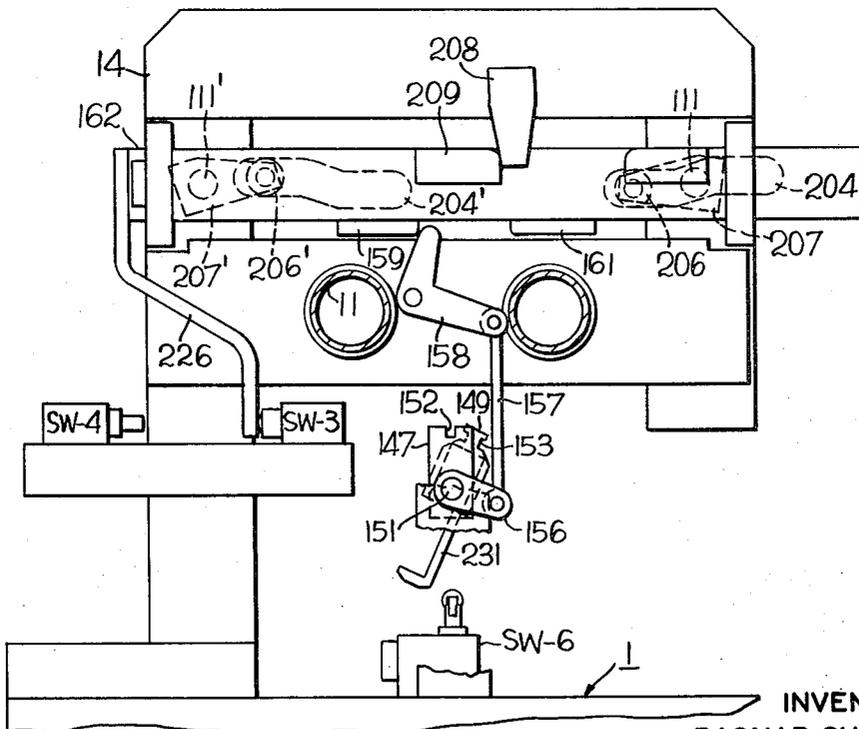


FIG. 29

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WIRE LENGTH MEASURING AND CUTTING APPARATUS

The invention relates to the production of electrical wire leads of preselected length, and it is concerned more particularly with an apparatus for successively cutting such leads from a continuous source of wire stock.

In order to provide great quantities of accurately measured electrical wire leads at a high rate of speed, apparatus have heretofore been developed wherein two counter reciprocating feeding clamps function alternately to advance wire stock through a cutting zone and wherein a cutting mechanism severs a preselected length of wire from the stock after each feeding stroke of each clamp. An apparatus of that type is disclosed, for instance, in U.S. Pat. No. 3,029,494, issued on Apr. 17, 1962 to K. H. Andren for "Art of Producing Electrical Conductors."

The counter reciprocating feeding clamps in apparatus of the mentioned type must be accurately timed so that their operation will be properly synchronized, that is, their feeding and return strokes must be of the same length and the arrival of one clamp at the end of its feeding stroke must coincide with the arrival of the other clamp at the end of its return stroke, and vice versa. Further, pairs of wire gripping jaws which travel back and forth in unison with the feeding clamps must be timed precisely to open and close as necessary when the feeding clamps have moved into their respective end positions. Additionally, the cutting mechanism which successively severs the wire stock into leads of preselected length requires precise timing, that is, a cutting stroke at the exact moment when a feeding stroke has been completed by one clamp but not before the gripping jaws of the other clamp have taken hold of the uncut wire.

In order to take care of the exacting timing requirements in an apparatus of the mentioned character relatively complex control mechanisms have heretofore been developed. Such mechanisms as heretofore constructed were fully operative to perform their intended functions and they were also capable of re-arrangement and adjustment for producing wire leads of various lengths. However, such earlier control mechanisms had the disadvantage of requiring a relatively large number of intricate interacting parts which, in turn, made the apparatus as a whole relatively expensive. Also, the necessary re-arrangement and adjustment of parts for changing the length of the produced wire leads required extensive manual labor which was costly, time consuming and inconvenient.

The principal object of the present invention is to provide an improved wire length measuring and cutting apparatus of the counter reciprocating feeding clamp type which avoids the hereinbefore outlined shortcomings and difficulties of the prior art.

More specifically, it is an object of the invention to provide an improved mechanism for cycling the apparatus, that is, for controlling the feed and return strokes of the feeding clamps, the successive gripping of wire stock alternately by the feeding clamps, the advancing of the gripped wire through a measuring zone of variable length, the operation of the cutting mechanism so that its cutting element will clear the wire during its advancement by the feeding clamps and

sever the advanced wire from stock during a short moment of standstill of the feeding clamp, and the successive release of the cut wire leads alternately from the feeding clamps.

A further object of the invention is to provide an improved drive mechanism for a pair of counter reciprocating feeding clamps, which will operate to stop the feeding clamps in accurately predetermined end positions without severe clash and thereby reduce shock and operating noise.

A still further object of the invention is to provide an improved wire length measuring and cutting apparatus of the above outlined character wherein the feeding clamps are equipped with up and down adjustable wire gripping jaws which may be lowered to grip a free end of wire stock on a given input level, then raise the gripped wire end to a feeding level, and finally lower the gripped wire end again to an output level in line with the input level.

A further object of the invention is to provide an improved wire length measuring and cutting apparatus of the hereinabove outlined character, wherein the counter reciprocating feeding clamps are linearly movable back and forth between two control stations, one fixed and the other adjustably secured in spaced relation to the fixed station, and wherein a change of the distance between the control stations automatically changes the length of the produced wire leads.

A further object of the invention is to provide an improved wire length measuring and cutting apparatus of the above mentioned character wherein the distance between the control stations can be changed while one of the feeding clamps is in cooperative engagement with one of the control stations and the other feeding clamp is in cooperative engagement with the other control station.

A still further object of the invention is to provide an improved wire length measuring and cutting apparatus of the above mentioned character which readily lends itself for use with, and automatic control of, a chain type conveying mechanism by means of which successively produced wire leads may be transferred from the measuring and cutting zone to supplementary finishing equipment such as apparatus for stripping insulation from the cut wire leads and for applying terminals thereto at one or both ends.

These and other objects and advantages are attained by the present invention various novel features of which will be apparent from the description herein of a preferred embodiment shown in the accompanying drawings.

Referring to the drawings:

FIG. 1 is a perspective partial view of an apparatus embodying the invention, as seen from its wire input end;

FIG. 2 is an enlarged perspective view showing a fixed control station at the wire input end of the apparatus and also part of one of the wire feeding clamps within the operating range of the control station;

FIG. 3 is a top view of the apparatus shown in FIG. 1;

FIG. 4 is an elevational view, partly in section, on line 4—4 of FIG. 3, showing the end of the apparatus remote from its wire input end;

FIG. 5 is a partial plan view of FIG. 4 with parts broken away and shown in section on line 5—5 of FIG. 4;

FIG. 6 is an enlarged elevational view partly in section on line 6—6 of FIG. 3; showing a rotary to linear motion transducer;

FIG. 7 is a side view of FIG. 6 with parts broken away and shown in section on line 7—7 of FIG. 6;

FIG. 8 is a top view of FIG. 7;

FIG. 9 is an enlarged end view of a wire feeding clamp and associated wire gripping mechanism, partly in section;

FIG. 10 is a side view of FIG. 9;

FIGS. 11 and 12 are views similar to FIG. 9 and show the wire gripping mechanism in different conditions of adjustment;

FIG. 13 is an enlarged plan view of parts of a fixed control station at the left of FIG. 3;

FIG. 14 is a side elevation, partly in section on line 14—14 of FIG. 13;

FIG. 15 is a partial end elevation taken on line 15—15 of FIG. 13;

FIG. 16 is a detail view taken on line 16—16 of FIG. 13;

FIG. 17 is an enlarged plan view of parts of an adjustable control station at the right of FIG. 3;

FIG. 18 is a side elevation, partly in section, on line 18—18 of FIG. 17;

FIG. 19 is a partial end elevation taken on line 19—19 of FIG. 17;

FIG. 20 is a detail view taken on line 20—20 of FIG. 13;

FIG. 21 is a plan view of a transducer control slide and latch assembly shown in FIG. 17;

FIG. 22 is a section view taken on line 22—22 of FIG. 3;

FIG. 22a is an enlarged view of a closed auxiliary wire gripping clamp;

FIG. 22b is an enlarged view of an open auxiliary wire gripping clamp;

FIG. 23 is an enlarged partial side view of a wire transfer conveyor;

FIG. 24 is a partial top view of a conveyor chain and wire clamp assembly;

FIG. 25 is an enlarged partial section on line 25—25 of FIG. 3;

FIG. 26 is an end elevation of a cycling mechanism at the wire input end of the apparatus shown in FIG. 1;

FIGS. 27 to 29 are view similar to FIG. 27 and showing the cycling mechanism in different positions of adjustment; and

FIGS. 30 and 31 are electric and hydraulic circuit diagrams for the apparatus shown in the preceding Figures.

DESCRIPTION

The principal components of the apparatus shown in the drawings are: A main frame 1; a pair of counter-reciprocating wire feeding clamps 2 and 3; a fixed control station 4 at the wire input end of the frame, as seen in FIG. 2; a shiftable, control station 6 opposite to the fixed control station 4, as seen in FIG. 3, a wire cutting mechanism 7, as seen in FIG. 26; and a cycling mechanism 8 at the wire input end of the frame, as seen in FIG. 1.

THEORY OF OPERATION

In theory, the clamp 2 travels during the final stage of a return stroke from the position in which it is shown in

FIG. 3 to the left into the control station 4 with wire gripping jaws on the clamp in an open position. At the same time, the clamp 3 travels during the final stage of a feed stroke from the position in which it is shown in FIG. 3 to the right into the control station 6 with wire gripping jaws on the clamp in closed position. Upon arrival of the clamps in the control stations, they come to a momentary standstill during which the wire gripping jaws of clamp 2 are closed and those of clamp 3 are opened by a first operating phase of the cycling mechanism 8. Also, while the clamps are still at standstill, the cutting mechanism 7 is actuated by a second operating phase of the cycling mechanism with the result that a wire lead which has been drawn to the right of FIG. 3 by a feed stroke of clamp 3 is severed from stock at the control station 4. After the cutting stroke of the cutting mechanism, the clamp 2 is started on a feed stroke toward the right and the clamp 3 is simultaneously started on a return stroke toward the left of FIG. 3 by a third operating phase of the cycling mechanism. Upon arrival of clamp 2 at the end of its feed stroke in station 6 and the simultaneous arrival of clamp 3 at the end of its return stroke in station 4, the clamps come again to a momentary standstill. The cycling mechanism is then immediately operated again to simultaneously open the gripping jaws of clamp 2 at station 6 and close those of clamp 3 at station 4; then to cut the wire at station 4 and thereby sever the lead which has been drawn from stock by the feed stroke of clamp 2, and finally to simultaneously initiate a return stroke of clamp 2 and a feed stroke of clamp 3. In this manner, production of a wire lead by a feed stroke of clamp 2 is immediately followed by a feed stroke of clamp 3 which, in turn, is again immediately followed by a new feed stroke of clamp 2. Such alternate functioning of the feeding clamps may continue for any desired length of time to successively produce wire leads of a given length and at a high rate of speed.

THE FEEDING CLAMPS

In actual construction of the apparatus, the feeding clamp 2 comprises a generally cube shaped housing 9 (FIG. 6) which rides on a drive shaft 11 (FIG. 3) and is guided between upper and lower channel shaped side bars 12 and 13 (FIG. 1) of the frame 1. The drive shaft 11 extends the full length of the frame 1 and is rotatably supported in a yoke 14 at the wire input end of the frame, and in a yoke 16 at the opposite end of the frame which carries power input gearing including an electric motor 17 (FIGS. 3 and 5).

The wire feeding clamp 3 is an opposite hand duplicate of the feeding clamp 2 and comprises a housing 9' (FIG. 25) which rides on a drive shaft 11' and is guided between upper and lower channel shaped side bars 12' and 13' of the frame 1. The drive shaft 11' (FIG. 3) extends parallel to the drive shaft 11 and is rotatably supported in the yokes 14 and 16 at the wire input and power input ends, respectively, of the frame.

Referring to FIGS. 4 and 5, power of the electric motor 17 is transmitted to the shafts 11, 11' so as to rotate these shafts simultaneously in opposite directions, as indicated by the arrows A and B in FIG. 4. This is accomplished by an endless V-belt 18 and an endless cog belt 19. The belt 18 connects a small diameter motor sheave 21 with a large diameter section

of an idler sheave 22; and the belt 19 is trained around a small diameter section of the idler sheave 22, a drive sheave 23 on the shaft 11, an idler sheave 24 and a drive sheave 23' on the shaft 11'.

FIGS. 4 and 5 also show a second train of endless belts 26 and 27 which connect the motor 17 with a solenoid operated clutch 28, and a chain drive 29 connects the clutch 28 with a spline shaft 31. The spline shaft 31 has a driving connection with a pair of chain conveyors 30 and 30' (shown in FIG. 3) by means of which the produced wire leads may be transferred to supplementary finishing equipment as will be explained more fully hereinbelow.

The housing 9 of the feeding clamp 2, as shown in FIGS. 6, 7 and 8, encloses a mechanical transducer 31 that converts rotary motion of the shaft 11 into linear motion of the housing 9 along the shaft. Preferably, the transducer is of the free-wheeling roller type which is well known in the art and which is disclosed, for instance, in U.S. Pat. No. 3,475,972 issued Nov. 4, 1969 to J. P. Steibel for "Controllable Motion and Force Converter." Briefly, the transducer comprises four rollers 32, 33, 34, and 36 which are housed in internal cavities of the housing 9. The cavity 37 which houses the roller 32 is diametrically opposed to a similar cavity (not shown) for the roller 34, and the cavity 38 which houses the roller 36 is diametrically opposed to a similar cavity (not shown) which houses the roller 33. The cavity 37 has a cylindrical inner surface whose axis extends radially of the shaft 11. Rotatably supported on that cylindrical surface and slideable axially thereon is a bushing 39 in which the roller 32 is mounted on a shaft 41 whose axis extends at right angles to the axis of the bushing 39. A Belleville washer 42 reacting between the housing 9 and the bushing 39 keeps the roller 32 pressed against the shaft 11. One end of the shaft 41 extends outward from the bushing 39 and overhangs the housing 9 at the side which faces the wire input end of the frame 1. The rollers 33, 34 and 36 are similarly supported on shafts, respectively, which protrude from the housing 9 toward the wire input end of frame 1. The protruding ends of the roller supporting shafts are caged in a face plate 47 which is piloted on the housing 9 for rotary adjustment about the axis of shaft 11, and which has a radial arm 48 carrying a spherical collar 49.

FIGS. 6, 7 and 8 show the transducer 31 adjusted for a return drive of the clamp 2 from its FIG. 3 position into the control station 2. Such return drive adjustment is made by swinging the control arm 48 and collar 49 from a straight upright neutral position as indicated by the dash dotted line N into the inclined position R of FIG. 6. Conversely, in order to adjust the transducer 31 for a feed drive of the clamp 2, the control arm 48 and collar 49 are swung from the N position to the F position indicated in FIG. 6. In the N position of the control arm 48 and collar 49 the axes of the rollers 32, 33, 34 and 36 extend parallel to the shaft 11, and while the rollers are urged into radial contact with the shaft by their associated Belleville washers, rotation of the shaft will be ineffective to develop an axial thrust upon the housing 9 in one direction or the other.

The speed at which the clamp 2 moves in the direction of a return stroke progressively increases as the control arm 48 is progressively rocked from the N

position to the R position in FIG. 6, and it progressively decreases to standstill as the arm 48 is rocked from the R position to the N position. Similarly, when the control arm 48 is rocked from the N position to the F position in FIG. 6 the traveling speed of the clamp 2 on a feed stroke progressively increases as the arm 48 is progressively adjusted from the N position to the F position, and it progressively decreases to standstill as the arm 48 is progressively rocked from the F position to the N position.

The foregoing explanations regarding the propulsion of the clamp 2 selectively in opposite directions analogously apply to the clamp 3, which incorporates a rotary to linear motion transducer corresponding to the transducer 31 of the clamp 2. The clamp 3 transducer has a control arm 48' (FIG. 25) corresponding to the control arm 48 of the clamp 2 transducer 31, but since the direction in which the shaft 11' rotates is opposite to that of shaft 11 a feed stroke of clamp 3 is effected by adjustment of the control arm 48' about the axis of shaft 11' in the same direction in which the control arm 48 of the clamp 2 transducer is adjusted about the axis of shaft 11 for a return stroke. Similarly, in order to propel the clamp 3 for a return stroke its transducer control arm 48' is adjusted about the axis of shaft 11' in the same direction in which the control arm 48 of the clamp 2 transducer is adjusted about the axis of the shaft 11 for a feed stroke. If the directions in which the shafts 11, 11' are rotated were reversed, as by reversal of the motor 17, the directions in which the transducer control arms are adjusted would obviously also have to be reversed.

FIGS. 9 to 12 show the wire gripping mechanism of the feeding clamp 2. This mechanism is located at the side of the clamp which faces the power input end of the apparatus and it is constructed as follows. A long jaw 51 is pivotally suspended on a pivot pin 52 which in turn is secured to a carrier slide 53. The transducer housing 9 has a recessed corner portion in which the carrier slide 53 is guided for up and down movement between an upper stop plate 54 and a lower stop plate 56. A coil spring 57 (FIG. 10) in the lower end of the carrier slide 53 bears against the stop plate 56 and tends to urge the slide upward against the stop plate 54. FIGS. 9 and 10 show the slide 53 in a lowered position as compared with FIG. 12 which shows the slide in its upper limit position. A roller 58 is mounted on the upper end of the slide and is cammed downward so as to lower the slide from the FIG. 12 position to the FIG. 9 position when the feeding clamp 2 enters the control station 6 on a feed stroke and when it enters the control station 4 on a return stroke. Similarly, the roller 58 is cammed upward so as to raise the slide 53 from the FIG. 9 position to the FIG. 12 position when the clamp 2 leaves the control station 6 on a return stroke and when it leaves the control station 4 on a feed stroke.

The long jaw 51 has a channel shaped intermediate portion which straddles a short jaw 59, and a pivot pin 61 extends through the channel flanges of the long jaw 51 and through hub portion of the short jaw 59 to provide for closing and opening of the wire gripping lips of the jaws by swinging movement of the jaw 59 towards and away from the jaw 51 about the axis of the pivot pin 61. A pair of guide links 62 extend between the pivot pin 61 and a fixed pivot pin 63 on the transducer

housing 9. The links 62 perform the important function of swinging the jaw assembly 51, 59 from a downwardly and laterally projected position as shown in FIGS. 9 and 11 to the upwardly and laterally retracted position shown in FIG. 12 when the carrier slide 53 is raised, and of swinging the jaw assembly 51, 59 from the upwardly and laterally retracted position of FIG. 12 to a downwardly and laterally projected position as shown in FIGS. 9 and 11 when the carrier slide is lowered.

FIG. 9 shows the jaw assembly 51, 59 in an open condition and in straddling relation to a wire lead 63; and FIGS. 11 and 12 show the jaw assembly 51, and 59 in closed condition and in gripping engagement with the wire lead 63. An actuating linkage for closing and opening the jaw assembly in its lowered condition and which also accommodates up and down adjustment of the closed jaw assembly between the FIG. 11 and FIG. 12 positions is shown in different conditions of adjustment in FIGS. 9, 11 and 12. Such linkage comprises a double armed lever 64, a link 66, a swivel block 67, a rod 68 and a surrounding coil spring 69, and an arm portion 71 of the short jaw 59. The lever 64 is fulcrumed on a pivot pin 72 which is mounted on an upper portion of the housing 9 in proximity to the side thereof which is guided on the frame bars 12, 13 (FIG. 22). The link 66 is pivoted at 60 to the lever 64 and 65 to the swivel block 67 in order to transmit rocking movement of the lever 64 to the swivel block 67 and thereby swinging the latter back and forth about its pivot pin 52 on the slide 53. The rod 68 has a pivot center 73 on the swivel block 67 at a radial spacing from the pivot pin 52, and an end portion of the rod 68 extends slideably through an over-size hole in the arm 71 of the short jaw 59. The spring 69 urges the arm 71 against a transverse stop pin 74 at the lower end of the rod 68. Rocking of the swivel block 67 about its pivot pin 52 in jaw closing directions, that is clockwise as viewed in FIG. 9, is yielding opposed by a torsion spring 76 which is wound around the pivot pin 72 for the lever 64.

The lever 64 has a finger portion 77 to which a downward, that is clockwise, thrust is imparted in the control station 4, and an upward or clockwise thrust in the control station 6, as will be explained more fully hereinbelow. The anticlockwise thrust application to the lever 64 adjusts the jaw assembly from the open position in which it is shown in FIG. 9 to the closed position in which it is shown in FIG. 11. During such adjustment the pivot center 73 of the rod 68 moves from one side of the dead center line 78 to the other, and in the transposed position of the pivot pin 73 as shown in FIGS 11 and 12 the expanding pressure of the spring 69 firmly but yielding clamps the wire lead 63 between the jaws 51 and 59.

After the jaw assembly 51, 59 has been adjusted to the closed FIG. 11 position while the clamp 2 is in the control station 4, the clamp 2 is started on a feed stroke toward the control station 6. Immediately upon the start of the feed stroke, the closed jaw assembly 51, 59 is moved from the lowered laterally projected FIG. 11 position to the raised laterally retracted FIG. 12 position. Such upward movement of the closed jaw assembly is accommodated by pivotal movement of the lever 64 and corresponding angular movement of the link 66. As the clamp 2 proceeds on a feed stroke, the raised jaw assembly clears the cutting mechanism 7 and

the transfer conveyor 30 at the wire input end of the apparatus. While the clamp 2 travels from the control station 4 to the control station 6 the closed clamp assembly 51, 59 is in the raised FIG. 12 position, and it remains in that position until it has entered the control station 6 and cleared the conveyor 30'. Thereafter, the closed jaw assembly is again lowered to the FIG. 11 position while clamp 2 is in the control station 6. This brings the lever 64 from the inclined FIG. 12 position to the approximately horizontal FIG. 11 position. An upward or clockwise thrust is then imparted to the finger 77 of the horizontal lever 64. This brings the clamp assembly 51, 59 back to the lowered open FIG. 9 position, and the wire lead is thus released preparatory to its attachment to the conveyor 30' at the control station 6.

Immediately after the lowered jaw assembly 51, 59 has been opened at the control station 6, the clamp 2 is started on a return stroke. The opened clamp assembly 51, 59 is thereby raised to the position in which it is shown in FIG. 25 and in which it clears the conveyor 30'. While the clamp 2 travels toward the control station 4, the raised jaw assembly remains open. Upon arrival of the clamp 2 at the control station 4 and after the raised open jaw assembly has cleared the conveyor 30 and the cutting mechanism 7, the open clamp assembly is lowered to the FIG. 9 position. It is then ready to be closed upon the free end of wire stock protruding into the wire receiving end of the apparatus, and the clamp 2 may again be started on a new feed stroke.

The feeding clamp 3 is equipped with a wire gripping mechanism which is an opposite hand duplicate of the one shown in FIGS. 9 to 12. Parts of the wire gripping mechanism on clamp 3 which correspond to those on clamp 2 are designated in FIG. 25 by the same but primed reference characters, and the explanations hereinbefore regarding the actuation of the jaw assembly 51, 59 analogously apply to the actuation of the jaw assembly 5', 59'. That is, the jaws 51', 59' are in a raised closed position as shown in FIG. 25 when the clamp 3 enters the control station 6 near the end of a feedstroke.

After the raised and closed jaws 51', 59' have cleared the conveyor 30' they are moved downward to a lowered closed position corresponding to FIG. 11 and thereafter to an open position corresponding to FIG. 9. Immediately upon the start of a return stroke of clamp 3 the jaws 51', 59' are adjusted to a raised open position corresponding to the FIG. 25 position of the jaws 51, 59. This enables the jaws 51', 59' to clear the conveyor 30' on their return travel toward the control station 4. As the clamp 3 enters the control station 4, the open jaws 51', 59' are first lowered to a wire straddling position corresponding to FIG. 9, and then to a closed wire gripping position corresponding to FIG. 11. The clamp 3 is now ready for a feed stroke, and as the clamp 3 travels from the control station 4 to the control station 6 its jaws 51', 59' are in the raised laterally retracted FIG. 25 position. The lateral retraction of the closed jaws 51', 56' on the clamp 3 during its feed stroke and the lateral retraction of the open jaws 51, 59 on the clamp 2 during its return stroke provides the necessary clearance for the passage of the clamp 3 on its feed stroke past the clamp 2 on its return stroke midway between the control stations 4 and 6. Similarly,

lateral retraction of the closed jaws 51, 59 on the clamp 2 during its feed stroke and lateral retraction of the open jaws 51', 59' on the clamp 3 during its return stroke provides for unimpeded passage of the clamp 2 on its feed stroke past the clamp 3 on its return stroke.

THE CONTROL STATIONS

As shown in FIGS. 2 and 3, the apparatus frame 1 comprises an upper horizontal longitudinal bar 79 of rectangular cross section which extends the full length of the frame between the end yokes 14 and 16 and to which it is rigidly secured at its opposite ends. Intermediate frame yokes 81 and 82 similar to the yokes 14 and 16 bridge the bar 79 intermediate its ends, and suspension blocks 83, 84 on the yokes overlie the bar 79 and are secured thereto by welding. The blocks 83, 84 are narrower than the bar 79 and leave its opposite sides unobstructed to provide clearance for movement of the control station 6 along the bar 79 as will be explained later.

Referring to FIGS. 13 to 16, the control station 4 comprises a horizontal base plate 86 which extends transversely below the rectangular frame bar 79. The plate 86 is firmly clamped to the underside of the bar 79 by four retainer blocks 87, 88, 89 and 91 and associated screws extending therethrough and into the plate 86. Fixedly secured to the underside of the plate 86 and in a midposition between the longitudinal sides of the frame 1 is a vertical cam block 92 which has a stepped cam groove 93 at its side facing the frame side bars 12 and 13. When the feeding clamp 2 proceeds on a return stroke from its FIG. 3 position, the roller 58 on the jaw carrier slide 53 enters the high end of the cam groove 93, and it then follows the cam groove and brings the carrier slide 53 down to the FIG. 9 position. Similarly, when the feeding clamp 2 starts on a feed stroke, the roller 58 on the jaw carrier slide 53 moves from the low end to the high end of the groove 93 and thereby raises the carrier slide 53 from its lowered FIG. 11 position to its raised FIG. 12 position.

A stepped cam groove 93' corresponding to the cam groove 93 is formed in the side of the block 92 which faces the frame side bars 12' and 13'. The roller 58' (FIG. 25) on the jaw carrier slide 53' of the feeding clamp 3 is lowered and raised by the cam groove 93' in the same manner as the roller 58 of the jaw carrier 53 is lowered and raised by the cam groove 93.

Also projecting from the underside of the station 4 base plate 86 and directly above the drive shaft 11 are two cam blocks 94 and 96 which define a return drive decelerating cam track 97 for the transducer control arm 48 of the feeding clamp 2. During a return stroke of the clamp 2 from the FIG. 3 position the spherical collar 49 on the control arm 48 is initially in its full speed return drive position which is indicated by the line R in FIG. 6 and which places the collar 49 into sidewise alinement with the open end of the cam track 97 which faces toward the station 6. Continued return movement of the clamp 2, brings the collar 49 into the cam track 97, and as the clamp 2 continues on its return stroke it is gradually brought to a standstill by coaction of the collar 49 with the cam track 97. As the collar 49 moves along the adjacent slanting edge of the cam block 94 the control arm 48 is moved from the R position to the N position indicated in FIG. 6, and the

clamp 2 stops in the position which places the control arm 48 and collar 49 in the N position which is indicated in FIG. 13 in dotted lines.

In order to initiate a feed stroke of the clamp 2 the collar 49 is moved from the N position to the *f* position in FIG. 13, that is, in a direction toward the F position indicated in FIG. 6. Such drive initiating shift of the collar 49 from the N position of the *f* position in FIG. 13 is effected by means of a cross slide 98 which is mounted on the underside of the plate 86 for horizontal back and forth movement transversely of the frame 1. The end of the cross slide 98 next to the cam track 97 abuts the collar 49 in the N position of the transducer control arm 48 when the clamp 2 comes to a standstill at the end of a return stroke. In order to thereafter initiate a feed stroke of the clamp 2, the slide 98 is given a short thrust in the direction toward the frame side bars 12, 13. Such thrust shifts the transducer control arm 48 into the *f* position indicated in FIG. 13, and as a result the clamp 2 starts on a feed stroke at a relatively slow speed. However, as the clamp 2 proceeds toward the control station 6 the collar 49 moves along a drive accelerating cam edge 99 of the block 96, and the transducer control arm 48 is thereby adjusted to its full speed position for the feed stroke.

The portion of the base plate 86 which extends laterally over the drive shaft 11' is equipped at its underside with cam blocks 94' and 96' which correspond to cam blocks 94, 96 and which define a return drive decelerating cam track 97' for the feeding clamp 3. Also, the cam block 96' has a drive accelerating cam edge 99' for the clamp 3 corresponding to the drive accelerating cam edge 99 for the clamp 2. A return stroke of the clamp 3 does not start until the cross slide 98 has received the mentioned thrust to initiate a feed stroke of the clamp 2. Consequently, the slanted end face of the cross slide 98 which in FIG. 13 extends into the decelerating drive track 97' will have alined itself flush with the cam face of the block 94 before the collar 49' of the returning feeding 3 enters the decelerating cam track 97'. The collar 49' of the clamp 3 transducer control arm 48' will therefore move to a stop position in station 4 corresponding to the stop position N of the collar 49 shown in FIG. 13. The clamp 3 may then be started on a feed stroke by a thrust of the cross slide 98 toward the frame side bars 12', 13' and into the position in which the cross slide is shown in FIG. 13.

The cross slide 98 has an upstanding stud 101 (FIG. 22) which projects upwardly through an opening 102 (FIG. 2) of the base plate 86. Back and forth shifting of the cross slide 98 is effected by means of a rock shaft 103 and an arm 104 on the rock shaft which has a forked end straddling the stud 101. The rock shaft 103 extends the full length of the frame and is journaled in the frame yokes 14, 16, 81 and 82. The necessary back and forth oscillations of the rock shaft 103 are effected by the cycling mechanism 8 which will be explained later.

As previously explained, the finger portion 77 of the clamp actuating lever 64 (FIG. 9) is given a downward thrust while the clamp 2 is at standstill in the control station 2, in order to adjust the jaws 51, 59 from their open wire straddling FIG. 9 position to the closed wire gripping FIG. 11 position. Such downward thrust is transmitted to the finger 77 by a vertically shiftable

depressor slide 106 (FIGS. 2, 13 and 22) which is mounted in a guide block 107 on the edge of the base plate 86 next to the frame bar 12. As shown in FIG. 22, the slide 106 has a foot plate 108 at its lower end, and the slide is in an upwardly adjusted position while the feeding clamp 2 moves on a return stroke into the control station 2. By the time the clamp arrives at its standstill position in station 4 the carrier slide 53 has been lowered by the cam groove 93 of block 92, and while the jaws 51, 59 are still open, as shown in FIG. 9, the finger 77 projects under the foot plate 108 of the raised depressor slide 106. A downstroke of the depressor slide 106 is then effected by means of a rock shaft 111 and an arm 112 thereon which has a forked end straddling a side lug 109 of the depressor slide. As a result of such downstroke of the depressor slide 106, the jaws 51, 59 are closed and the lever 64 is moved into a generally horizontal position as shown in FIG. 11. When the clamp 2 thereafter moves on a feed stroke out of the control station 4, the carrier slide 53 is raised to the FIG. 12 position by coaction of the roller 58 with the cam groove 93. With the gripping mechanism in the adjusted position shown in FIG. 12, the feed clamp 2 proceeds on a feed stroke toward the control station 6.

A depressor slide 106' which is a duplicate of the slide 106 is mounted in a guide block 107' on the edge of the base plate 86 next to the frame bar 12'. A rock shaft 111' and arm 112' which correspond to the rock shaft 111 and arm 112 transmit up and down movement to the depressor slide 106'. As will be explained later, the rock shafts 111 and 111' are oscillated by the cycling mechanism 8 in such a manner that one depressor slide moves up while the other moves down, and vice versa. Accordingly, the depressor slide 106' is down while the depressor slide 106 is up as shown in FIG. 22. This positioning of the depressor slides is reversed at the start of a feed stroke of clamp 2 and it remains reversed until the feed stroke of clamp 2 has been completed. By that time the clamp 3 has moved on a return stroke into the control station 4, and the finger 77' of the actuating lever 64' for the jaws 51', 59' has moved under the foot plate 108' of the raised depressor slide 106'. A downstroke of the depressor slide 106' is then effected by the cycling mechanism to close the jaws 51', 59' on clamp 3 preparatory to a feed stroke of the clamp 3 and to a return stroke of clamp 2.

Referring now to the control station 6, the general organization of this station is similar to that of the control station 4. However, a distinguishing feature of the control station 6, as compared with the control station 4, is that the control station 6 is in its entirety adjustable endwise along the frame bar 79 in order to vary its spacing from the control station 4. Such endwise adjustment of the control station 6 not only varies the length of the produced wire lead but it also automatically varies the cycling of the apparatus as required for the increased or decreased length of the produced lead. The accomplishment of these results will become more fully apparent from the further explanations hereinbelow.

The control station 6, as shown in FIGS. 17 to 21, comprises a base plate 113 which is clamped to the underside of the frame bar 79 by four retainer blocks 114 and associated screws 116 which extend through the retainer blocks and into the base plate 113. At the un-

derside of the plate 113, directly below the frame bar 79, a cam block 117 has a stepped cam groove 118' (FIG. 20) for lowering the jaw carrier slide 53' (FIG. 25) of the feeding clamp 3 at the end of a feed stroke and for raising the slide 53' at the beginning of a return stroke of the clamp 3. The block 117 has another stepped cam groove 118 (FIG. 18) for lowering the jaw carrier slide 53 of the feeding clamp 2 at the end of a feed stroke and for raising the jaw carrier slide 53 at the beginning of a return stroke of the clamp 2.

Also mounted at the the underside of plate 113, directly above the drive shaft 11', a feed drive decelerating cam track 119' is formed by laterally spaced cam blocks 121', 122', and the block 122' has a return drive accelerating cam face 123' at an angle to the cam track 119'. As previously explained, the transducer control arm 48' of the feeding clamp 3 is in the full speed feed position shown in FIG. 25 as the clamp 3 approaches the control station 6 on a feed stroke. While the clamp 3 continues its feed stroke from the FIG. 3 position it is decelerated and finally brought to a standstill under the plate 113 by coaction of the collar 49' with the decelerating cam track 119'. Such coaction swings the control arm 48' from its full speed feed position to its neutral position which is indicated by the dotted circle N' in FIG. 17.

A subsequent shift of the control arm 48' from its N' position to its return feed position is effected by a cross slide 124 which is mounted under the plate 113 for back and forth movement transversely of the frame bar 79. The cross slide 124 has a thrust shoulder 126 (FIG. 21) which in the adjusted condition of the slide as shown in FIG. 17 is flush with the cam face of the block 121'. A short thrust of the cross slide 124 from the clamp 3 side of the frame 1 toward the clamp 2 side, that is, toward the bottom of FIG. 17, swings the transducer control arm 48' from its neutral position into an initial return drive position. As the clamp 3 then proceeds on its return stroke its transducer control arm is cammed into the full speed return drive position by coaction of the collar 49' with drive accelerating cam face 123' of the block 122'.

A feed drive decelerating cam track 119 for the feed clamp 2 is formed at the underside of the plate 113 above the shaft 11 by cam blocks 121, 122 corresponding to the cam blocks 121', 122', and the cam block 122 has a return drive accelerating cam face 123 at an angle to the cam track 119. When the transducer control arm 48 of the clamp 2 has been swung into its full speed feed drive position at the control station 4 its collar 49 is in a position of lateral alinement with the entrance end of the cam track 119 (FIG. 17) of the control station 6. Shifting of the cross slide 98 at the station 4 which initiates a feed stroke of clamp 2 is accompanied by the mentioned shift of the cross slide 124 at the station 6 toward the bottom of FIG. 7. A thrust shoulder 127 (FIG. 21) on the cross slide 124, which in the FIG. 17 position of the slide projects into the cam track 119, is thereby moved into flush alinement with the cam face of the block 121, thereby clearing the path of the roller 49 on the transducer control arm 48 along the cam track 119.

When the shaft 103 is rocked in the direction of arrow S in FIG. 2 to start the feeding clamp 2 at station 4 on a feed stroke such rocking movement is trans-

mitted to the cross slide 124 at station 6 to start the feeding clamp 3 on a return stroke. For that purpose a long strap rail 128 (FIG. 1 and 3) is secured to depending arms 129 along the shaft 103, and thrust blocks 131 on the upper side of cross slide 124 engage the lower part of the strap rail 128 from opposite sides. When the control station 6 is moved along the frame bar 79 to vary its spacing from the control station 4, the blocks 131 slide along the strap rail 128 and thus maintain a power transmitting connection between the rock shaft 103 and the cross slide 124 in any adjusted position of the control station 6.

After the cross slide 98 in station 4 and the cross slide 124 in station 6 have been shifted in unison by rocking of shaft 103 in the direction of arrow S in FIG. 2 to simultaneously initiate a feed stroke of clamp 2 and a return stroke of clamp 3, the cross slides remain in their shifted positions until the clamp 2 has come to a standstill in station 6 and the clamp 3 has come to a standstill in station 4. The shaft 103 is then rocked back in opposition to the arrow S, which causes the slides 98 and 124 to shift back to the positions in which they are shown in FIGS. 13 and 17, respectively. Such return shift of the slides 98, 124 initiates a feed stroke of clamp 3 from station 4 and a return stroke of clamp 2 from station 6. After the clamps have completed their respective feed and return strokes, the clamp 2 will be back in the control station 2 for a new feed stroke and the clamp 3 will be back in the station 6 for a new return stroke.

The cross slide 124 is equipped with a pair of latch levers 132 and 132' for cooperative engagement, respectively, with the collars 49 and 49' of the transducer control arms 48 and 48'. The lever 132' is fulcrumed at 133' (FIG. 21) on the slide 124, and at 134' (FIG. 17) on the base plate 113. When the transducer control arm 48' is in its neutral position at station 6 the latch lever 132' bears against the collar 49' and forces the transducer control arm 48' to shift so that the transducer 31' follows the control station 6 when it is moved toward or away from the station 4. Similarly, the latch lever 132 is fulcrumed at 133 (FIG. 21) on the slide 124 and at 134 (FIG. 17) on the base plate 113. Assuming that the clamp 2 has moved into the control station 6, the latch lever 132 bears against the collar 49 and forces the transducer control arm 48 to shift, so that the transducer 31 follows the control station 6 when it is moved toward or away from the control station 4.

Also mounted on the base plate 113 of the station 6 are two up and down adjustable lift slides 136, 136' for the jaw actuating levers 64, 64', respectively, on clamps 2 and 3. A guide bracket 137' (FIGS. 17 and 25) for the lift slide 136' is mounted on the edge of the plate 113 adjacent the frame bar 12' and has a lateral recess in which the slide 136' is shiftably retained in a vertical position. At its lower end the slide 136' has a lift lip 138' which is engageable with the finger 77' of the jaw actuating lever 64' in a jaw opening direction after the clamp 3 has moved on a feed stroke to its standstill position at station 6. In order to transmit the required upthrust to the lift slide 136' a long strap rail 139' is secured to arms 141' of the rock shaft 111' so as to extend lengthwise under a side lug 142' of the lift slide 136'.

At the clamp 2 side of the apparatus (FIG. 25) the lift slide 136 is mounted for up and down movement in a guide bracket 137 on the edge of the base plate 113 next to the frame side bar 112. At its lower end the slide 136 has a lift lip 138 which is engageable with the finger 77 of the jaw actuating lever 64 on clamp 2 so as to swing the lever 64 in a jaw opening direction after the clamp 2 has moved on a feed stroke to its standstill position at the station 6. Here again, in order to transmit the required upthrust to the lift slide 136 a long strap rail 139 is secured to arms 141 of the rock shaft 111 so as to extend lengthwise under a side lug 142 of the lift slide 136.

When the control station 6 is moved along the frame bar 79 to vary its spacing from the control station 4 the side lugs 142, 142' of the lift slides 136, 136' slide along the upper edges of the strap rails 139, 139' so as to remain operatively connected with the rock shafts 111, 111', respectively in any adjusted position of the control station 6. As previously mentioned, the shafts 111, 111' are simultaneously rocked by the cycling mechanism 8 in opposite directions so that one of the depressor slides 106, 106' at station 4 will be lifted while the other is lowered, and vice versa. The effect of the opposite rocking movements of the shafts 111, 111' is the same at station 6 with respect to the lift slides 136, 136'. That is, when one of the lift slides is up the other is down, and vice versa. The depressor slide 106 in station 4 and the lift slide 136' in station 6 are thus operatively inter-related so that the jaws 51, 59 on clamp 2 will grip a wire protruding into the apparatus at the left of FIG. 3 while the jaws 51', 59' on clamp 3 release a wire which has been advanced by a feed stroke of clamp 3. Similarly, the depressor slide 106' in station 4 and the lift slide 136 in station 6 are operatively inter-related in such a manner that the jaws 51', 59' on clamp 3 will grip a wire protruding into the apparatus at the lift of FIG. 3, while the jaws 51, 59 on clamp 2 release a wire which has been advanced by a feed stroke of clamp 2.

The Wire Cutting Mechanism

As shown in FIG. 1, a reel 143 with a supply of wire stock thereon is mounted on a dispensing mechanism 144, and wire 63 from the reel 143 is inserted into a wire input tube 145 which is supported on the frame yoke 14 and swingable about a transverse pivot axis intermediate its ends. The inner end of the tube 145 (FIG. 14) rests loosely on a support 146. A mechanism for cutting the wire 63 at some distance from the inner end of the tube 145 comprises a stationary blade 147 (FIG. 14) on a frame post 148, and a swingable blade 149 on a rock shaft 151. The stationary blade has a square notch 152 (FIG. 26) at its upper end into which a portion of the wire 63 protruding from the tube 145 may be inserted from above. The swingable blade 149 (FIG. 26) is laterally recessed from both sides, to form two cutting edges 153 and 154. An actuating arm 156 on the rock shaft 151 is connected by a link 157 with a bell crank lever 158 on the frame yoke 14. An upstanding arm of the bell crank lever 158 is alternately engageable by striker pads 159, 161 on a horizontally reciprocable master slide 162 of the cycling mechanism 8 so as to rock the shaft 151 alternately in opposite directions and thereby effect alternate clockwise and

anticlockwise cutting strokes of the blade 154 as viewed in FIGS. 27 to 30.

When the feeding clamp 2 moves on a return stroke into the control station 4, its open gripping jaws are lowered into the space between the wire guide tube 145 and the cutting blades 147, 149 so as to straddle an end portion of wire 63 protruding from the inner end of tube 145. After the clamp 2 has come to its standstill position at the control station 4, its open jaws 51, 59 are closed by a downstroke of the depressor slide 106, and thereafter the feeding clamp 2 is started on a feed stroke by a feed drive initiating shift of the cross slide 98 at the control station 4. While the clamp 2 advances on its feed stroke with the wire from the supply reel 143 gripped by its closed and raised gripping jaws 51, 59 the wire is pulled through the tube 145 and dragged through the notch 152 of the stationary blade 147. During such advancement of the wire by a feed stroke of the clamp 2 the cutting blade 149 remains in the angled position in which it is shown in FIGS. 26 and 27. Final advance movement of the clamp 2 within the control station 6 lowers the gripped wire end to the input level at which it was picked up at the control station 4. A subsequent lift stroke of the lift slide 136 at the station 6 then opens the gripping jaws 51, 59 and thereby releases the end of the wire which has been pulled from the supply reel 143. Immediately thereafter the striker pad 159 of the master slide 162 hits the upstanding arm of the bell crank lever 158 and causes cutting of the wire in the notch 152 of the stationary blade 147 by a clockwise cutting stroke of the blade 149 as viewed in FIG. 28. Such cutting stroke severs a wire lead of desired length from the wire stock on the reel 143.

Prior to the clockwise cutting stroke of the blade 149 the gripping jaws 51', 59' of the clamp 3 have been closed upon the portion of the wire which extends between the tube 145 and the cutting blades 147, 149. During the subsequent feed stroke of the clamp 3 a new length of wire is pulled from the supply reel 143 and dragged through the cutter notch 152 while the cutting blade 149 remains in the angled position in which it is shown in FIG. 29. Final advance movement of the clamp 3 within the control station 6 again lowers the gripped wire end to the input level (FIG. 14) at which it was picked up by the clamp 3 at the station 4. After the clamp 3 jaws have been opened by a lift stroke of the lift slide 136' at the station 6, the bell crank lever 158 is hit by the striker pad 161 of the master control slide 162 and causes cutting of the wire in notch 152 by an anticlockwise cutting stroke of the blade 149 as viewed in FIG. 29. Such anticlockwise cutting stroke severs a second wire lead of desired length from the wire stock on reel 143.

Successive cutting of wire leads of the same length from stock on the reel 143 may thus be effected by a cutting stroke of the blade 149 after a feeding stroke of each of the feeding clamps 2 and 3.

The Wire Transfer Conveyors

The wire transfer conveyor 30 which as shown in FIG. 3 extends transversely of the main frame 1 near the control station 4 comprises an endless link chain 163 and associated driving and idler sprockets 164 and 166 as shown in FIG. 22. The driving sprocket 164 is mounted on the spline shaft 31 which as shown in FIG.

5 is connected by drive chain 29 with solenoid controlled clutch 28. The idler sprocket 166 is rotatably mounted on an upstanding bracket 167 at the outer end of a lateral extension 168 of the main frame 1. A support plate 165 for the link chain 163 is mounted on the frame extension 168 between the sprockets 164 and 166.

The chain 163 in itself is of conventional construction and of the type wherein laterally opposite pairs of inner side bars 169 (FIG. 24) are connected by hinge bushings 171 and alternate with laterally opposite outer side bars 172 which are connected by hinge pins 173 extending through the hinge bushings. A series of identical auxiliary wire gripping clamps 174 are mounted on the chain 163 at equal spacings from each other, each clamp being mounted between a pair of inner side bars 169 and associated hinged bushings 171 of the chain.

As the chain is moved by anticlockwise rotation of the drive sprocket 164, as viewed in FIG. 22, complementary wire gripping jaws 176 and 177 of each clamp are successively actuated so as to move to an open wire straddling position at the upper periphery of the drive sprocket 164, then a closed wire gripping position as illustrated by FIG. 22a, then to an open wire releasing position at the sprocket wheel 166 as illustrated by FIG. 22b, and then to a reclosed position for travel without a wire along the lower run of the chain toward the drive sprocket 164. As best shown in FIGS. 22a and 22b, each jaw comprises a base portion 178 which has opposite arcuately recessed end faces 179 and 181, and a gripping arm 182 which extends from the base portion 178 between the end faces 179, 181. The arcuately recessed end faces 179 of the jaws 176, 177, respectively, are rockably seated on the hinge bushings 171 between opposite inner side bars 169, and the arcuately recessed end faces 181 of the jaws are hingedly interconnected by a floating pin 183. For purposes of assembly and disassembly the pin 183 is axially shiftable into and out of cooperative engagement with the recessed end faces 181 while the end faces 179 are seated on the bushings 171. Holes 184 (FIG. 24) in the opposite side bars 169 are located in a midposition between the hinge bushings 171, and the pin 183 may be brought into axial alignment with the holes for insertion or withdrawal therethrough by simultaneous rocking of the jaws on the hinge bushings to an intermediate position between their open and closed positions.

The jaws 176, 177 are biased to a closed position by means of springs 186 and a rod 187 which extends through the jaws and supports the springs in compressed condition on its opposite ends. The jaw 176 has an actuating finger 188 which extends obliquely toward and under the the base portion 178 of the jaw 177, and by means of which opening and closing of the jaw is controlled as the chain travels around the sprockets 164 and 166.

Referring to FIG. 23, pairs of adjacent teeth 189 of the sprocket wheel 164 alternate with gaps 191 therebetween at a circumferential pitch which is twice the linear pitch of the chain 163. Consequently, when the sprocket wheel rotates the pairs of teeth 189 will enter into the chain links which comprise the outer side bars 172, and the chain links which comprise the inner

side bars 169 and bushings 171 will settle in the gaps 191. As the closed clamps 174 on the lower run of the chain 163 are carried toward the sprocket wheel 164 by rotation of the spline shaft 31, their actuating fingers 188 are yieldingly retained in projected positions by the pressure of the clamp springs 186. The lateral width of the fingers 188 is reduced so that they may overlap the sprocket wheel at one side during the rotation of the latter. A cam roller 192 is swingably mounted within the operating range of the actuating fingers 188 by means of a collar 193 surrounding the shaft 31. The collar 193 together with the cam roller 192 is rockable back and forth independently of the sprocket wheel 164 by means of a trip solenoid 194 which is connected with the collar 193 by a link 196.

In the condition of the apparatus as shown in FIG. 22 a portion of wire 63 which has been advanced by a feed stroke of one of the feeding clamps 2 and 3 is straddled by an open conveyor clamp 174. The actuating finger 188 of the open clamp rests on the cam roller 192 which is held in a projected clamp opening position by the spring biased armature of the de-energized trip solenoid 194. While the wire 63 is severed from stock by a cutting stroke of the blade 149 (FIG. 28) the solenoid 194 is momentarily energized and pulls the cam roller 192 out from under the actuating finger 188 of the wire straddling clamp 174. As a result, the clamp closes, and at the same time an electrical trip signal is sent to the solenoid coil of the clutch 28 (FIG. 3).

The clutch 28 is of the well known self-cycling type which engages itself when its solenoid coil is momentarily energized, and which disengages itself automatically when its driven shaft has been turned from one predetermined rotary position to another. A clutch of this type is disclosed, for instance, in U. S. Pat. No. 3,521,730 issued July 28, 1970 to J. H. Weatherby for Clutch Brake Having Positive Output Position Selection.

Operation of the clutch 28 causes the shaft 31 and sprocket wheel 164 to rotate and advance the conveyor chain 163 a distance which brings the actuating finger 188 of a new conveyor clamp 174 into engagement with the cam roller 192 which has been projected into camming position by the spring bias of the trip solenoid 194. While the new clamp 174 moves around with the sprocket wheel 164 during the advance movement of the chain 163 it is initially closed but subsequently opened by coaction of its actuating finger 188 with the projected cam roller. When the sprocket wheel 164 stops rotating wire 63 which has been advanced by a feed stroke of one of the feeding clamps 2 and 3 is again straddled by an open conveyor clamp 174.

At the discharge end of the conveyor 30, the idler sprocket 166 has pairs of adjacent teeth 189' which alternate with gaps 191' therebetween the same as on the drive sprocket 164. As the chain 163 wraps itself around sprocket 166 the clamps 174 settle in the gaps 191' and their actuating fingers 188 are forced against laterally projecting shoulders 197 adjacent the gaps 191'. The jaws 176 are thereby swung into clamp opening positions and the floating pins 183 transmit the clamp opening swings of the jaws 176 to the jaws 177. Wire leads 63 which have been carried along the upper run of chain 163 are dropped from the open clamps 174 as they travel around with the sprocket wheel 166.

In the lower peripheral region of the sprocket wheel 166 the jaw actuating fingers recede from the shoulders 197. The jaws 176, 177 therefore swing into clamp closing positions under the pressure of the springs 186 as the clamps move into the lower run of the conveyor chain 163.

The foregoing explanations regarding the conveyor 30 analogously apply to the conveyor 30' which is essentially a duplicate of the conveyor 30. However, as distinguished from the conveyor 30 which is retained in a transversely fixed position on the apparatus frame, the conveyor 30' is transversely shiftable to vary its spacing from the fixed conveyor 30 when the control station 6 is shifted to vary its spacing from the fixed control station 4. To provide for such shifting of the conveyor 30' its drive sprocket 164' (FIG. 5) is slidable along the spline shaft 31, and a frame extension 198 (FIG. 3) which carries the idler sprocket and chain support plate of the conveyor 30' is slidably connected with the main frame 1 for back and forth shifting in the longitudinal direction of the latter. The trip solenoid 194' (FIG. 3) for the clamps of the conveyor 30' is suitably arranged so as to follow back and forth shifting of the drive sprocket 164' along the spline shaft 31.

As shown in FIG. 3, wire leads 63 which are moved out from under the feeding clamps 2 and 3 by the conveyors 30, 30' extend at their opposite ends a short distance beyond the conveyor chains. For further processing of the wire leads, such as stripping insulation from their opposite ends and fastening connecting terminals thereto, suitable equipment, not shown, may be mounted on the frame extensions 168 and 198.

THE CYCLING MECHANISM

Referring to FIG. 1, guide brackets 199 and 201 for the master slide 162 are mounted on the frame yoke 14 at the wire input end of the apparatus. A double acting pneumatic cylinder 202 is mounted on the bracket 199 and has a piston rod 203 which is connected with an end bracket 204 of the master slide.

FIGS. 1 and 26 show the master slide 126 in its extended limit position to which it is moved by an expanding stroke of the cylinder 202, and FIG. 29 shows the master slide in its retracted limit position to which it is moved by a contracting stroke of the cylinder 202.

Milled into the master slide from its inner side which faces the control station 4 are two stepped cam grooves 204 and 204' as shown in dotted lines in FIGS. 26 to 29. The cam groove 204 has horizontal upper and lower end portions and a slanted connection portion therebetween. A cam follower roller 206 within the cam groove 204 is mounted on an arm 207 of the rock shaft 111 for the depressor slide 106 and lift slide 136 at the clamp 2 side of the apparatus. The cam groove 204', like the cam groove 204, has upper and lower end portions connected by a slanting portion, and a cam follower roller 206' within the groove 204' is mounted on an arm 207' of the rockshaft 111' for the depressor slide 106' and the lift slide 136' at the clamp 3 side of the apparatus.

The rockshaft 103 for the drive initiating cross slides 98 and 124 of the control stations 4 and 6 has a depending arm 208 which overlaps the master slide 162 at its outer side and whose lower end is alternately engageable by striker pads 209 and 211 on the master

slide upon back and forth movement of the latter by the pneumatic cylinder 202.

Admission of air pressure to the cylinder 202 is controlled by a four way, two position solenoid valve 212 which has hose connections 213, 214 with the barrel and gland ends, respectively, of the cylinder 202. An electrical circuit (FIGS. 30 and 31) for the coils 216 and 217 of the solenoid valve includes a cycling switch Sw-1 on the base plate 86 of the control station 4, a cycling switch Sw-2 on the base plate 113 of the control station 6, two programming switches Sw-3 and Sw-4 (FIG. 1) on the frame yoke 14, a manually operable on-off switch Sw-5, and two time delay relays R-1, R-2 symbolically shown in FIGS. 30 and 31.

The cycling switches Sw-1 and Sw-2 are of the temporary contact type and they are closed by movement of the feeding clamps into the control stations 4 and 6. A rocker assembly for closing the switch Sw-1 comprises a rockshaft 218 (FIG. 13) at the end of the control station next to the frame yoke 14, an upstanding arm 219 (FIG. 15) on the rock shaft opposite the switch Sw-1, two depending arms 221, 222 on the rock shaft, and a screw threaded abutment rod 223 on the lower end of each of the arms 221, 222. The rod 223 on arm 221 is hit by the clamp 2 when it arrives on a return stroke at its standstill position in station 4, and the resulting rocking of the arm 219 closes the switch Sw-1. Similarly, the rod 223 on the arm 222 is hit by the clamp 3 when it arrives on a return stroke at its standstill position in station 4.

A rocker assembly 218' - 223' (FIGS. 17, 18 and 19) similar to the rocker assembly 218-223 is mounted at the end of control station 6 next to the frame yoke 16 for closing the switch Sw-2 when either the clamp 2 or the clamp 3 arrives on a feed stroke at its standstill position in station 6. Rocking of arm 219' (FIG. 17) is transmitted to switch Sw-2 by a shift rod 224.

The programming switches Sw-3 and Sw-4, unlike the cycling switches Sw-1 and Sw-2, are of the temporary break type, that is, they are held closed by spring pressure and must be pushed to open. The master slide 162 has a depending dog leg extension 226 which keeps the switch Sw-4 open while the master slide 162 is in its fully extended position as shown in FIG. 30, and which keeps the switch Sw-3 open while the master slide is in its fully retracted position as shown in FIG. 31.

The circuit diagram of FIG. 30 illustrates the condition of the electrical and hydraulic components of the cycling mechanism while the mechanical feeding clamps 2 and 3 are positioned as illustrated by FIG. 3. Under these conditions the barrel end of cylinder 202 is pressurized by air passing from inlet line 227 through valve 212 to hose line 213. At the same time the gland end of cylinder 202 is vented through hose line 214 and outlet 228 of valve 212.

Return travel of feeding clamp 2 and feed travel of feeding clamp 3 closes switches Sw-1 and Sw-2. These switches are in series with coil 216 of solenoid valve 212 via closed programming switch Sw-3 and relay R-1. Energizing current will therefore flow to coil 216 from current source 229 via on-off switch Sw-5. The resulting shift of valve 212 as shown in FIG. 31 pressurizes the gland end and vents the barrel end of cylinder 202, and consequently the master slide will move from its fully extended to its fully retracted position.

Successive phases of the retracting stroke of the master slide are illustrated by FIGS. 26 to 29. While the master slide is in its fully extended position as shown in FIG. 26 the cam follower roller 206 is in the upper part of cam groove 204, and the roller 206' is in the lower part of groove 204'. The striker pad 159 is separated some distance from the upper arm of bell crank lever 158, and the striker pad 209 is separated a somewhat greater distance from arm 208 of the clamp drive initiating rock shaft 103.

Movement of the master slide from its FIG. 26 position to the position in which it is shown in FIG. 27 brings the roller 206 into the lower part of groove 204, and the roller 206' into the upper part of groove 206'. The jaw control shaft 111 is thereby rocked to close the jaws on clamp 2 in station 4, and the jaw control shaft 111' is simultaneously rocked to open the jaws on clamp 3 in station 6. The striker pad 159 just touches the bell crank lever 158, and the striker pad 209 is still separated some distance from the arm 208 of shaft 103.

Movement of the master slide from the FIG. 27 position to the FIG. 28 position swings the bell crank lever 158 through an angle which brings the cutting blade 149 over the notch 152 of the stationary blade 147 and causes a wire therein to be cut by the edge 153 of the blade 149. Also, an arm 231 on the cutter shaft 151 has moved over and closed a temporary contact switch Sw-6 which is mounted on the main frame 1. Closure of the switch Sw-6 sends an actuating impulse to the conveyor trip solenoids 194, 194' and to the solenoid operated clutch 28 through the circuit illustrated by FIG. 30. As a result, a wire lead severed by the cutting stroke of blade 149 is immediately grabbed by a pair of conveyor clamps by operation of the trip solenoids, and the conveyors are advanced one step by operation of the clutch 28 to bring a new pair of conveyor clamps into wire receiving position.

Movement of the master slide from the FIG. 28 to the FIG. 29 position causes the striker pad 209 to swing the arm 208 on shaft 103 through an angle which shifts the cross slide 98 in a station 4 and the cross slide 124 in station 6 to initiate a feed stroke of clamp 2 and a return stroke of clamp 3. During this final movement of the master slide the cutting blade 149 is moved past the notch 152 of the stationary blade 147, the arm 231 swings past the conveyor control switch Sw-6 so that it will open, and the programming switch Sw-3 is opened by the dog leg 226 of the master slide.

FIG. 31 shows the condition of the cycling mechanism after a retracting stroke of the master slide and shortly before the feeding clamp 2 enters the control station 6 on a feed stroke and the feeding clamp 3 enters the control station 4 on a return stroke. Arrival of the clamps at their standstill positions again closes both cycling switches Sw-1 and Sw-2, but an energizing impulse will now pass to the coil 217 of the solenoid valve 212 through the closed programming switch Sw-4 and relay R-2. The resulting shift of the solenoid valve 212 causes an expanding stroke of the cylinder 202 and a corresponding extending stroke of the master slide 162.

The extending stroke of the master slide restores the cycling mechanism to the condition illustrated by FIG. 30. The sequence of the operating phases of the master slide during the extending stroke follows the same pattern as during the retracting stroke. That is, the jaw

control shafts 111, 111' are first rocked to open the jaws of clamp 2 at station 6 and simultaneously close the jaws of clamp 3 at station 4. Next, the bell crank lever 158 is rocked by the striker pad 161 to sever the wire by a cutting stroke of the blade edge 154, and the conveyor control switch Sw-6 is closed to actuate the transfer conveyors 30, 30'. Finally, the drive initiating shaft 103 is rocked by the striker pad 211 to initiate a feed stroke of clamp 3 and a return stroke of clamp 2.

SUMMARY

The apparatus may be started with the master slide 162 of the cycling mechanism either in the extended position shown in FIG. 26 or in the retracted position shown in FIG. 29. If it is first started after insertion of wire into the tube 145 with the master slide in the extended position and with the feeding clamps 2 and 3 out of the control stations 4 and 6, the clamp 2 will move on a return stroke toward the control station 4, and the clamp 3 will simultaneously move without a wire on a feed stroke toward the control station 6.

As the clamps enter the control stations, they are slowed down and come to a standstill with their gripping jaws lowered to the wire input and output levels, respectively; the jaws of clamp 2 being open and those of clamp 3 being closed. A retracting stroke of the master slide from the FIG. 26 position is then initiated by operation of the cycling switches Sw-1, Sw-2, solenoid valve 212 and shift cylinder 202. Such retracting stroke first causes gripping of the wire by the lowered clamp 2 jaws in station 4 and opening of the lowered clamp 3 jaws in station 6; then swinging of the blade 149 through a cutting stroke, along with actuation of the transfer conveyors by operation of the conveyor switch Sw-6 trip solenoids 194, 194' and solenoid clutch 28; and finally starting the clamp 2 on a feed stroke and clamp 3 on a return stroke. The feed stroke of clamp 2 pulls the first wire lead from the supply reel 143.

Arrival of the clamps 2 and 3 at their standstill positions in the stations 6 and 4, respectively, initiates an expanding stroke of the master slide 162 by operation of the cycling switches, solenoid valve and shift cylinder. Such expanding stroke first causes opening of the lowered clamp 2 jaws in station 6 and simultaneous closing of the lowered clamp 3 jaws in station 4; then swinging of the blade 149 through a cutting stroke severing the first lead from the stock on supply reel 143 and actuation of the transfer conveyors by operation of switch Sw-6, trip solenoids, and solenoid clutch, and finally starting clamp 2 on a return stroke and clamp 3 on a feed stroke.

The severed wire lead is straddled by open gripping jaws of the transfer conveyors near the control stations 4 and 6, and the conveyor clamps are closed by operation of the trip solenoids 194, 194' while the blade 149 sweeps through the cutting stroke. At the same instant the transfer conveyor chains are advanced one step by operation of the solenoid clutch 28 to present a new pair of open conveyor clamps to the next lead which is measured out by the subsequent feed stroke of clamp 3. The operating sequence of the feeding clamps, cycling mechanism and cutting mechanism then repeats itself automatically and produces the next wire lead which is moved sidewise in unison with the first lead but at a

rearward transverse spacing therefrom by operation of the transfer conveyors. By continuing the described sequence of operations any desired number of wire leads of preselected length may be produced automatically and at a relatively high rate of speed such as several thousand per hour.

In order to vary the length of the produced wire leads, the control station 6 is moved along the frame bar 79 to a correspondingly spaced position from the control station 4 after loosening of the fastening screws 116 (FIG. 17) for the retainer blocks 114. If the electrical circuit of the cycling switches Sw-1, Sw-2 is opened manually by switch Sw-5 continued rotation of the drive shafts 11, 11' will bring one of the feeding clamps to its standstill position in station 4 and the other in station 6. The transducers on the clamps then remain in their neutral positions because no shift signal will be received by the solenoid valve 212. With the transducer control arm of the clamp in station 6 being pushed out of neutral, it will follow the station 6 movement. The conveyor 30' would have to be adjusted along the spline shaft 31, and with it the trip solenoid 194' as required to allow the station 6 to a new position. While the station 6 is moved along the frame bar 79, the cross slide 124 and the lift slides 136, 136' of the station move along the strap rails 128, 139, and 139', respectively.

After the station 6 has been adjusted to the desired new position it is locked by tightening of the screws 116, and the switch Sw-5 is closed. The apparatus will then be operable as before but the produced wire leads will be of the desired new length.

I claim:

1. In a wire length measuring and cutting apparatus, the combination of a frame; a pair of simultaneously rotating drive shafts mounted on and extending between opposite ends of said frame; a pair of wire feeding clamps shiftable, respectively, along said shafts and non-rotatably guided on said frame for counter reciprocating feed and return strokes thereof; a pair of mechanical transducers movable, respectively, with said feeding clamps along said shafts in cooperative engagement therewith and operable to convert rotary movements of said shafts into axial movements of said feeding clamps selectively in opposite directions; cycling means operatively associated with said transducers so as to effect said feed and return strokes of said feeding clamps; wire input means at one end of said frame; jaw means operatively mounted on each of said feeding clamps for selective adjustment thereon to wire gripping and wire releasing positions in cooperative relation to wire protruding from said input means; wire cutting means operatively mounted on said frame adjacent said one end thereof; and actuating means for said jaw and cutting means controlled by said cycling means so that said jaw means will be in said wire gripping position during said feed strokes and in said wire releasing position during said return strokes of said feeding clamps, and so that said wire cutting means will execute a cutting stroke upon completion of a feed stroke of each of said feeding clamps.

2. An apparatus as set forth in claim 1 and further comprising wire conveying means extending transversely of said frame; auxiliary wire clamping means operatively associated with said conveying means and

selectively adjustable to wire gripping and wire releasing positions; actuating means for said conveying and auxiliary wire clamping means controlled by said cycling means so that upon completion of a feed stroke of each of said feeding clamps said auxiliary wire clamping means will be adjusted to said wire gripping position thereof and said conveying means will subsequently be moved a predetermined distance transversely of said frame; and actuating means operatively associated with said conveying means for adjusting said auxiliary wire gripping means from said wire gripping to said wire releasing position thereof.

3. In a wire length measuring and cutting apparatus, the combination of a frame; a pair of simultaneously rotating drive shafts mounted on and extending between opposite ends of said frame; a pair of counter reciprocating wire feeding clamps shiftable, respectively, along said shafts and non-rotatably guided on said frame; a pair of mechanical transducers movable, respectively, with said feeding clamps along said shafts in cooperative engagement therewith and each including a control element selectively adjustable to neutral and opposite axial drive establishing positions; cycling means operatively associated with said transducer control elements so as to initiate a feed stroke of one of said feeding clamps from one toward the other of said frame ends while simultaneously initiating a return stroke of the other feeding clamp from said other toward said one frame end, and subsequently to initiate a return stroke of said one feeding clamp while simultaneously initiating a feed stroke of said other feeding clamp; wire input means at said one end of said frame; jaw means operatively mounted on each of said feeding clamps for selective adjustment thereon to wire gripping and wire releasing positions in cooperative relation to wire protruding from said wire input means; wire cutting means operatively mounted on said frame adjacent said one end thereof; and actuating means for said jaw and cutting means controlled by said cycling means so that said jaw means will be in said wire gripping position during said feed strokes and in said wire releasing position during said return strokes of said feeding clamps, and so that said wire cutting means will execute a cutting stroke upon completion of a feed stroke of each of said feeding clamps.

4. An apparatus as set forth in claim 3 wherein a pair of drive decelerating cam elements are fixedly mounted on said frame in cooperative relation to said transducer control elements so as to stop said return strokes of said feeding clamps at said one frame end, and said feed strokes at a predetermined distance therefrom; and wherein said cycling means are operable to adjust said transducer control elements to a first operative position for simultaneously initiating a feed stroke of one and a return stroke of the other of said stopped feeding clamps, and to subsequently adjust said transducer control elements to a second operative position for simultaneously initiating a return stroke of said one and a feed stroke of the other of said stopped feeding clamps.

5. An apparatus as set forth in claim 4 wherein said cycling means comprise a master slide reciprocally mounted on said frame; motor means on said frame operable to shift said master slide alternately in opposite directions; motion transmitting means operatively connected with said master slide and cooperable

with said transducer control elements on said feeding clamps in said stopped conditions of the latter so as to initiate a feed stroke of one and a return stroke of the other of said feeding clamps in a response to a shift of said master slide in one direction, and so as to initiate a return stroke of said one and a feed stroke of said other feeding clamp, in response to a shift of said master slide in the other direction.

6. An apparatus as set forth in claim 5 and further comprising motion transmitting means operatively connected with said master slide and with said wire cutting means so as to operate the latter by a shift of said master slide in either direction.

7. An apparatus as set forth in claim 5 and further comprising control means for said motor means responsive to movement of one of said feeding clamps, into one of its stopped positions so as to effect a shift of said master slide in one direction, and responsive to movement of said one feeding clamp into the other of its stopped positions so as to effect a shift of said master slide in the other direction.

8. An apparatus as set forth in claim 5 and further comprising dual control means for said motor means operative to effect a shift of said master slide from one position to another upon a feed stroke of one and a return stroke of the other of said feeding clamps, and to subsequently effect a shift of said master slide from said other to said one position upon a return stroke of said one and a feed stroke of said other feeding clamp.

9. An apparatus as set forth in claim 5 and further comprising a pair of drive accelerating cam elements and a pair of drive decelerating cam elements mounted on said frame in cooperative relation to said transducer control elements so as to adjust the latter to full speed positions subsequent to initiation of said feed and return strokes of said feeding clamps, and so as to adjust said transducer control elements to neutral positions upon completion of said feed and return strokes of said feeding clamps.

10. An apparatus as set forth in claim 9, wherein one of said drive decelerating and one of said drive accelerating cam elements are mounted at said wire input end of said frame, and wherein the other drive decelerating and accelerating cam elements are adjustably mounted for positioning at preselected spacings from said wire input end.

11. In a wire feeding and cutting apparatus, the combination of a frame; a pair of simultaneously rotating drive shafts mounted on and extending between opposite ends of said frame; a pair of wire feeding clamps shiftable, respectively, along said shafts and non-rotatably guided on said frame for counter reciprocating feed and return strokes thereof; a pair of mechanical transducers movable, respectively, with said feeding clamps along said shafts in cooperative engagement therewith and operable to convert rotary movements of said shafts into axial movements of said feeding clamps selectively in opposite directions; cycling means operative associated with said transducers so as to initiate said feed and return strokes of said feeding clamps, wire input means at one end of said frame; wire gripping jaws mounted, respectively on said feeding clamps for back and forth movement thereon into and out of wire straddling positions, and each selectively adjustable in said wire straddling position to wire

gripping and wire releasing positions in cooperative relation to wire protruding from said wire input means; means including cam elements fixedly mounted on said frame and cam follower elements associated, respectively, with said jaws for moving said jaws into said wire straddling positions preparatory to said feed strokes, and out of said wire straddling positions preparatory to said return strokes of said feeding clamps; wire cutting means operatively mounted on said frame adjacent said one end thereof; and actuating means controlled by said cycling means for adjusting said jaws in their wire straddling positions to said wire gripping positions preparatory to said feed strokes, and to said wire releasing positions preparatory to said return strokes of said feeding clamps, and for operating said wire cutting means upon completion of a feed stroke of each of said feeding clamps.

12. An apparatus as set forth in claim 11 wherein said cycling means comprises a master slide reciprocably mounted on said frame, a pair of cam tracks on said master slide, and cam follower elements in cooperative relation, respectively, with said cam tracks and with said jaws so that movement of said master slide in one direction will adjust one of said jaws to said wire gripping position and the other jaw to said wire releasing position, and so that movement of said master slide in the other direction will adjust said one jaw to said wire releasing and said other jaw to said wire gripping position.

13. A wire feeding and cutting machine as set forth in claim 12 wherein said reciprocable master slide is further operatively connected with said wire cutting

means so that the latter will move into cutting position by movement of said slide element in one direction, and so that said cutting means will again move into cutting position by movement of said master slide in the other direction.

14. An apparatus as set forth in claim 13 and further comprising a pair of endless conveyors extending transversely of said frame and spaced transversely from each other, and auxiliary wire clamping means operatively associated with said conveyors and controlled by said master slide so as to move from wire straddling to wire gripping positions upon a feed stroke of each of said feeding clamps.

15. In a wire length measuring and cutting apparatus of the type wherein a pair of counter reciprocating wire feeding clamps are alternately operative to advance a length of wire from a supply of wire stock a wherein a cutting mechanism severs the advanced wire length after a feed stroke of each of said clamps, the improvement comprising, a pair of transversely spaced shafts rotatably mounted on said apparatus in axially fixed positions, drive means for continuously rotating said shafts, a pair of rotary to lineal motion transducers having driving connections, respectively, with said shafts and axial thrust transmitting connections, respectively, with said feeding clamps, and control means operatively associated with said motion transducers for initiating a feed stroke of one and a return stroke of the other of said feeding clamps, and for subsequently initiating return stroke of said one and a feed stroke of the other of said feeding clamps.

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