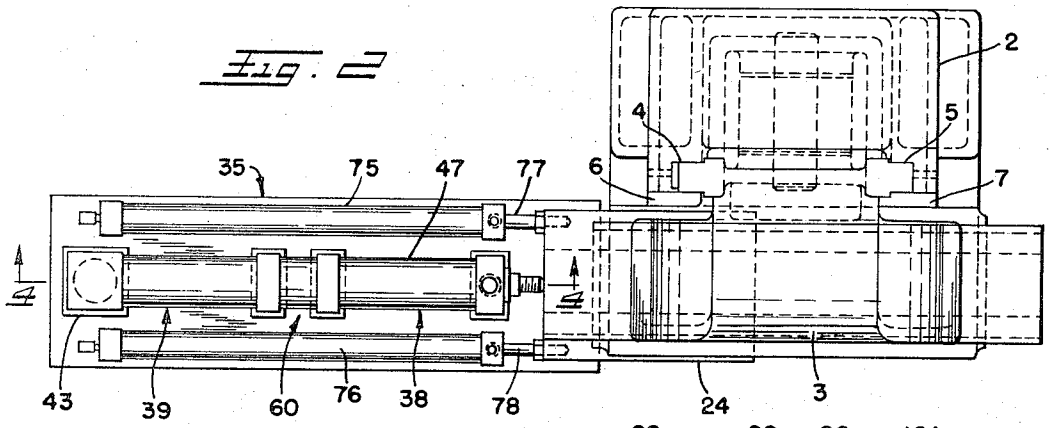
Sept. 12, 1967 W. E. MIZE 3,340,756

DIE ACCELERATOR

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Fig. 2



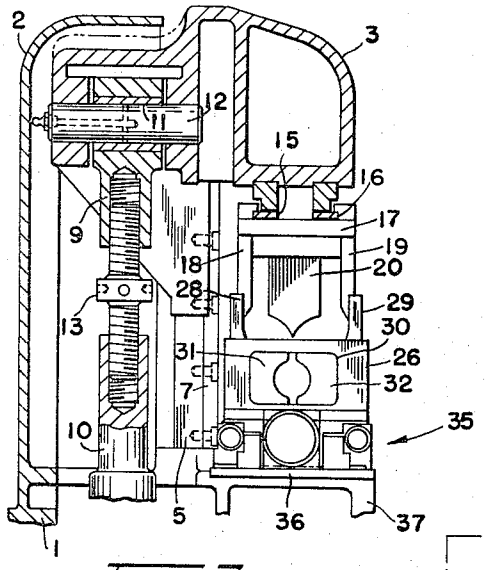


Fig. 3

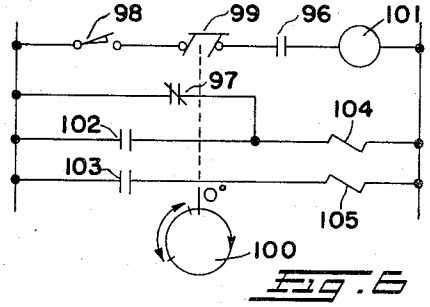


Fig. 6

Fig. 1

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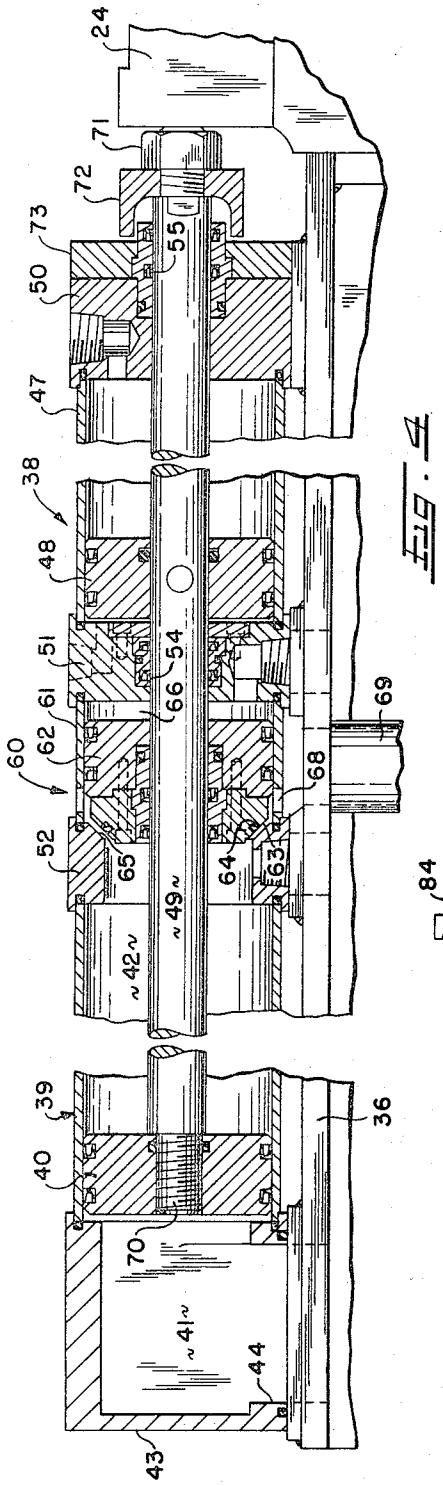


FIG. 4

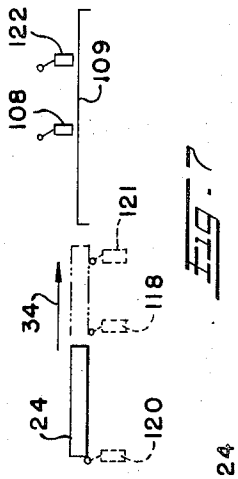


FIG. 7

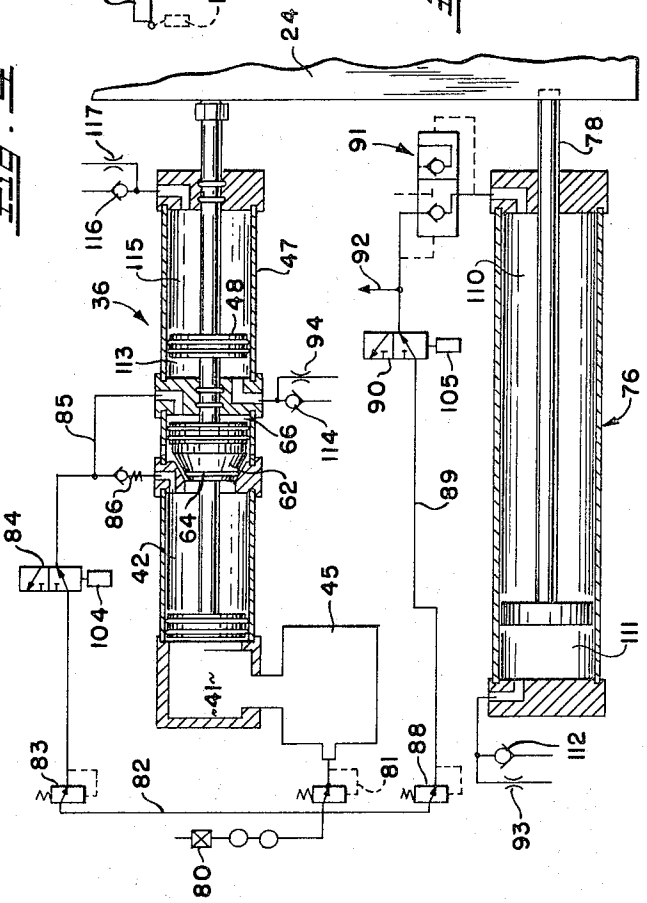


FIG. 5

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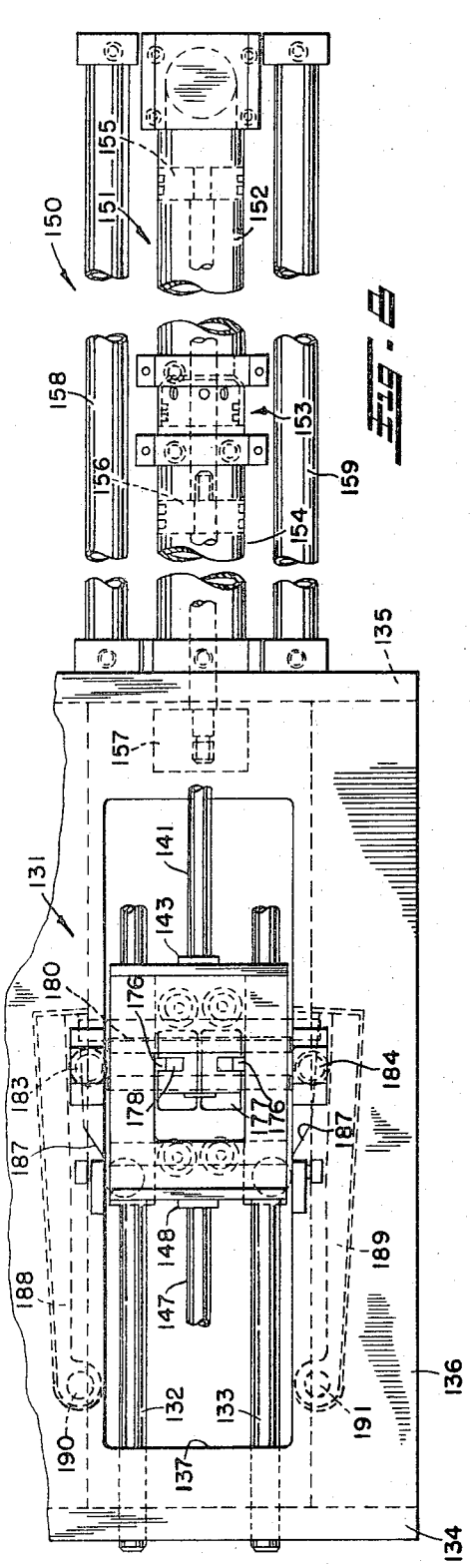


FIG. 3

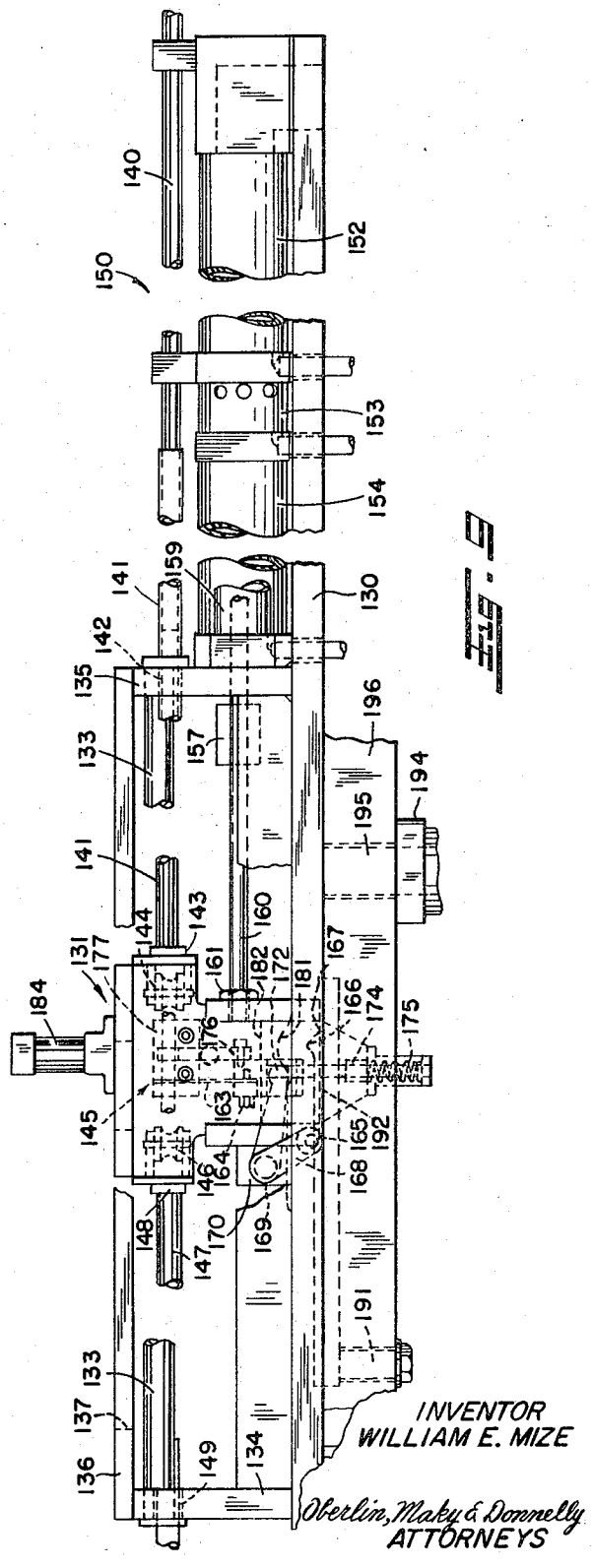


FIG. 4

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3,340,756

DIE ACCELERATOR

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Filed Jan. 8, 1965, Ser. No. 424,413
21 Claims. (Cl. 83—320)

ABSTRACT OF THE DISCLOSURE

A die accelerator for flying tools and the like having an air blast piston and cylinder assembly operative when triggered to accelerate the die to the speed of the work and including a snubber assembly to stop the accelerator with a return mechanism operating to return the die and recock the accelerator to be triggered for the next operating cycle.

This invention relates generally as indicated to a die accelerator and more particularly to an air operated die accelerator for flying cut-offs capable of moving the cut-off to a very high velocity within a short distance.

Automatic flying cut-off machines have been used for many years in steel and non-ferrous rolling mills. Where the work being severed lacks sufficient stiffness to push the cut-off die or tool forward without buckling, an accelerator is provided. The accelerator then powers the die table or cut-off tool accelerating the same to the speed of the work whereat the work is cut. After the cut, the die table or tool is then slowed to a stop and returns to its start position.

Accelerators may be of the mechanical type such as illustrated in the copending application of Charles J. Bognar, Serial No. 39,250 entitled, "Method and Apparatus for Accelerating a Flying Tool," filed June 28, 1960, now Patent No. 3,169,429, or pneumatic cylinders may be employed to power the cut-off die as disclosed in the copending application of Kenneth R. Keska et al., Serial No. 181,748 entitled, "Programmed Cut-Off Mechanism," filed Mar. 22, 1962, now Patent No. 3,173,319. However, most such accelerators for cut-off machines have one basic limitation and that is the ability to move the cut-off through the cycle in a short distance and still obtain a very high velocity for the relatively heavy die slide and die. Since the mill speed is generally limited by the operational speed of the cut-off, it is apparent that an accelerator capable of obtaining higher velocities in a shorter distance will increase the economic output of the mill.

Such high linear velocities are obtained with the present invention by utilization of an air blast or explosive force obtained from regular plant line air pressures.

It is accordingly a principal object of the present invention to provide an air operated die accelerator capable of moving a die slide and die to a very high velocity within a short distance.

A further principal object of the present invention is the provision of an air operated explosion or blast type accelerator which can accelerate conventional cut-off dies to speeds in excess of 650 feet per minute within a very short distance.

Yet another object is the provision of a die accelerator which can readily be attached to existing cut-off machines remarkably to improve their performance.

A further object is the provision of a cut-off die accelerator which can readily be adapted to machines employing cut length accuracy improvement devices such as shown in the aforementioned Keska et al. copending application while still improving remarkably the speed of operation thereof.

A yet further object is the provision of a highly simplified air operated accelerator which does not require high pressures from special compressors and the like but need operate only from normal shop line pressures.

Still another object is the provision of such an accelerator having sufficient power for operation of the cutter.

Other objects and advantages of the present invention will become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawings setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principle of the invention may be employed.

In said annexed drawings:

FIG. 1 is a fragmentary side elevation of an accelerator in accordance with the present invention attached to a conventional cut-off press;

FIG. 2 is a top plan view of the cut-off illustrated in FIG. 1;

FIG. 3 is a fragmentary vertical section of such cut-off as seen from the line 3—3 of FIG. 1;

FIG. 4 is an enlarged fragmentary longitudinal section of the main actuating cylinder of the accelerator taken substantially on the line 4—4 of FIG. 2;

FIG. 5 is a fragmentary schematic piping diagram illustrating more clearly the operation of the accelerator;

FIG. 6 is a schematic wiring diagram of the accelerator;

FIG. 7 is a schematic diagram illustrating the position of the various limit switches;

FIG. 8 is a fragmentary top plan view of an accelerator in accordance with the present invention employed with a cam type cut-off; and

FIG. 9 is a fragmentary side elevation of the accelerator and cut-off shown in FIG. 8.

Referring first to FIGS. 1, 2 and 3, there is illustrated a conventional cut-off press to which the accelerator of the present invention is attached. Such cut-off may include a sub-base 1 in which is mounted the motor driven crank shaft and an air operated clutch, electrically controlled, which will provide non-repeat single stroke operation, manual cutting, and jogging. At the rear of the base, there is provided a frame 2 supporting the head 3. The head 3 includes vertically elongated bearing surfaces accurately fitted to machined ways 4 and 5 in the frame 2 and long steel gibs 6 and 7 retain the head in such ways and assure lasting alignment. Vertical movement of the head 3 is obtained by upper and lower connecting rods 9 and 10 seen in FIG. 3 with the lower rod 10 being connected to the crankshaft in the sub-base 1. The upper rod 9 is mounted on bushing 11 on pin 12 mounted in the center rear of the head 3. A screw adjustment 13 is provided between the upper and lower connecting rods 9 and 10 for shut-height adjustment.

Mounted on the underside of the forwardly projecting portion of the head 3 are rails 15 and 16 on which is mounted for sliding movement punch holder 17 downwardly from which project side cams 18 and 19 with the punch or blade 20 therebetween. The sub-base 1 is provided with rails 22 and 23 similar to the rails 15 and 16 provided on the head 3 and mounted on the rails on the base is a die slide 24 on which is supported a die shoe 25, side guides 26 and 27, and upstanding cam guides 28 and 29 which receive the side cams 18 and 19 secured to the punch holder 17. the side guides 26 and 27 are provided with windows indicated at 30 in FIG. 3 through which the elongated work W passes. Mounted for opening and closing movement between the side guides 26 and 27 are die blocks 31 and 32 which may have cooperating work grip-

ping surfaces effective momentarily to surround and grip the elongated work as the blade **20** passes therethrough. Such die blocks are actuated by the side cams **18** and **19** as the blade descends. Reference may be had to the copending application of Frank Szel, Serial No. 383,482, entitled "Tube Cut-Off Mechanism," filed July 17, 1964, now Patent No. 3,298,213, for an illustration of a sliding cut-off die that may be used in the illustrated cut-off.

It can now be seen that the work W moving in the direction of the arrow **34** passing through the cut-off dies will be severed as the head **3** descends moving the blade **20** through the work. In order to accelerate or move the cut-off dies with the work to obtain the flying cut-off, there is provided the accelerator mechanism illustrated generally at **35**. The accelerator **35** is mounted on a shelf or plate **36** which is supported by vertical plates **37** extending from the sub-base **1** and it will be seen that the accelerator including its support may readily be attached to and removed from the base of the cut-off machine.

The accelerator **35** includes a main actuating cylinder assembly **38** which in reality is a cylinder-valve-cylinder combination. Such cylinder assembly includes an outboard or "blast" cylinder **39** as seen at the left in FIGS. 4 and 5 which has therein a piston **40**, upon which the pressures in the chambers **41** and **42** can exert force. The chamber **41** includes the cavity within cylinder assembly end cap **43** which has a large vertically extending passage **44** extending through the shelf **36** to reservoir **45**. It will be appreciated that the area of the piston **40** on the side toward the chamber **42** is less than that on the opposite or chamber **41** side, but the charged pressures in the respective chambers may be such that the piston **40** moves in neither direction. In the illustrated embodiment, the pressures may be equal with friction preventing movement.

On the die or inboard end of the assembly **38** is a cushioning or snubbing cylinder **47** which serves to prevent excessive shock in either direction, and to some extent control the speed of return to the "cocked" position shown in FIGS. 4 and 5. A piston **48** is mounted within the cylinder **47** and both of the pistons **40** and **48** are mounted on a common piston rod **49**. The cylinder **47** extends between cylinder end member **50** and cylinder retainer **51** while the cylinder **39** extends between the end cap **43** and cylinder retainer **52**. The cylinder support members **43**, **52**, **51** and **50** are all mounted on the shelf **36** and the rod **49** extends through the members **52**, **51** and **50** and through sliding seals shown at **54** and **55** in the members **51** and **50**, respectively.

Between the cylinders **39** and **47** is a "blast" valve assembly **60** which includes cylinder **61** extending between the retainers **51** and **52** and valve member **62** slidable therein. The valve member **62** is axially slidable within the cylinder **61** and also on the rod **49** and suitable sliding seals are provided between the member and the rod as well as between the member and the cylinder **61**, as shown.

The member **62** is provided with a conical valve surface **63** which includes an O-ring seal **64** which cooperates with the tapered or conical seat **65** in the cylinder retainer **52**. The valve member **62** is free to move on the rod **49** within the cylinder **61** in response to the pressures in chambers **42** and **66**, respectively.

Since it is apparent that the exposed area of the valve member **62** on the chamber **42** side thereof is less than that on the chamber **66** side, equal pressures in such chambers will seat or close the valve moving the same to the left until the seal **64** engages the seat **65**. When the valve member **62** is opened or moved to the right as seen in FIG. 4, chamber **42** is exhausted to atmosphere through a multiplicity of holes or ports **68** in the cylinder **61**, such ports being located about the circumference of the assembly and which have a combined area approximately equal to that of the valve opening between the seat **65** and the member **62** when the latter is against the

retainer **51**. In this manner, the entire rod end of cylinder **39** is opened and extremely rapid exhaust of the chamber **42** is obtained. The cylinder **61** may, if desired, be provided with an annular housing, not shown, to channel the exhaust from the ports **68** downwardly through exhaust tube **69** for noise reduction and safety purposes.

The piston rod **49** is secured to the piston **40** at one end by the threaded connection **70** illustrated and at the opposite end is provided with a nut **71** threaded thereon holding in place annular stop **72** which may engage the face member **73** on the cylinder retainer **50** to keep the pistons **48** and **40** from damaging contact with the retainer **51** and the end cap **43**, respectively.

The piston rod **49** is not attached to the die slide **24** and it is noted that the stroke of the cylinder-valve-cylinder assembly **38** is substantially less than the total horizontal movement of the die slide. For example, in the illustrated embodiment, the stroke of the assembly **38** may be approximately eight inches while the die slide has a stroke from about twenty-four to about thirty inches.

Referring now particularly to FIGS. 2 and 5, it will be seen that on either or both sides of the assembly **38** are conventional piston-cylinder assemblies **75** and **76**, the rods **77** and **78** thereof being connected to the die slide **24**. These piston-cylinder assemblies have a stroke equal to that of the die slide. Referring now particularly to FIG. 5, it will be seen that air may enter from the regular plant source through shut-off valve **80** and pressure regulator **81** to reservoir **45** and thus the chamber **41** communicating therewith. At the same time, air moves through line **82** through pressure regulator **83** and through deenergized solenoid valve **84** into chamber **66** through line **85**. Air pressure thus provided to the chamber **66** causes the valve member **62** to move to the left or to a closed position. Spring loaded check valve **86** requires some pressure before it permits air into the chamber **42**. In this manner, the chamber **66** is charged first and shifts the valve **62** to a closed position before the chamber **42** receives a large amount of air. When the valve **62** is closed, the valve **86** then permits a rapid flow of air into the chamber **42** and the aforementioned area differences on each end of the valve **62** maintain the same in a closed condition even though the pressures in chambers **66** and **42** are the same.

At the same time that the chambers **42** and **66** are being charged, air is moving through pressure regulator **88** in the conduit **89** and through deenergized solenoid valve **90** to the rod ends of piston-cylinder assemblies **75** and **76** through respective quick exhaust valves **91**. Conduit **92** is connected to the piston-cylinder assembly **75** on the opposite side of the actuator assembly **36**. The pressure thus entering the rod ends of the piston-cylinder assemblies **75** and **76** causes the same to retract and cocks the main actuating cylinder assembly **36**. The rate of speed at which the die returns and at which cocking occurs is determined by the pressure setting of the pressure regulator **88**, as well as by adjustment of the restrictions **93** and **94**. The restrictions **93**, of course, control the flow rate from the blind ends of the piston-cylinder assemblies **75** and **76** and the restriction **94** controls the flow rate from the outboard end of the cushioning or snubbing cylinder **47**.

Referring now to FIG. 6, there is illustrated a simple electrical control which may be used with the present invention. Contacts **96** and **97** may be actuated when the material drive or mill is running. Limit switch **98** is the flag limit switch which is mounted on the material run-out table and rotary limit switch **99** may be operated by a cam **100** on the crankshaft so that the contacts open as the cutter or blade leaves the material and recloses as the cut-off head approaches its top or stop position. The switch contacts **98**, **99** and **96** are in series with a control relay **101** which when actuated closes contacts **102** and **103** controlling solenoids **104** and **105** actuating valves **84** and **90**, respectively. (See FIG. 5.)

Operation

With the mill drive running, the material moving in the direction of the arrow **34** strikes a flag **108** on the run-out table **109** as seen in FIG. 7 closing contacts **98** to energize relay **101** which closes contacts **102** and **103** energizing both solenoid valves **84** and **90**. When valve **90** shifts, quick exhaust valve **91**, which may be mounted right on the cylinder for minimum air travel and rapid exhaust, shifts and exhausts chamber **110** in the piston-cylinder assemblies **75** and **76**. The shifting of the valve **84** exhausts chamber **66** which immediately opens valve member **62**, which in turn exhausts chamber **42**. It is here noted that the check valve **86** prevents the exhausting of chamber **42** until the valve member **62** is open.

The pressure in chamber **41** now moves the piston **40** and the die slide **24** forward at a rate of acceleration determined by the setting of the pressure regulator **81**. Atmosphere freely enters the chamber **111** at the blind end of each cylinder **75** and **76** through check valves **112** as well as chamber **113** through check valve **114**. It is noted that the chamber **115** on the opposite side of the snubber or cushioning piston **48** is also provided with a check valve **116** and an adjustable restriction **117**.

Within the stroke of the piston **40** the die slide **24** is accelerated to tube or work speed and the die slide **24** leaves contact with the end of the piston rod **49** and continues forward or to the right as seen in FIGS. 4 and 5. As the piston **48** moves forward, pressure builds up in the chamber **115** due to the restriction **117** and snubs or cushions the forward motion of the rod **49** and the pistons thereon.

The cut cycle may be initiated either by another contact in the flag limit switch **108** or by a limit switch **118** actuated by the passage of the die slide as seen in FIG. 7. It will be appreciated that other means may be provided to energize the cut cycle in response to work end position, die position, the relative speeds of the two, and like factors.

As the cut cycle continues and as the blade or cutter **20** comes back out of the material, the rotary contact **99** will open deenergizing solenoid valves **84** and **90**. Quick exhaust valves **91** then reclose and pressure is supplied to chambers **110** in the piston-cylinder assemblies **75** and **76** to brake and stop the die slide. Such pressure within the chambers **110** then returns the die slide and recocks the assembly **36**. In this manner, the system is then ready for the next explosion or actuation.

When the processing line or material drive is stopped, the contacts **96** and **97** return to the normal position as shown in FIG. 6 and the latter energizes the solenoid **104** of valve **84** but not the solenoid **105** of valve **90**. Then, the pressure in chamber **41** works against that in chamber **110** of each of the piston-cylinder assemblies **75** and **76** and the die slide moves forward to the end of the stroke of the piston rod **49**. This tends to move the die toward the center of the machine opening as seen in FIG. 1 for stationary cuts, thereby avoiding excess mechanical stresses in the cut-off head **3** and the support members. When the line is restarted, extremely rapid recocking occurs by the energization of the solenoid **105** through the relay **101**. Such recocking occurs in approximately 0.3 second.

It will be appreciated that other control circuits incorporating devices to prevent overtravel, run safe conditions, and the like may be employed. For example, in FIG. 7, there is illustrated the position of a cut and/or die return switch **120** sensing the position of the die slide at its cocked position. Because of the extremely rapid acceleration obtained with the explosive or blast cylinder assembly, in some cases depending upon the work speed, the cut cycle may be initiated as soon as the die slide **24** leaves its cocked position. The speeds obtained by the accelerator can, of course, be varied by adjusting the pressure regulator **81** and, for example, a setting of about 30 p.s.i. will produce an acceleration to about 300 feet per minute in the illustrated embodiment. Since plant line pressures are available to approximately 100 p.s.i., it can be seen that extremely rapid speeds may be obtained. Also, as seen in FIG. 7 an overtravel switch **121** may be positioned near the end of the path of movement of the die slide **24** to detect an overtravel condition. On the run-out table **109**, a dump switch **122** may be positioned beyond the flag **108** for the purpose of clearing the cut stock from the path of the oncoming work.

Cut-off embodiment shown in FIGS. 8 and 9

In this embodiment of the invention, there is illustrated a cut-off machine which is designed to synchronize die speed to work speed of approximately 600 feet per minute, and, for the particular machine illustrated, to cut aluminum, brass, or copper tubing in sizes ranging from ⅛-inch O.D. to ⅝-inch O.D. As opposed to the FIG. 1 embodiment wherein the air blast accelerator is simply attached to a conventional cut-off press, in this embodiment a single power source may be used for both accelerating the die and operating the cutter. The cut-off unit thus involves two basic assemblies, namely, the power source which is the air blast accelerator and a cut-off mechanism. The air blast accelerator may be substantially that shown in the FIG. 1 embodiment, but need not be controlled or moved to a horizontal center position when the processing line is stopped.

Referring first to FIG. 9, it will be seen that the cut-off may be mounted on a table **130** with the die mechanism illustrated generally at **131** being mounted for limited horizontal sliding movement on two shafts **132** and **133** which extend between frame uprights **134** and **135** mounted on the table or base **130**. A top plate **136** extends between such uprights and is provided with a window or opening **137**. The tubular workpiece **140** enters the machine from the right as viewed in FIG. 9 and passes into a guide tube **141** mounted in bushing **142** in the upright **135** and secured at **143** to the die assembly **131**. The workpiece then passes through a set of guide rollers **144**, through the clamping dies and cut-off mechanism illustrated generally at **145**, and then through exit guide rollers **146** into exit guide tube **147**. Such exit guide tube is secured at **148** to the die assembly **131** and is mounted in bushing **149** in the exit upright **134**. The workpiece then moves on to the left onto a run-out table, not shown.

The cut-off press or die assembly **131** will move to the left along the guide rods **132** and **133** as the result of the action of the accelerator mechanism shown generally at **150**. Such accelerator may be substantially identical to that disclosed in the FIG. 1 embodiment and comprises the actuator assembly **151** which includes reading from right to left the blast cylinder **152**, the blast valve **153**, and the snubber or cushioning cylinder **154**. The rod of the assembly **151** has mounted thereon the blast piston **155** and the cushioning piston **156** and is attached at its inboard end to pusher block **157**.

On each side of the assembly **151** there is positioned the die return piston-cylinder assemblies **158** and **159**, the rods **160** of which are connected at **161** to the assembly **131**. Referring now to the die assembly **145**, the cut-off blade **163** is carried by support member **164** which is moved upwardly to perform the cutting operation. Such upward movement is obtained when rollers **165** engage the rise portion **166** of cam tracks **167**. The rollers **165** are mounted on arms **168** which are in turn mounted on a transverse shaft **169** which is mounted on block **170** of the assembly **131**. At the center of such transverse shaft there is provided an arm having a ball end **172** thereon engaged within a ball socket in the blade carrier **164**. The center arm supporting the ball **172** is approximately twice as long as the arms **168** and the ball **172** will therefore move at approximately twice the rotational velocity of the rollers **165**. The cam surface **166**

on the tracks **167** are such that after acceleration of the blade support **164**, the blade **163** will reach a velocity which is constant and about twice that of the forward motion of the cutting assembly. Accordingly, if the accelerator assembly **150** moves the assembly **131** at about 600 feet per minute, the blade **163** will be moving upwardly at about 1200 feet per minute.

Attached to the blade support **164** through guide rods **174** are springs **175** urging the support **164** and thus the blade **163** downwardly. Such springs then tend to keep the rollers **165** in contact with the cam track **167**. The guide rods **174** also serve to eliminate twist in the blade support **164** as well as in the blade. The springs **175** assist in the return of the blade support **164**, and also absorb a portion of the energy remaining in the support and blade **163** after the cut has been made.

As the blade support **164** moves upwardly, cams **176** attached there to close die blocks **177** through rollers **178** to confine the tube to be cut. The tube preferably is not clamped by such die blocks, but approximately 0.005 inch clearance is provided. The die blocks **177** may be carried on transversely extending shafts **180** for movement toward and away from a tube confining position.

After the cut, the remaining energy in the moving parts may cause the rollers **165** to leave the cam tracks **167** and move upwardly toward the top track surface **181**. Such top track surface may be formed as part of the snubber **182** mounted on the rods, not shown, of snubber piston-cylinder assemblies **183** and **184**. Such snubber assemblies will then absorb the remaining energy in the upward vertical movement of the blade and holder and the springs **175** will then return the blade to its lower position and additional blade return force may be developed in the falling portion of the upper cam track **181**.

Referring now particularly to FIG. 8, it will be seen that soon after the blade has cut the work and then returned while the cut-off assembly **131** continues in its forward motion, the rollers **165** will contact deflecting cam tracks **186** and **187** on pivot members **188** and **189** which contain the cam tracks **167**. As such forward motion continues, the members **188** and **189** pivot about the axes **190** and **191**, respectively, placing the rollers **165** on a new path **192** which lies behind and slightly lower than the path **167**. The path **192**, of course, does not have the cam rise **166** therein so that as the cut-off assembly **131** is returned by the piston-cylinder assemblies **158** and **159**, the rollers are not cammed and no cut-off motion occurs.

A piston-cylinder assembly **194** seen in FIG. 9 has the rod **195** thereof projecting through the base member **196** may be employed to engage the rollers **165** when the assembly **131** is properly positioned thereover and thus rotate the arms **168** to obtain a stationary or manual cut.

It can now be seen that there is provided in the embodiment of FIGS. 8 and 9 a cut-off machine utilizing the power source of the air blast accelerator for both accelerating the die and operating the cutter. The high speed obtained by moving the die forward by means of the accelerator may then be employed to impart an even higher speed to the movement of the cutter through the work. In this manner, the explosive or air blast accelerator of the present invention may be employed in conventional press type cut-offs remarkably to improve the performance thereof and may also be utilized to impart the necessary cutting action to the blade in addition to accelerating the same to the speed of the work.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

I, therefore, particularly point out and distinctly claim as my invention:

1. A cut-off for elongated travelling work comprising a cut-off die mounted for movement with such work, an accelerator for moving such die to the speed of the work for the operation of the die, said accelerator comprising an air blast cylinder having a piston rod in driving engagement with such die, the stroke of said rod being shorter than the stroke of such die, and an air blast valve at the rod end of said air blast cylinder operative rapidly to exhaust the same whereby said rod will drive such die to the speed of the work.

2. A cut-off as set forth in claim **1** including means to stop said cut-off after the work has been severed and to return the same to starting position while simultaneously recocking said air blast cylinder for operation of the next cut-off cycle.

3. A cut-off as set forth in claim **1** wherein said air blast valve comprises a valve member mounted on said rod for movement therealong operative when moved to open the rod end of said air blast cylinder.

4. A cut-off as set forth in claim **1** including a snubber cylinder in tandem with said air blast cylinder operative to cushion the movement of said rod.

5. A cut-off as set forth in claim **1** including an air reservoir in communication with the blind end of said air blast cylinder operative to store energy for driving said rod against said cut-off, and means to regulate the pressure of the air within said reservoir to control the ultimate speed of said cut-off.

6. A cut-off as set forth in claim **1** including cam means responsive to movement of said cut-off with such work operative to actuate said cut-off into such work, and means operative to increase the velocity of said cut-off into the work over that of the cut-off with the work.

7. In combination, a flying tool for elongated travelling work, an accelerator operative to move said tool to the speed of the work comprising a rod in driving engagement with said tool, and means explosively to actuate said rod through a stroke shorter than that of said tool to impart to the latter a velocity equal to that of the work.

8. The combination set forth in claim **7** wherein said means explosively to actuate said rod includes a cylinder surrounding said rod, means to store energy within said cylinder, and means to release said energy to obtain such explosive actuation.

9. The combination set forth in claim **8** wherein said cylinder and rod comprise a pneumatic piston-cylinder assembly, an air reservoir having direct communication with the blind end of said assembly, and means quickly completely to exhaust the rod end of said assembly to obtain such explosive actuation.

10. The combination set forth in claim **9** including means to brake said flying tool and return the same to starting position while simultaneously recocking said pneumatic piston-cylinder assembly for the next cycle of operation.

11. The combination set forth in claim **10** including a snubber piston-cylinder assembly in tandem with said pneumatic piston-cylinder assembly operative to cushion the movement of said rod.

12. The combination set forth in claim **11** wherein the means to exhaust quickly and completely the rod end of said pneumatic piston-cylinder assembly comprises an air blast valve interposed between said assembly and said snubber piston-cylinder assembly.

13. The combination set forth in claim **12** wherein said air blast valve is pneumatically operated and effective to open the rod of said pneumatic piston-cylinder assembly to actuate said rod through said stroke.

14. In combination, a flying tool for elongated travelling work, an accelerator for said tool operative to move said tool from a starting at rest position to the speed of the work comprising an air blast piston-cylinder assembly in driving engagement with said tool, means to store energy in said cylinder, and means to release said energy to drive said tool to the speed of the work.

15. The combination set forth in claim **14** including an air reservoir in direct communication with the blind

end of said air blast piston-cylinder assembly, and means to regulate the pressure of the air within said reservoir to control the ultimate speed obtained for said flying tool.

16. The combination set forth in claim **14** including means to brake said tool and return the same to starting position while simultaneously recocking said air blast piston-cylinder assembly for operation of the next cycle.

17. The combination set forth in claim **14** including pneumatic piston-cylinder assemblies having a stroke equal to that of the tool operative to brake said tool and return the same to starting position while simultaneously recocking said air blast piston-cylinder assembly for operation of the next cycle.

18. The combination set forth in claim **14** including means responsive to the completion of the operation of the tool on such work to brake such tool and return the same to such starting at rest position while simultaneously storing energy in said cylinder.

19. A die accelerator for a cut-off for elongated travelling work comprising a blast cylinder and a snubber cylinder arranged in tandem and having a common rod in driving engagement with said cut-off, a blast valve interposed between said blast cylinder and snubber cylinder operative rapidly to exhaust said blast cylinder whereby the latter will drive said cut-off to the speed of the work, said snubber cylinder cushioning movement of said rod.

20. In combination, a flying tool for elongated travelling work, an accelerator for said tool operative to move said tool to the speed of the work comprising an air blast piston-cylinder assembly in driving engagement with said

tool, means to store energy in said cylinder, and means to release said energy to drive said tool to the speed of the work, said means to release said energy comprising a blast valve at the rod end of said air blast piston-cylinder assembly, said blast valve including an annular valve member having a frusto-conical surface adapted to seat in the rod end of said assembly.

21. In combination, a flying tool for elongated travelling work, an accelerator for said tool operative to move said tool to the speed of the work comprising an air blast piston-cylinder assembly in driving engagement with said tool, means to store energy in said cylinder, and means to release said energy to drive said tool to the speed of the work, said means to release said energy comprising a pneumatically operated valve member on the piston rod of said air blast cylinder assembly having differential areas on opposite sides thereof operative to maintain the valve member closed when the air pressures thereon are equal.

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