

May 25, 1926.

1,585,893

C. J. COBERLY

PIPE SLOTTING MACHINE

Filed Oct. 1, 1923

11 Sheets-Sheet 1

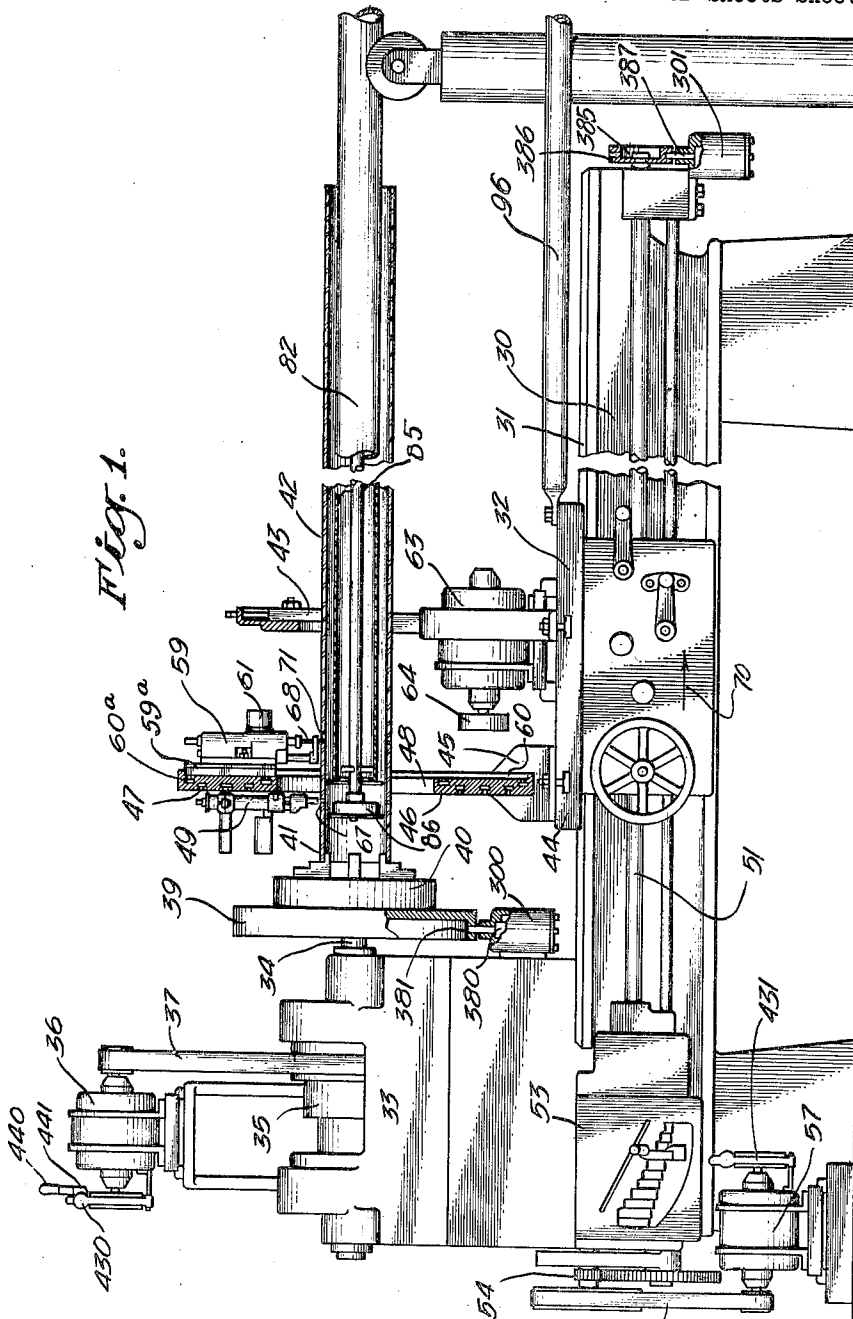


Fig. 1.

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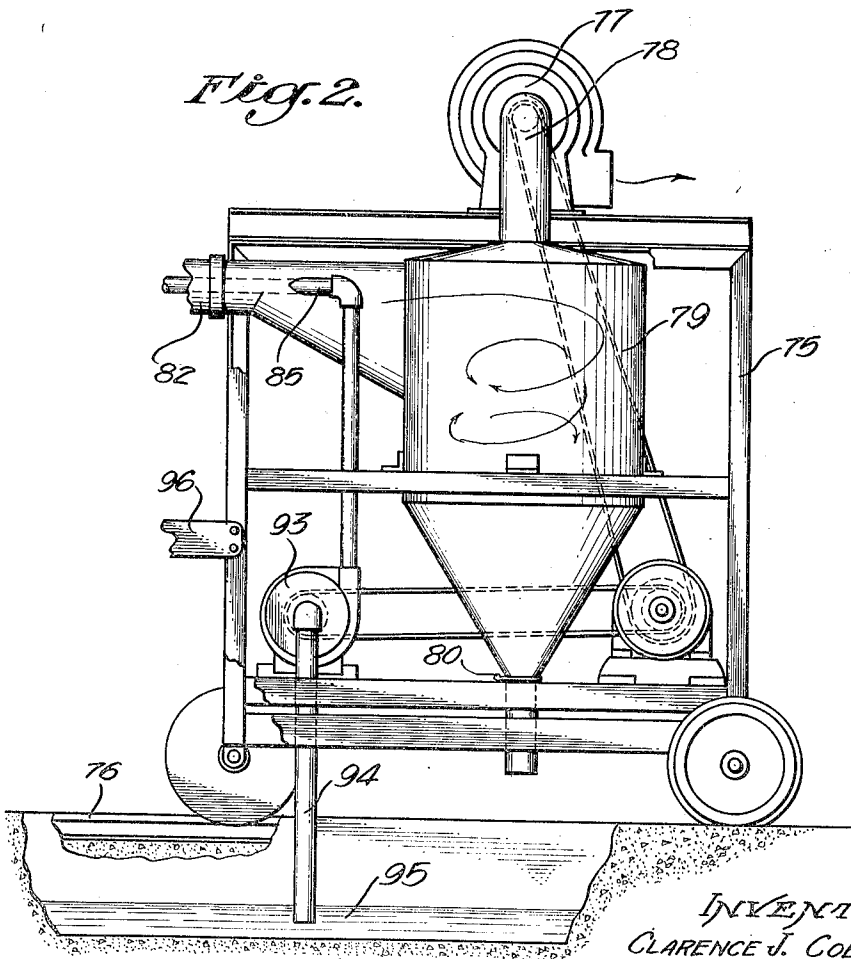
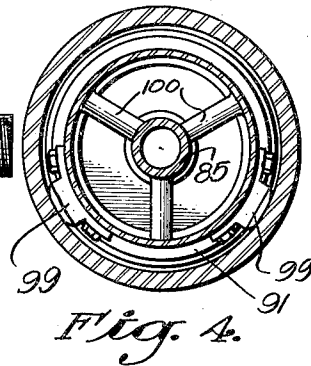
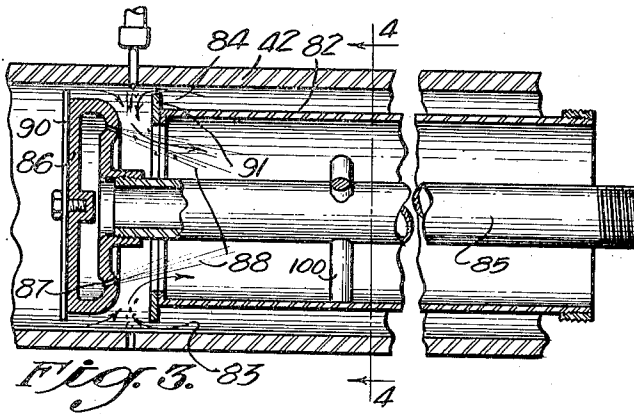
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11 Sheets-Sheet 2



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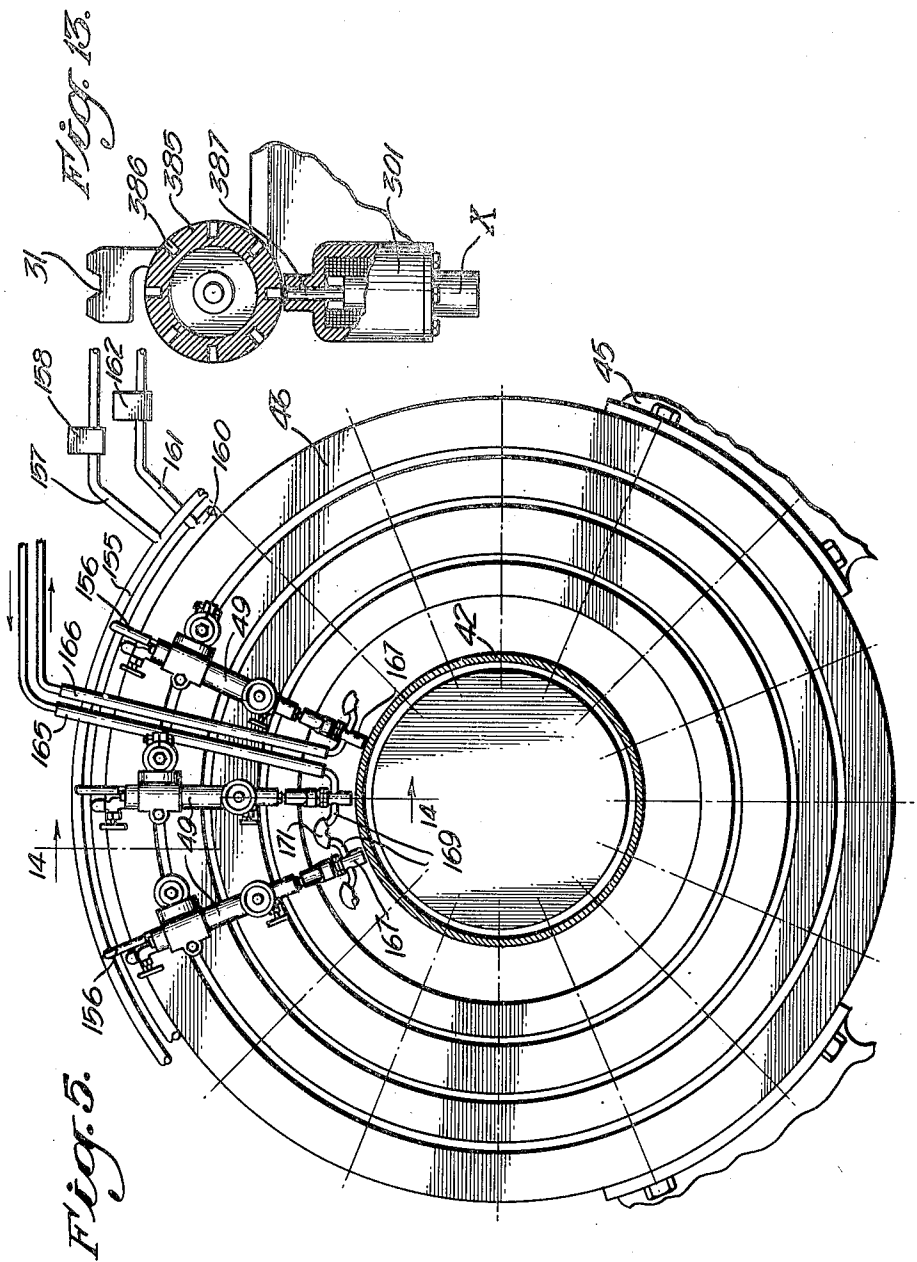
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11 Sheets-Sheet 3



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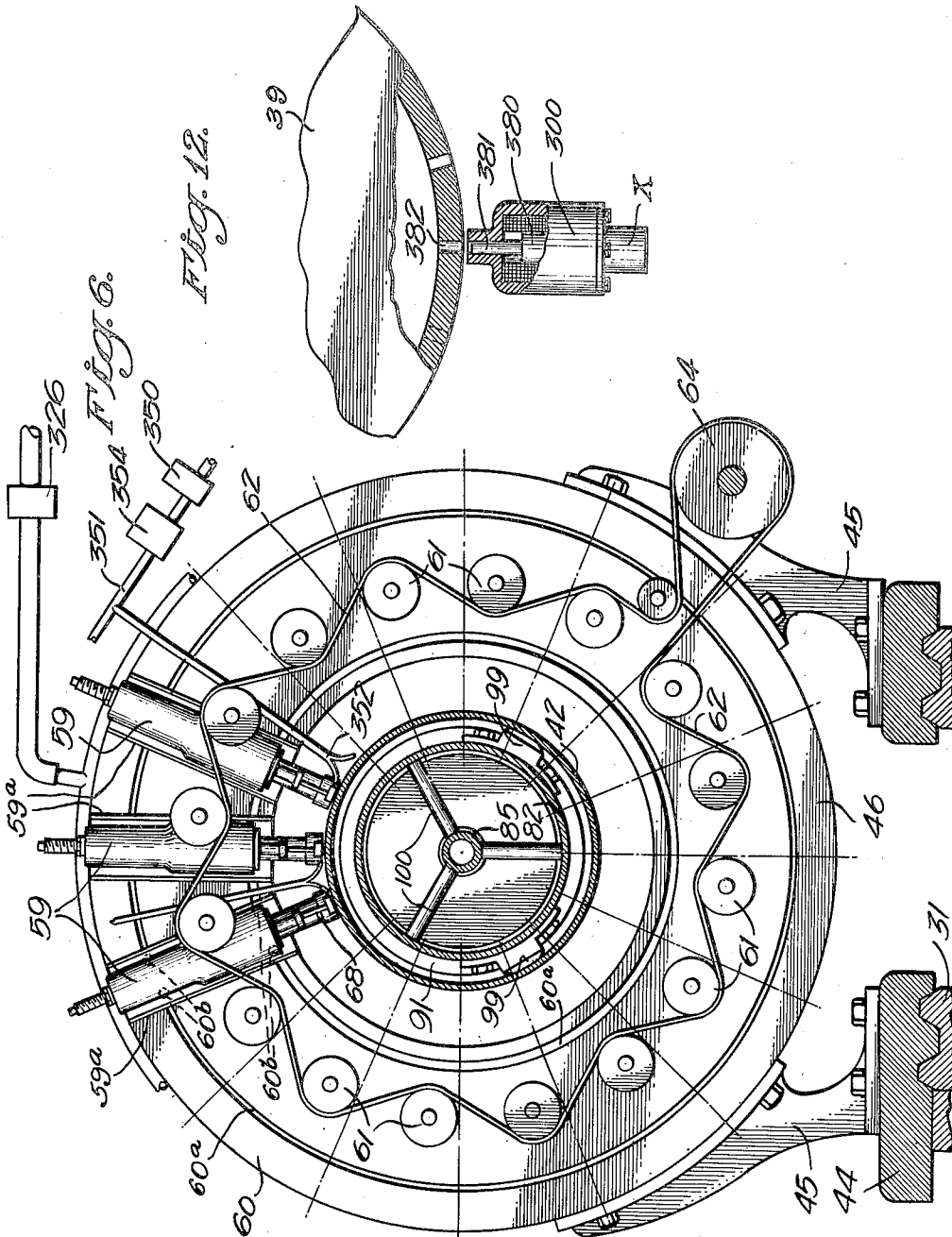
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11 Sheets-Sheet 4



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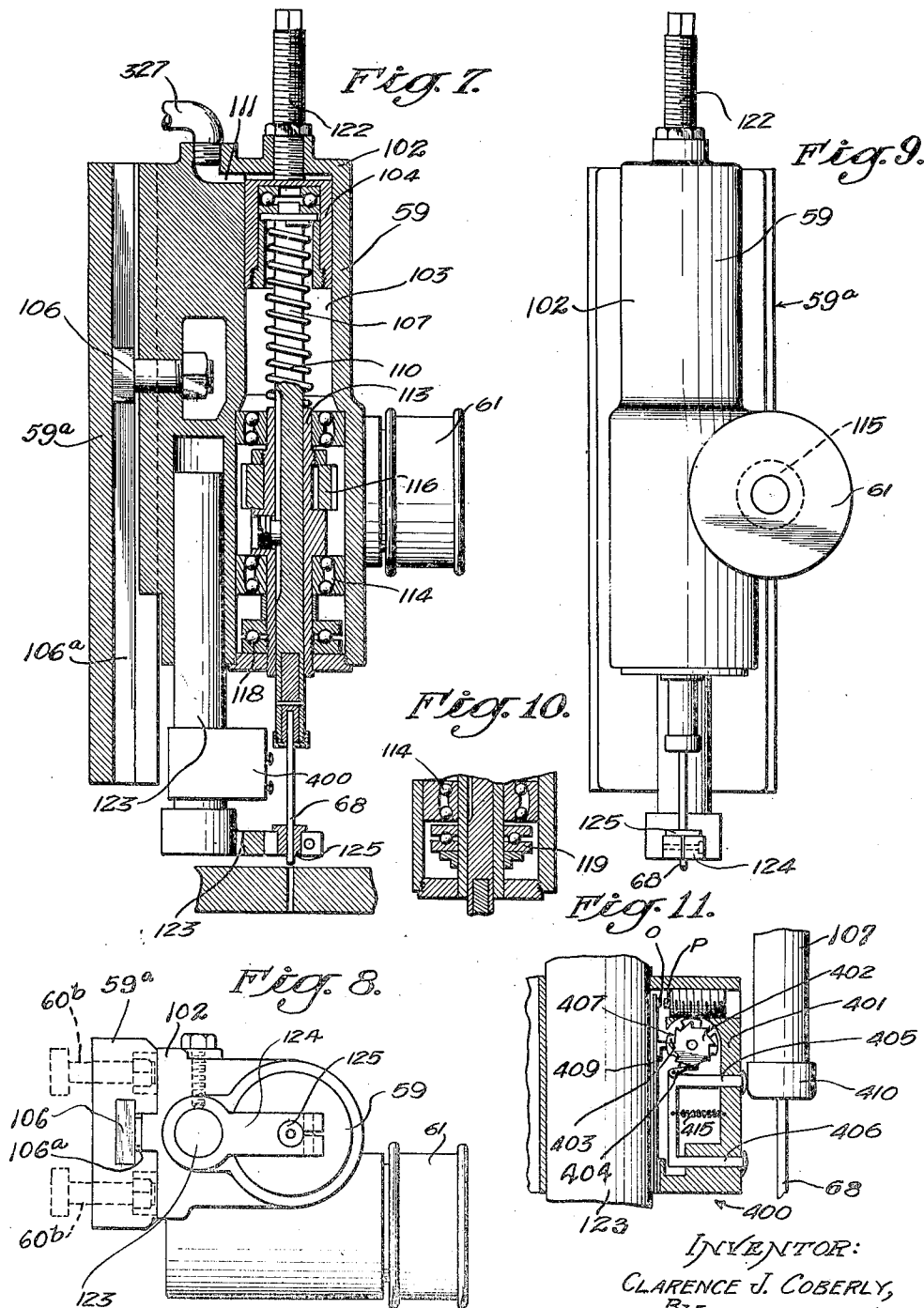
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11 Sheets-Sheet 5



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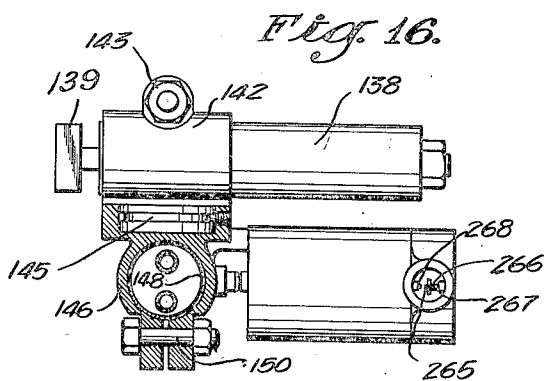
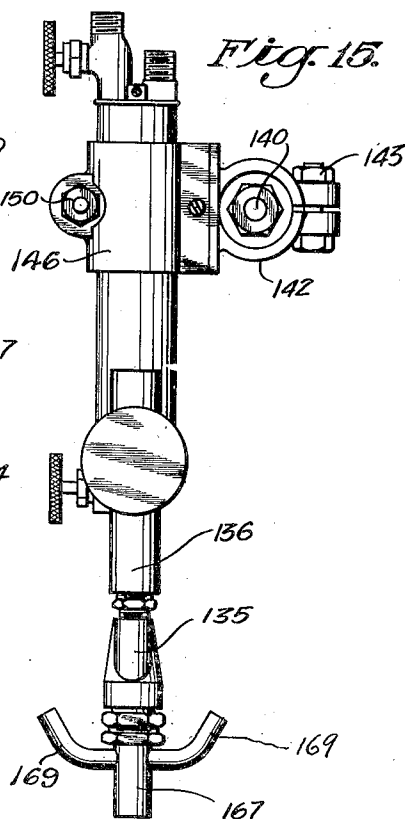
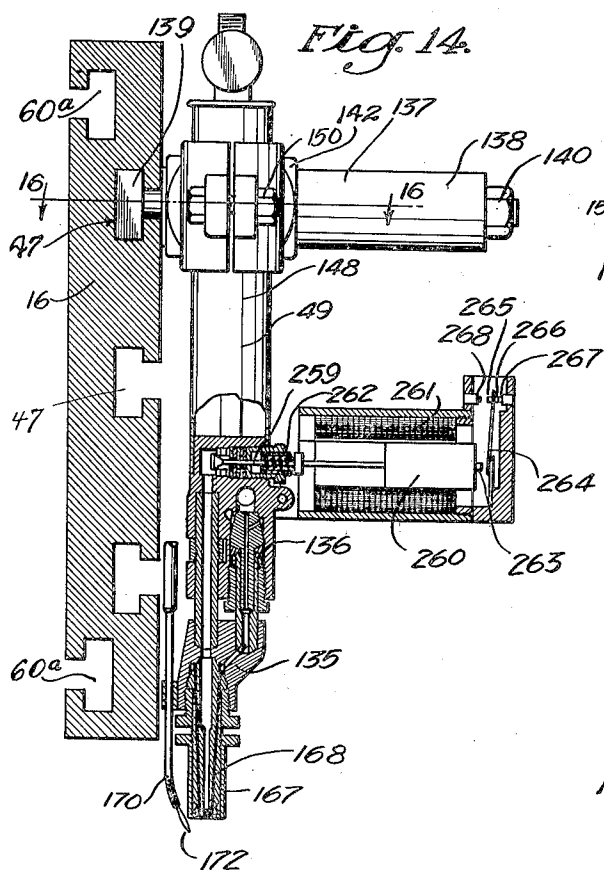
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PIPE SLOTTING MACHINE

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11 Sheets-Sheet 6



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PIPE SLOTTING MACHINE

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Fig. 17.

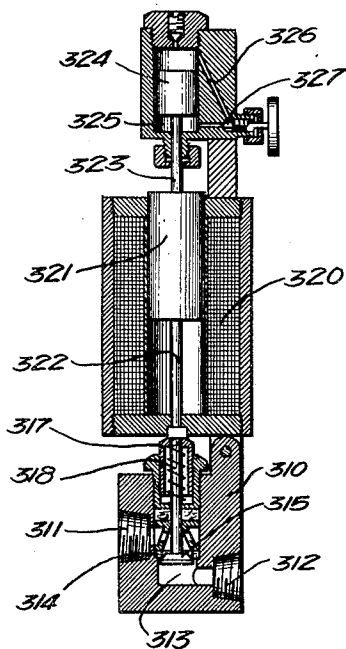


Fig. 27.

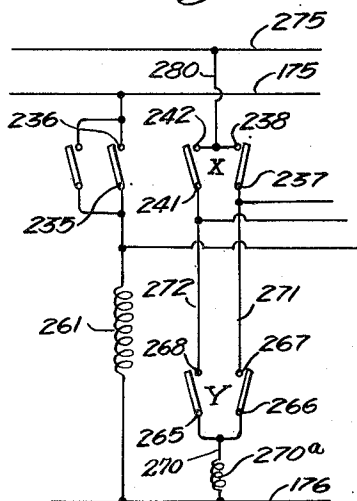
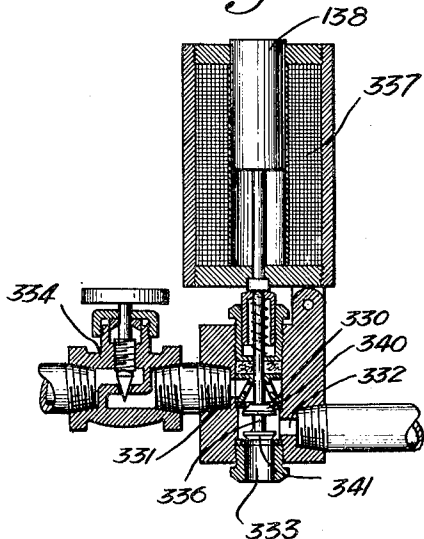


Fig. 18.



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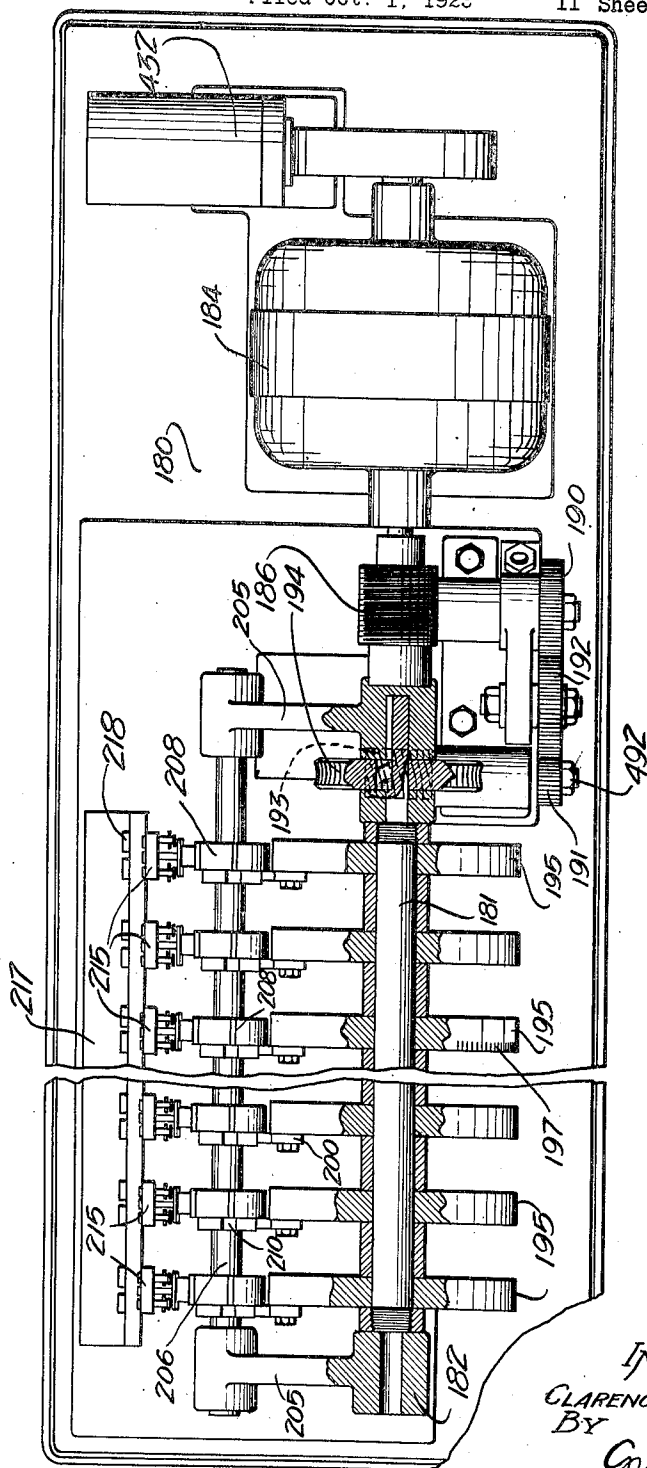
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Fig. 20.



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PIPE SLOTTING MACHINE

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Fig. 21.

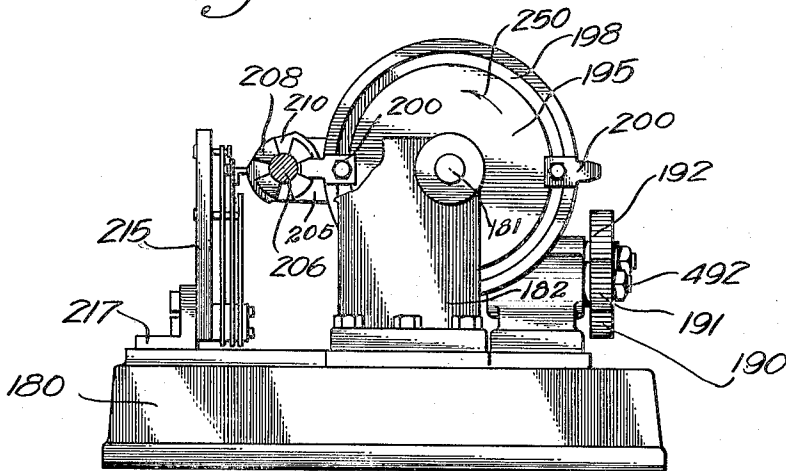


Fig. 23.

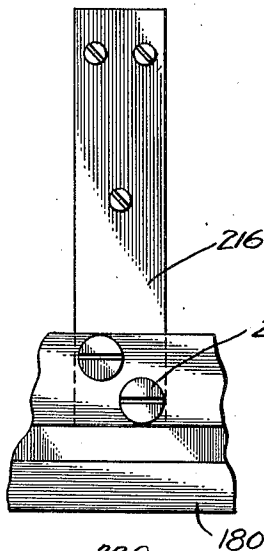


Fig. 22.

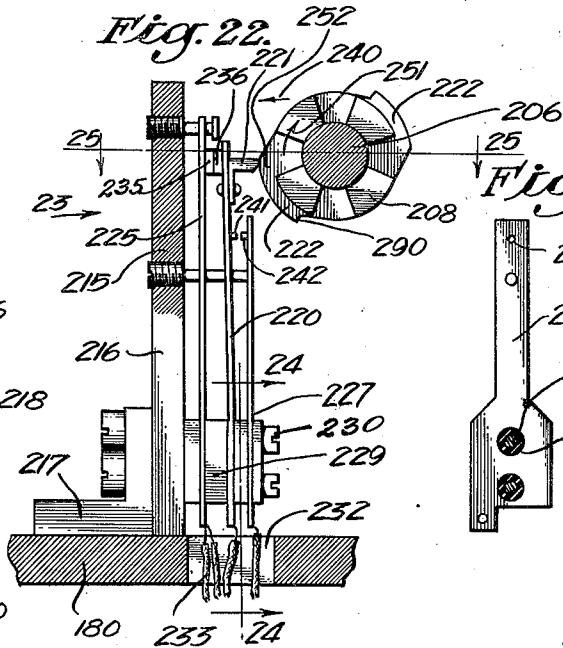


Fig. 24.

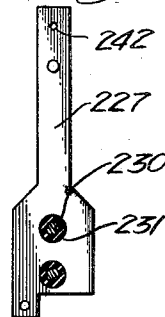
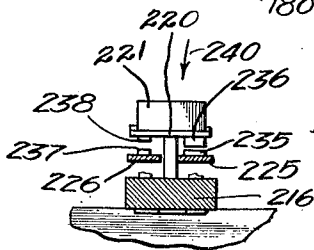


Fig. 25.



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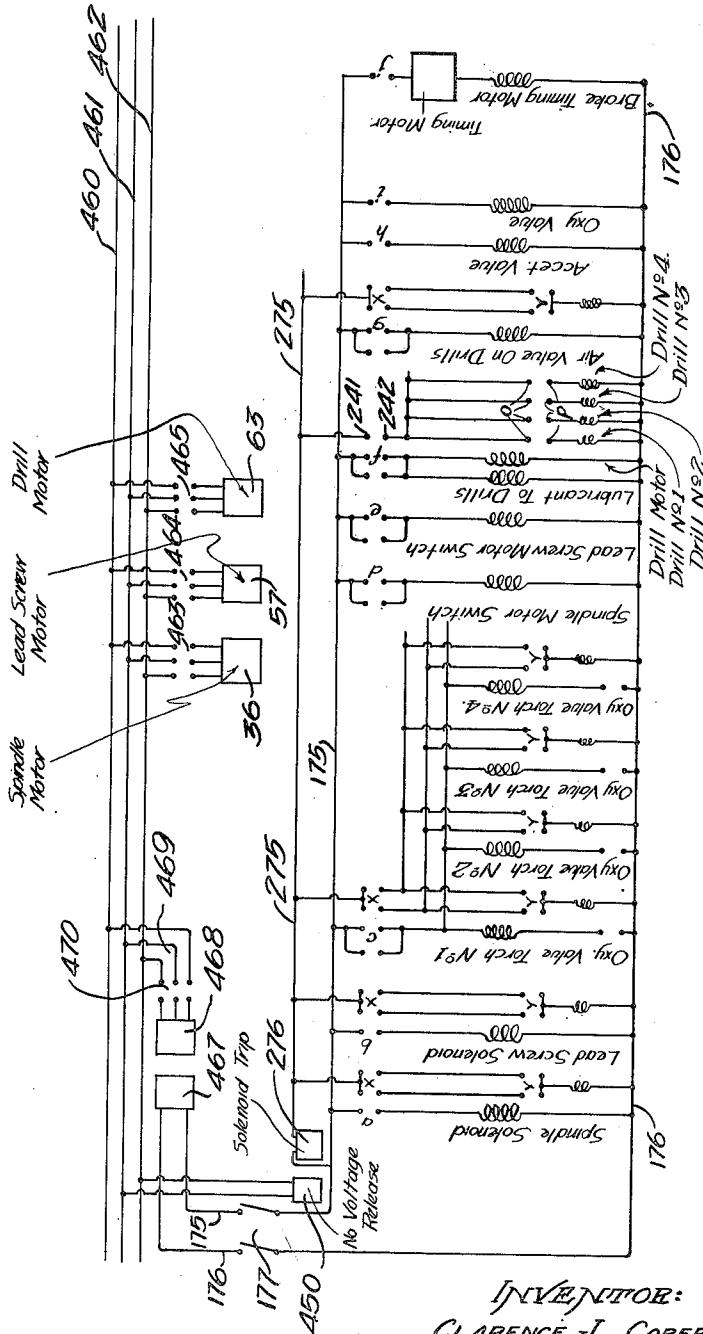
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Fig. 26.



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UNITED STATES PATENT OFFICE.

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PIPE-SLOTTING MACHINE.

Application filed October 1, 1923. Serial No. 665,917.

This invention relates to the art of cutting metals by the use of oxygen, and relates particularly to a machine for cutting slots in pipe in such a manner that a well strainer is thereby formed.

When a well has been completely drilled, it is customary to set a casing therein having a strainer at the bottom for excluding sand and gravel, but permitting the passage of liquids. Such strainers are often formed by perforating sections of casing which are placed at the bottom of the well, various means being employed to accomplish this perforation.

My invention provides a machine which, by the use of an arrangement of cutting torches, cuts elongated narrow perforations in the pipe. By the use of this machine, a perforation, narrow at the outer extremity and of increased width at the inner extremity so as to be self-clearing, and of consistent width throughout its length, is provided, thus converting the pipe into an ideal well strainer at a minimum expense.

It is an object of the invention to provide an automatically controlled machine having a movable support upon which an arrangement of cutting torches may be adjusted in radial disposition relative to the pipe. A relative movement between the torch support and the pipe is provided so that the cutting action of the torch results in the formation of elongated perforations or slots.

It is a further object of the invention to provide means whereby the action of the torch is automatically controlled and correlated in such a manner that the combined cutting action of the torches results in the formation of a series of uniform slots.

It is a further object of the invention to provide automatically controlled drills for perforating properly spaced holes in the pipe through which the cutting flame is directed at the start of the cutting operation.

It is a further object of the invention to provide an exhaust means for removing the slag from the interior of the pipe being slotted, and means for cooling the slag in a manner to prevent its adherence to the inside of the pipe or the exhaust means.

It is a further object of the invention to provide a timing device for controlling the

sequence of operation of the various mechanical elements incorporated in the machine.

It is a further object to provide in conjunction with the timing device a means for checking the operation of the co-operative mechanisms. This checking means is arranged to shut down the machine in event that any one of the mechanisms fails to properly function or does not function in properly timed sequence.

Although the invention is described as being particularly applied to a device for slotting pipe, it will be recognized hereinafter that the invention also incorporates a metal cutting machine employing a plurality of metal cutting torches and means for automatically controlling the torches so that they will be alike in cutting action. It is not believed that at the present time any device has been devised and employed in which a number of cutting torches are simultaneously employed, having correlated controlled mechanism whereby the action of the torches is synchronized. It is evident where a number of torches are to be employed simultaneously that such control is necessary if the device is to be operated by one attendant, as the adjustment of each torch, if separately connected, would require a considerable portion of an attendant's time and would most likely make necessary the employment of a number of attendants.

The especial advantages of the invention and further objects thereof will be made evident hereinafter.

Referring to the drawings which are for illustrative purposes only,

Fig. 1 is a side elevation of a machine embodying the principles of my invention.

Fig. 2 is an elevation of the exhaustor employed in conjunction with the cutting machine.

Fig. 3 is an enlarged fragmentary sectional view showing in detail the construction of the cooling spray head.

Fig. 4 is a section on a plane represented by the line 4-4 of Fig. 3.

Fig. 5 is an enlarged face view of the torch supporting member.

Fig. 6 is a view showing the manner in which the drills are mounted upon the rearward face of the torch supporting member.

Fig. 7 is a vertical section showing the interior construction of one of the drills.

Fig. 8 is a plan view corresponding to Fig. 7.

Fig. 9 is a front elevation of the drill.

Fig. 10 is a fragmentary section showing the manner in which the thrust bearings in the drill are placed for a reverse direction of rotation.

Fig. 11 is a fragmentary partially sectioned view showing the check switch employed on each drill.

Fig. 12 shows the index mechanism employed for controlling the movement of the pipe slotting face plate.

Fig. 13 is a partially sectioned view showing the index plate and the lead screw of the device.

Fig. 14 is a partially sectioned view to an enlarged scale showing the torch mounted on the torch support.

Fig. 15 is a front elevation of the torch shown in Fig. 14.

Fig. 16 is a section taken on a plane represented by the line 16—16 of Fig. 14.

Fig. 17 is a sectional view showing the type of valve employed in the oxygen and acetylene supply piping.

Fig. 18 is a vertically sectioned view showing the air valve which controls the feeding of air for the purpose of advancing the drill spindles.

Fig. 19 is a side elevation of the timing device.

Fig. 20 is a partially sectioned plan view thereof.

Fig. 21 is an end elevation of the device taken as indicated by the arrow 21 in Fig. 19.

Fig. 22 is a partially sectioned enlarged view showing the type of switch employed in the timing device.

Fig. 23 is an elevational view derived from Fig. 22, as indicated by the arrow 23.

Fig. 24 is a section taken upon a plane represented by the line 24—24 of Fig. 22.

Fig. 25 is a fragmentary sectional view taken upon a plane represented by the line 25—25 of Fig. 22.

Fig. 26 is a wiring diagram illustrating schematically the arrangement and control of the mechanism incorporated in the slotting machine.

Fig. 27 is an enlarged fragmentary section of the diagram.

As shown principally in Fig. 1 of the drawing, the invention employs a bed 30 which is similar in construction to the bed of a lathe, and which is provided with ways 31 upon which a carriage 32 is slidable. Supported at one end of the bed 30 is a head 33 supporting a spindle 34 having a cone pulley 35, whereby it may be driven from a motor 36 by means of a belt 37. Upon the rightward end of the spindle 34 is mounted an index plate 39 having concentric there-

with a chuck 40 which is preferably of universal type and is arranged to grip the end 41 of a length of pipe 42 placed in the machine for the purpose of being slotted. The pipe may be supported by a steady rest 43, or other means suitable to the characteristics and strength of the pipe. On the forward end 44 of the carriage 32 is mounted, by means of brackets 45, a torch supporting member 46 in the form of an annular plate having T slots 47 and a comparatively large central opening 48 therein.

It is the function of the device, as hereinbefore explained, to cut slots in the pipe 42. This is accomplished by means of cutting torches 49, preferably of the oxy-acetylene type, which torches are arranged radially upon the supporting member 46, as shown in Fig. 5. These cutting torches have the cutting nozzles thereof disposed inwardly so that when in operation they cut radial openings through the wall of the pipe 42. By providing a relative movement between pipe and the torches during the cutting action, it is possible to produce slots of any desired length or extension. For example, by rotating the pipe through use of the motor 36, it is possible to cause the formation of circumferential slots in the pipe. By rotating the pipe and simultaneously advancing the carriage 32, helical slots may be obtained, and by merely moving the carriage while maintaining the pipe stationary, longitudinal slots are obtained.

In this description of the invention, explanation of the device in the production of longitudinal slots will receive our attention, it being understood that the other formation of slots may be readily accomplished by the use of known gear construction. For the purpose of advancing the carriage, a lead screw 51 is provided which is driven through a change gear box 53, gears 54 and belting 56 from the lead screw motor 57.

When cutting metal by the use of an oxygen stream, it is customary to start to cut at the edge of the piece, this being due to the fact that when the starting of a cut is attempted within the plate, the flow of oxygen is obstructed by the metal and blows outwardly in a manner to form a hole of considerably greater diameter than the width which is ordinarily cut by the stream of oxygen delivered by the cutting torch. I have found that by drilling a small hole through the metal at the point where the cut is to be started, the oxygen stream will be allowed to pass freely and the blowing out thereof around the sides will be eliminated, and a cut of uniform size obtained without the undesirable presence of the malformation now produced in the starting of a cut within the edges of a metal object.

In the slotting machine, I employ a number of drills 59 corresponding to the num-

ler of torches 49. These drills are mounted radially upon the rearward face 60 of the supporting member 46, as indicated in Fig. 6. These drills are provided with projecting pulleys 61 which are drivably engaged by a belt 62 which is driven by the drill motor 63 having a pulley 64. The general operation of the device is substantially as follows:

10 A series of holes are first drilled at the plane indicated by 67, (see Fig. 1) these holes being circumferentially spaced to correspond with the positions of the torches 49. The torches are then brought into alignment
15 with the holes indicated at 67, whereupon the drills 59 operate and cause the drill bits 68 to drill a second series of holes in the pipe. The heat flames of the torches 49 are then lighted, with the result that the metal
20 surrounding the holes indicated at 67 is preheated, and when the proper temperature thereof is reached, a cutting stream of oxygen is delivered from the nozzles of the torches, and the carriage through the action
25 of the lead screw 51 is advanced in the direction indicated by the arrow 70, with the result that a longitudinal slot is formed. Upon reaching the end of the cut, the flow of oxygen is discontinued, but the advance of
30 the carriage continues at this time until the nozzles of the torches 49 are brought into alignment with the second set of holes indicated at 71 in Fig. 1. The drills are then operated to drill a succeeding set of holes
35 and slots are then cut, starting with holes 71.

In order to preserve a maximum strength in the pipe, it is desirable to offset the spacing of the consecutive circular rows of slots. This is accomplished by partly rotating the
40 pipe through rotation of the index plate 39 and chuck 40, by the motor 36.

Another feature of the invention consists of a means for removing the slag from the interior of the pipe 42, as the cutting action
45 progresses. This means, as shown in Fig. 2, consists of a carriage 75 which travels upon a track 76, aligned with the movement of the carriage 32, and which is provided with an exhaust fan 77 which communicates
50 through piping 78 with a centrifugal separator 79 having a door 80 in the lower end thereof. Extending forwardly from the separator 79 is an exhaust nozzle 82 which consists preferably of a pipe of a diameter
55 permitting its extension within the pipe 42. Due to the action of the fan 77, a strong suction is created within the pipe 82, with the result that air is drawn into the nozzle as indicated by the arrows 83 in Fig. 3.
60 Within the pipe 82 is extended a spray pipe 85 having a spray head 86 mounted on the end thereof, this spray head being provided with inwardly directed orifices 87, through which fine sprays of water are directed as indicated at 88. On the end of the spray head

86, a plate 90 is mounted, this plate being replaceable by plates of various sizes dependent upon the diameter of pipe being
70 slotted. On the inner end of the pipe 82, one of a set of removable rings 91 is placed. The plate 90 and the removable ring 91 are of such size that the space between the edges thereof and the interior face of the pipe 42 is constricted in a manner to cause a flow of
75 air along the inner wall of the pipe.

When a pipe of large diameter is to be slotted, the exhaust nozzle and spray head are readily adapted to use therewith, by increasing the diameter of the members 90 and
80 91. Water is supplied to the spray head 86 by a pump 93 which, through a pipe 94, draws water from a sump 95 which is in the form of a ditch disposed between the tracks 76 so that it will be under the carriage 75.
85 Through a link 96 the carriage 75 is moved with the carriage 32, thus causing the mouth of the exhaust nozzle to be maintained in alignment with the cutting torches. In view of the fact that the pipe 42 does not travel
90 axially, it is necessary for the exhaust nozzle to move axially therewithin. Therefore, slides 99 (see Figs. 4 and 6) are provided near the forward end of the nozzle, these
95 slides 99 resting on the interior of the pipe 42 and sliding therealong as the exhaust nozzle advances. For the purpose of supporting the spray pipe 85 within the pipe 82, any desirable means such as the radial arms 100 may be employed.

As shown in Figs. 7, 8 and 9, each drill
100 unit 59 includes a casting 102 arranged to slide along a radial plate 59^a and be clamped in adjusted position thereon by a T bolt 106 engaging into a T-slot 106^a in said plate.
105 The several plates 59^a are secured to the rearward face 60 of the support 46 by T-bolts 60^b (indicated in Figs. 6 and 8) engaging in concentric T-slots 60^a formed in said rearward face 60. By this arrangement the several plates 59^a may be relatively
110 spaced circularly and clamped in radial alignment with the work, and subsequently the individual drill units may each be adjusted radially upon its separate plate 59^a.
115 In the upper portion of each casting 102 a cylinder 103 is formed in which there operates a piston 104. Downwardly extending from the piston 104 is a spindle 107 which at its lower end carries a drill bit 68. The
120 spindle is normally held in upward position by a spring 110 but is caused to advance downwardly when air or other fluid is introduced through an opening 111 into the upper end of the cylinder 103. The spindle
125 107 is splined through a rotary sleeve 113 which may be mounted in self-aligning ball bearings 114 and is driven from the pulley 61 through a worm gear 115 and a worm wheel 116.

From an inspection of Fig. 6, it will be

seen that the belt 62 drives the alternate pulleys 61 in opposite directions. Therefore, the thrust of the worm and wheel on the sleeve is applied either upwardly or downwardly, depending upon the direction of rotation of the worm. In Fig. 7, a thrust bearing 118 is shown for receiving the downward thrust of the sleeve 113. In Fig. 10, a thrust bearing 119 is shown in a position to receive an upward thrust of the sleeve 113. In the construction employed, a slight change in the installation of the thrust bearing equips the drill for either right or left hand rotation of the pulley. The travel of the spindle and the raised position of the drill bit 68 will naturally vary with the diameter and thickness of pipe employed in the slotting machine. For adjusting the outward travel of the spindle 107, an adjustment screw 122 is provided at the upper end of the casting 102, and for supporting the drill bit 68, a vertically movable post 123 is provided having a rearwardly extending arm 124 in which a hardened steel bushing 125 is held for guiding the drill 68. The number and spacing of the drill units 59 is arranged in accordance with the diameter of the pipe and the number of torches employed.

The construction of the torches is shown in Figs. 14, 15 and 16, Fig. 14 being a section taken substantially as indicated by the line 14 of Fig. 5. The torches 49, as indicated in Fig. 14, are of standard construction except for the fact that the nozzle heads 135 thereof are of special form and are placed in close relationship to the control head 136. A particular type of bracket 137 is employed for mounting the torch on the slotted member 46, this bracket consisting principally of a post 138 which is secured to the face of the member 46 by means of a T bolt 139 which extends through the post 138 and has a nut 140 on the outer end thereof. Sliding upon the member 138 is a sleeve 142 which may be clamped in any position along the post 138 by means of a clamping bolt 143, or may be rotated thereon. Upon a cylindrical projection 145, formed upon the sleeve 142, a second clamping sleeve 146 is mounted, this sleeve being arranged to receive the barrel 148 of the torch 49 and being provided with a clamping bolt 150. The peculiar construction of these brackets enables the torches to be clamped in any direction of extension.

Oxygen is delivered to the torches 49 through a header 155 having outlets 156 and a feeder 157, through which feeder the header receives the oxygen gas, this feeder 157 being provided with a valve 158 of special construction, which will hereinafter be described. The acetylene is delivered to the torches through a header 160 which is fed by a feeder 161 having a specially constructed

valve 162. As shown in Fig. 5, water delivery and takeoff pipes 165 and 166 are provided for the purpose of delivering cooling water to the jackets 167, Fig. 14, which enclose the torch nozzles 168. These water jackets are interconnected through pipes 169 and coupling tubes 171 so that a continuous flow of water is directed through the consecutive water jackets and the overheating of the cutting tips 168 is thus prevented. As also shown in Fig. 14, pilots 170 are provided for the purpose of directing a small pilot flame 172 adjacent to each nozzle, so that the torches will be kept lighted and will be relighted in case of any backfire.

In Fig. 26 is diagrammatically represented the electrical control of the equipment and the various mechanisms thereof. Power for operating is derived originally from a three phase alternating circuit consisting of wires 460, 461 and 462, from which the spindle motor 36, the lead screw motor 57 and the drill motor 63 are supplied with electrical energy through separate sets of wires in which three pole switches 463, 464 and 465 are placed.

For the purpose of controlling and checking the action of the various parts, direct current is generated by a generator 467 driven by a three phase motor 468, fed from the three phase circuit through wiring 469, and a three pole switch 470. The generator 467 feeds a main line consisting of conductors 175 and 176, the timing switches *a, b, c, d, e, f, g, h, i, and j* are connected with the separate mechanism indicated in the diagram. The switches *a, b, c, and g* are a part of the timing device shown in Figs. 19, 20 and 21, which comprises essentially a base 180 upon which a horizontal shaft 181 supported in journals 182 is held in driven relationship through a system of reducing gears 183 with the motor 184. The reducing gear arrangement consists essentially of a worm 186 which is mounted on the shaft 187 of the motor, which worm engages a worm wheel 188 which drives a gear 190. From the gear 190 a gear 191 is driven through a removable speed ratio changing idler 192. The gear 191 is mounted upon a shaft 492 which has keyed thereon a worm 193, Fig. 20, which drives a worm wheel 194 mounted on a shaft 181. On the shaft 181 discs or rotors 195 are placed and are rigidly secured so as to rotate with the shaft 181. The rotors are suitably graduated as indicated at 197, and are equipped with annular T slots 198 which receive T bolts 199 for holding in place adjustable tooth members 200. Disposed in integrally formed brackets 205 is a shaft 206 which carries cams 208 of the type shown in Figs. 21 and 22. The members 200, it will be noticed, are of toothed formation and are arranged to engage pockets 210 formed integrally or associated with

the cams 208 in which it is preferable to provide four pockets 210 so that the cam will be rotated through an angular distance of 90 degrees at each engagement therewith by a tooth member 200.

Adjacent to each of the cams 208 is placed a switch member 215 which is shown in detail in Figs. 22 to 25. Each switch member 215 comprises a vertical post 216 which may be supported on the base 180 by means of the angle member 217 and machine screws 218. Upon the front of the post 216 a central spring contact member 220 is placed which has a dog 221 at the upper end thereof, arranged to be engaged by the cam projections 222. Between the member 220 and the post 216, a pair of flat spring members 225 and 226 are mounted, while in front of the member 220 a single contact spring 227 is mounted, all of the members 220, 225, 226 and 227 being supported between insulating plates 229 and by insulated bushings 231 and secured to the post 216 by bolts 230. It is convenient to provide an opening 232 beneath the lower ends of the spring contact members to which interconnecting wires may be soldered, as shown at 233 in Fig. 22.

In Fig. 25 a contact point 235 is shown upon the member 225, which contact member is arranged for engagement by a contact member 236 secured upon the rearward face of the spring 220. The spring member 226 is provided with a contact point 237 arranged for engagement by a point 238, which is also mounted on the spring 220. It will be noticed that the space between the pairs of contact points 235, 236, 237 and 238 is not the same and therefore when the spring member 220 is moved in the direction of the arrow 240 in Figs. 22 and 25, contact will be made between the points 235 and 236 before the contact members 237 and 238 come together. As shown in Fig. 22, a contact point 241 is mounted on the front side of the spring 220, which is arranged to engage a contact 242 mounted on the spring 227. The contacts 235 and 236 constitute a control switch, or in other words one of the switches designated in Fig. 26 as *a*, *b*, *c*, etc. The switches formed by the pairs of contacts 237—238, and 241—242 are checking switches and form part of the means for checking the operation of the specific mechanism with which they are associated.

The cam operating members 200 are mounted upon the rotors 195 in position to engage and rotate the cams 208 in proper sequence. The rotation of the members 195 is in the direction of the arrow 250 of Fig. 21, which therefore would cause a rotation of the cam 208, Fig. 22, in the direction of the arrow 251. As the cam is rotated through its quarter revolution, the sloping approach 252 to the projection 222 forces the dog 221 rearwardly, with the result that

contact is made between the points 235 and 236 and contact between the points 241 and 242 is broken. Shortly afterward when the dog 221 is brought nearer the outer face of the cam projection 222, the contact points 237 and 238 are brought together, thus closing one of the checking switches.

For an example of the operation of a control switch and checking switch system, Fig. 27 may be considered in conjunction with Figs. 14 and 22. The oxygen valve 259, Fig. 14, controlling the delivery of the cutting stream of oxygen is operated by an armature 260 impelled by a solenoid 261. On the rearward end of the armature 260 is a projection 263 which engages two spring members 264, having contacts 265 and 266 disposed at the upper end thereof. When the solenoid 261 is not energized and the armature 260 is held back by the spring 262 in the position shown in Fig. 14, the contact point 266 will rest in engagement with the point 267. When the armature is impelled forwardly in order to open the valve 259, the contact member 264 will spring forwardly, allowing the point 265 to rest against a point 268. The solenoid 261 is represented in the fragmentary diagram, Fig. 27, and the contact points 265, 266, 267 and 268 are also represented therein. The contact points 265 and 266 are connected to the line wire 176 through conductor means 270 and the contact points 267 and 268 are respectively connected by wires 271 and 272 with the contact points 237 and 241 of the timing switch member shown in Fig. 22. The contact members 242 and 238 of the switch 115 communicate with a parallel line wire 275 which leads to a solenoid trip 276 arranged to open the switch 177 when electrical energy is passed there-through. It will be seen that in event of contacts 242—241 and 268—265 being in engagement at one time, electrical energy would flow through the conductors 176 and 275 with the result that the entire system would be shut down.

Let it be considered that the cam projection 222, Fig. 22, is not in engagement with the dog 221. At this time the spring member 220 will rest in outward position with contact between the points 235—236 and 237—238 broken, and the switch comprised of the points 241 and 242 closed. Owing to the fact that the contact members 235 and 236 are separated, the solenoid 261, Fig. 14, will rest in a position to hold back the member 264, which results in the contacts 265 and 268 being opened and the contacts 266 and 267 being closed. Therefore, no current will flow between the conductors 176 and 275; but suppose that the armature at this time were stuck in forward position, the contact points 268 and 265 would then be in engagement and a closed path through

the conductors 270, 272 and 280 would be provided with the result of the actuation of the trip solenoid 276.

When engagement of a cam operating projection 200 causes the rotation of the cam 208, the switch C, consisting of the contact points 235 and 236, will first be closed as the dog 221 is forced outwardly, with the result that the solenoid 261 will be energized, causing the armature 260 to move forwardly. At this time the contact points 241 and 242 will have been disengaged due to the forcing rearwardly of the member 220, Fig. 22, and the spring member 264, Fig. 14, will have swung forwardly so that contact is made between the points 265 and 268. Shortly thereafter, upon further rearward movement of the spring member 220 under pressure of the cam, contact will be made between the points 237 and 238. If at the time this contact is made, the contact between the points 266 and 267 has not been broken due to the failure of the solenoid 261 to force the core 260 inwardly, current will flow between the conductors 176 and 275 with the result of shutting down the system.

In this manner an automatic check is at all times maintained on each mechanism of the machine, so that in event one element fails to properly operate, the machine will be shut down and an annunciator having an electromagnet 270^a is operated, thus notifying the attendant that something is wrong.

At the drop off 290, Fig. 22, of the cam projections 222, a slight slope is provided in order to provide a space of time between the opening of the contacts 235—236 and 237—238 and of the closing of the contacts 241 and 242, thus allowing ample time for the core 260 to return to the position in which it will hold the contact points 265 and 268 out of engagement. The checking switch arrangement may be designated as sets of switches X and Y, shown in Fig. 27. Therefore in Fig. 26, each of the control switches *a*, *b*, *c*, and *g* may be shown with checking switches X and Y where such use is necessary, the use thereof being indicated on the spindle index solenoid 300, Fig. 12, the lead screw index solenoid 301, Fig. 13, and the air valve solenoid 337 for the drills indicated in Fig. 18.

In Fig. 17 the valve mechanism for controlling the delivery of oxygen to the flames in the cutting torches is shown. The position of this valve is indicated by 158 in Fig. 5. A member 310 is provided with an inlet 311 and an outlet 312, which communicate with a vertically drilled opening 313, in which a valve seat 314, closed by a valve member 315, is disposed. By forcing a cap 317 downwardly against the action of a spring 318, the valve will be opened and oxygen allowed to flow. This downward

forcing of the valve is accomplished by means of a solenoid 320, which impels a core 321 having a shaft 322 extending there-through. The upper end 323 of the shaft 322 is equipped with a piston 324, which reciprocates in a cylinder 325. The cylinder is filled with a liquid material which can flow only through passages 326, controlled by a valve 327. The movement of the piston 324 is therefore controlled entirely by the rate at which the liquid in the cylinder 325 may flow through the passage 326 from one side of the piston to the other. The acetylene valve indicated at 162 in Fig. 5, is of substantially the same construction as the oxygen valve, with the exception that the piston and cylinder speed control is omitted, allowing the valve to snap open or closed. By this arrangement I am enabled to provide a lag in the closing and opening of the oxygen valve, thus permitting the acetylene flame to be lighted before the appearance of oxygen and allowing the acetylene to be shut off before the closing off of the oxygen which is desirable as it prevents formation of carbon in and on the torch tip.

The air valve indicated at 326, Fig. 6, controls the flow of air into the air header from which the leads 327 (see Fig. 7) are taken to the separate cylinders 103 of the drill units 59. This air valve shown in Fig. 18 provides a block 330 having an inlet 331 and outlets 332 and 333. Through a needle valve 334 air is directed into the inlet 331 and may flow through the outlet 332 when the valve member 336 is depressed by the action of the solenoid 337 on the armature 338. When the member 336 is forced downwardly, its valve member 340 is removed from engagement with the valve cooperating seat and its valve member 341 is brought into a position to close and prevent the passage of air through the opening 333. The rate of flow of the air is controlled by the needle valve 334, therefore determining the rate of speed at which the drill spindles will advance or, in other words, regulating the rate of feed of the drill bits into the metal walls of the pipe. The return of the spindles after the hole has been drilled is, however, not retarded, as the air may flow freely from the opening 333 when the valve member 336 is raised into a position to close the valve 340.

A valve similar to the one just described may be employed at 350 in Fig. 6 to control the delivery of air through a header 351, which feeds the air nozzles 352 employed for cooling and lubricating the drill bits during their cutting operation. An oil atomizer 354 may be employed in conjunction with the header 351, whereby fine particles of atomized oil may be intermixed with the stream of air and thus carried to the drill for the purpose of lubrication. For the pur-

pose of holding the spindle 34 and the lead screw 51 in proper indexed position, the solenoids 300 and 301, Figs. 1 and 5, are employed. The armature 380 of the solenoid 300 supports a pin 381, which is arranged to engage openings 382 in the face plate 39, which is supported upon the spindle 34, and an index plate 385 is provided upon the rearward end of the lead screw which is provided with openings 386 arranged for engagement by a pin 387. The pins 381 and 387 are applied and released in proper sequence through the action of the timing device which will be readily understood from the diagram, Fig. 26.

The check circuit for checking the action of the drills 59 differs in regard to the number of contacts employed and is merely a single contact arrangement instead of a double or multiple arrangement, indicated at X and Y. On the post 123, Fig. 7, the checking switch 400 is mounted, the details of which are shown in Fig. 11. In a hollow body 401 a ratchet 402, associated with a cam member 403, is mounted in a position suitable for engagement by pawls 404 supported by a member having outwardly extending fingers 405 and 406. It will be noticed that there are two teeth in the ratchet 402 for every projection 407 of the cam member 403, therefore, it is necessary for two teeth of the ratchet 402 to be advanced in order to bring a projection 407 into engagement and then out of engagement. The cam projections 407 are arranged to force a spring member 409 rearwardly so as to separate the contact points O and P. The members 405 and 406 may be conveniently an integral structure and the actuating pawl 404 arranged to engage and rotate the ratchet wheel when the members 405 and 406 move outwardly after being depressed.

The operation of the device is substantially as follows:

When the spindle 107 is in raised position, the cap 410 on the lower end thereof is in engagement with the member 405 and holds the same in depressed position as shown. At this time the air valve 325, controlling the flow of air to the cylinder, and the contact points 241 and 242 of the controlling switch, connected to the drill motor, are in closed position and the drill motor is not in operation. When the cam 208 is rotated for the purpose of starting the drill motor, the control switch *f*, consisting of the contact points 235 and 236, is closed and at this time the contact points 241 and 242 are separated. The drill spindle then moves downwardly and the cap 410, Fig. 11, moves out of position in front of the finger 405, allowing it to move outwardly under the action of the spring 415 with the result that the pawl 404 moves the ratchet 402 one tooth, thus bringing the cam 407 out of engagement

with the member 409 so that the switch contact at this time becomes closed. At the lower end of the spindle travel the cap 410 engages the finger 406 and forces it inwardly with the result that the pawl 404 is brought into a position in which it will engage a succeeding tooth of the ratchet 402. There can, however, be no movement of the pawl in an outward direction to cause the turning of the ratchet wheel 402 until the spindle has started upwardly and has cleared the finger 406 so as to allow it to move outwardly. At the time the cap 410 forces the finger 406 inwardly, the drill motor switch *f* is closed, the points 241 and 242 open, and the switch consisting of the points O and P closed. Let it be supposed that the spindle of the drill now considered sticks down and does not return when the air in the cylinder 103 is released. The member 406 will be maintained in depressed position therefore causing the contact points O and P to remain closed, with the result that, upon the opening of the switch *g* and the closing of the contact points 241 and 242, a circuit would be formed between the line wires 176 and 275 through the closed contacts O and P and the closed contacts 241 and 242, thus causing the operation of the solenoid trip 276 with the result of opening the switch 177.

As a safety factor a no voltage release 450 is provided for tripping the switch 177 in case the three phase feeding circuit, consisting of the conductors 460, 461 and 462, should be shut off for any reason. The spindle motor 36, the lead screw motor 57, and the timing mechanism motor 184 are respectively provided with solenoid brakes 430, 431 and 432, Figs. 1 and 20 which are electrically connected in circuit with the motors in such a manner that the brakes will be applied when the current is discontinued. In making adjustments in the setting up of the machine for the slotting of a certain size pipe, the spindle 34 must be manually rotated. Therefore, it is desirable to provide a lever 440, Fig. 1, which will operate a cam 441 in a manner to separate the brake members of the solenoid brake so that the motor may be turned manually when the propelling current is off.

The timing device is so constructed as to provide a marked flexibility in adjustment. The speed at which the shaft 181 is driven may be varied by changing the proportions between the gears 190, 191 and 192. The positions and number of the toothed operating members 200 on the disks 195 may be varied to provide the desired sequence and timing of the mechanisms constituting the slotting machine. For instance, the pipe to be slotted may be quite thick and it would be necessary to withdraw the drills several times during the drilling operation. This

may be accomplished by inserting additional toothed members 200 to give the desired repetition of operation of the drills.

I claim as my invention:

1. In a pipe slotting machine, the combination of: means for holding a pipe; a plurality of relatively spaced cutting torches disposed exteriorly of and radially with respect to said pipe with the nozzles thereof spaced in cutting arrangement relative thereto; means for supporting said torches in circular disposition around the pipe; and means for producing a relative movement between said supporting means and said pipe.
2. In a pipe slotting machine, the combination of: means for rotatably holding a pipe; a plurality of relatively spaced cutting torches disposed exteriorly of and radially with respect to said pipe with the nozzles thereof spaced in cutting arrangement relative thereto; means for supporting said torches in circular disposition around the pipe; and means for producing a relative movement between said supporting means and said pipe.
3. In a pipe slotting machine, the combination of: means for holding a pipe; a plurality of cutting torches disposed around said pipe in relatively spaced substantially radial positions; and carriage means for supporting said torches so that they may be carried relatively along said pipe.
4. In a pipe slotting machine, the combination of: means for holding a pipe; a plurality of cutting torches disposed around said pipe in relatively spaced substantially radial positions; and means, movable relative to said pipe supporting means, for supporting said torches in such a manner that they may be moved relatively along said pipe.
5. In a pipe slotting machine, the combination of: means for holding a pipe; a plurality of relatively spaced cutting torches disposed radially in cutting position with respect to said pipe; means for supporting said torches; and means for producing a relative movement between said pipe and said torches so that the cutting action of said torches will produce slots in said pipe.
6. In a pipe slotting machine, the combination of: means for holding a pipe; a plurality of relatively spaced cutting torches disposed radially in cutting position with respect to said pipe; means for supporting said torches; means for producing a relative movement between said pipe and said torches so that the cutting action of said torches will produce slots in said pipe; and means for timing said movement for the purpose of producing slots of a definite length.
7. In a pipe slotting machine, the combination of: means for holding a pipe; torches disposed in cutting position with respect to said pipe; means for supporting said torches; means for producing a relative movement between said pipe and said torches so that the cutting action of said torches will produce slots in said pipe; means for mechanically forming holes at the points where said slots are to begin, through which holes the flames from said torches pass when starting their respective cuts; and means for timing said movement for the purpose of producing slots of a definite length.
8. In a pipe slotting machine, the combination of: means for holding a pipe; torches disposed in cutting position with respect to said pipe; means for supporting said torches; means for producing a relative movement between said pipe and said torches so that the cutting action of said torches will produce slots in said pipe; and means for mechanically forming holes at the points where said slots are to begin, through which holes the flame from said torches pass when starting their respective cuts.
9. In a pipe slotting machine, the combination of: means for holding a pipe; torches disposed in cutting position with respect to said pipe; means for supporting said torches; means for producing a relative movement between said pipe and said torches so that the cutting action of said torches will produce slots in said pipe; and an exhaustor for drawing the slag from said pipe.
10. In a pipe slotting machine, the combination of: means for holding a pipe; torches disposed in cutting position with respect to said pipe; means for supporting said torches; means for producing a relative movement between said pipe and said torches so that the cutting action of said torches will produce slots in said pipe; an exhaustor for drawing the slag from said pipe; and means for introducing a spray of cooling liquid for the purpose of cooling said slag.
11. In a pipe slotting machine, the combination of: means for holding a pipe; torches disposed in cutting position with respect to said pipe; means for supporting said torches; means for producing a relative movement between said pipe and said torches so that the cutting action of said torches will produce slots in said pipe; an exhaustor for drawing the slag from said pipe; and means for introducing a spray of cooling liquid in the form of a spray at the mouth of said exhaustor for the purpose of cooling said slag.
12. In a pipe slotting machine, the combination of: means for holding a pipe; torches disposed in cutting position with respect to said pipe; means for supporting said torches; means for producing a relative movement between said pipe and said torches so that the cutting action of said torches will produce slots in said pipe;

and an exhauster consisting of an exhaust nozzle arranged to extend within said pipe and exhaust means producing a draft through said nozzle for drawing the slag from said pipe.

13. In a pipe slotting machine, the combination of: means for holding a pipe; torches disposed in cutting position with respect to said pipe; means for supporting said torches; means for producing a relative movement between said pipe and said torches so that the cutting action of said torches will produce slots in said pipe; and an exhauster consisting of an exhaust nozzle, a carriage supporting one end of said nozzle, a collector at the end of said nozzle, and an exhaust fan for drawing a draft of air through said nozzle for drawing the slag from said pipe.

14. In a pipe slotting machine, the combination of: means for holding a pipe; torches disposed in cutting position with respect to said pipe; means for supporting said torches; means for producing a relative movement between said pipe and said torches so that the cutting action of said torches will produce slots in said pipe; an exhauster consisting of an exhaust nozzle arranged to extend within said pipe and exhaust means producing a draft through said nozzle for drawing the slag from said pipe; a spray head at the mouth of said nozzle for emitting a spray of cooling fluid for cooling the slag produced by the cutting action of said torches on the metal of said pipe; and means for supplying said cooling fluid to said spray head.

15. In a pipe slotting machine, the combination of: means for holding a pipe; torches disposed in cutting position with respect to said pipe; means for supporting said torches; means for producing a relative movement between said pipe and said torches so that the cutting action of said torches will produce slots in said pipe; an exhauster consisting of an exhauster nozzle arranged to extend within said pipe, and exhaust means producing a draft through said nozzle for drawing the slag from said pipe; a spray head at the mouth of said nozzle for emitting a spray of cooling fluid for cooling the slag produced by the cutting action of said torches on the metal of said pipe, said spray head being of substantially the same diameter as said nozzle and being spaced away from the mouth of said nozzle to provide an annular opening therebetween; and means for supplying said cooling fluid to said spray head.

16. In a pipe slotting machine, the combination of: means for holding a pipe; torches disposed in cutting position with respect to said pipe; means for supporting said torches; means for producing a relative movement between said pipe and said

torches so that the cutting action of said torches will produce slots in said pipe; an exhauster consisting of an exhauster nozzle arranged to extend within said pipe and exhaust means producing a draft through said nozzle for drawing the slag from said pipe; a spray head at the mouth of said nozzle for emitting a spray of cooling fluid for cooling the slag produced by the cutting action of said torches on the metal of said pipe, said spray head being of substantially the same diameter as said nozzle and being spaced away from the mouth of said nozzle to provide an annular opening therebetween; and means for supplying said cooling fluid to said spray head, comprising essentially a force pump and duct means communicating between said pump and said spray head.

17. In a pipe slotting machine, the combination of: means for holding a pipe; cutting and feeding mechanisms cooperating in a manner to produce slots in said pipe; a power drive and checking means arranged to render all of said mechanisms inoperative on failure of one of said mechanisms to properly function, said checking means comprising a device operating in unison with all of said mechanisms and functioning to throw out the power drive with an interruption in the normal sequence of operation of the several mechanisms.

18. In a pipe slotting machine, the combination of: means for holding a pipe; cutting and feeding mechanisms cooperating in a manner to produce slots in said pipe, a timing device controlling the sequence of operation of said mechanisms; a power drive and checking means arranged to render all of said mechanisms inoperative on failure of one of said mechanisms to properly function, said checking means comprising a device operating in unison with all of said mechanisms and functioning to throw out the power drive with an interruption in the normal sequence of operation of the several mechanisms.

19. In a machine for performing a series of operations on an article, the combination of: means for holding the article; mechanisms cooperating in performance of a series of operations on said article; a power drive; timing means controlling the sequence of operation of said mechanisms; and means associated with said timing means for rendering all of said mechanisms inoperative when any one of said mechanisms fails to properly function, said last named means comprising a device operating in unison with all of said mechanisms and functioning to throw out the power drive with an interruption in the normal sequence of operation of the several mechanisms.

20. In a machine for performing a series of operations on an article, the combination

of: means for holding the article; mechanisms cooperating in performance of a series of operations on said article; a power drive; timing means controlling the operation of said mechanisms; and means associated with said timing means for rendering all of said mechanisms inoperative when any one of said mechanisms fails to properly function, said last named means comprising a device operating in unison with all of said mechanisms and functioning to throw out the power drive with an interruption in the normal sequence of operation of the several mechanisms.

21. In a machine for performing a series of operations on an article, the combination of: means for holding the article; mechanisms cooperating in performance of a series of operations on said article; timing means controlling the operation of said mechanisms; and means associated with said timing means for rendering all of said mechanisms inoperative, said means being electrically operated; switches associated with said mechanisms, arranged for operation in consequence of the operation of said mechanism, said switches being arranged to close a circuit leading to said means for rendering the machine inoperative when any one of said mechanisms fails to properly function.

22. In a machine for performing a series of operations on an article, the combination of: means for holding the article; mechanisms for performing the operations on said article; a rotary timing member independent of the machine operating mechanisms; means for driving said rotary member at a constant rate of speed; rotary cam members; switch members; cam projections on said cam members arranged to operate said switch members; and engagement means on said rotary member arranged to intermittently rotate said cam members.

23. In a machine for performing a series of operations on an article, the combination of: means for holding the article; mechanisms for performing the operations on said article; a timing member moving at a constant rate of speed; switches for controlling the operation of said mechanisms; engagement means on said timing member arranged to operate said switches in proper order to give the required sequence and duration of operation of said mechanisms; and means for checking the operation of said mechanisms, arranged to shut down said machine when any of said mechanisms fail to function in proper sequence or duration.

24. In a machine for performing a series of operations on an article, the combination of: means for holding the article; mechanisms for performing the operations on said article; a timing member moving at a constant rate of speed; switches for controlling the operation of said mechanisms; engage-

ment means on said timing member arranged to operate said switches in proper order to give the required sequence and duration of operation of said mechanisms and means for effecting the operation of said mechanisms, arranged to shut down said machine when any of said mechanisms fail to function in proper sequence or duration, said checking means consisting of primary switches operated by said timing member, secondary switches operated by the movement of said mechanisms and means correlating the action of said primary and secondary switches.

25. In a machine for performing a series of operations on an article, the combination of: means for holding the article; mechanisms for performing the operations on said article; a timing member moving at a constant rate of speed; switches for controlling the operation of said mechanisms; engagement means on said timing member arranged to operate said switches in proper order to give the required sequence and duration of operation of said mechanisms; and means for checking the operation of said mechanisms, arranged to shut down said machine when any of said mechanisms fail to function in proper sequence or duration, said checking means consisting of primary and secondary switches operated respectively by said timing member and said mechanisms and so arranged in checking circuit that said switches will alternately open said checking circuits when all of the elements of said machine are functioning.

26. In a machine for performing a series of operations on an article, the combination of: means for holding the article; mechanisms for performing the operations on said article; a timing member moving at a constant rate of speed; switches for controlling the operation of said mechanisms; engagement means on said timing member arranged to operate said switches in proper order to give the required sequence and duration of operation of said mechanisms; and means for checking the operation of said mechanisms, arranged to shut down said machine when any of said mechanisms fail to function in proper sequence or duration, said checking means consisting of a throw-out for shutting off the flow of electric current to said mechanisms, checking circuits communicating with said throw-out, primary switches operated by said timing member, and secondary switches operated by said mechanisms, the action of said primary and secondary switches being correlated when said mechanisms are functioning in such a manner that the primary and secondary switches will during alternate periods hold said checking circuits open.

27. In a device of the class described, the combination of: a holder; a plurality of gas cutting torches supported on said holder;

means controlling the relative disposition of said torches and material being operated upon; and electric means controlling the cutting operation of said torches.

5 28. In a device of the class described, the combination of: a holder; a plurality of gas cutting torches supported on said holder; means controlling a relative movement between said torches and material being operated upon; and electric means controlling the cutting operations of said torches.

10 29. In a device of the class described, the combination of: a holder; a plurality of gas cutting torches supported on said holder; and automatic means correlating the cutting operation of said torches in a manner to provide a standardized action of each torch.

15 30. In a device of the class described, the combination of: a holder; a plurality of gas cutting torches supported on said holder; means controlling the cutting operation of said torches; and automatic means correlat-

ing the operation of said torches in a manner to provide a standardized action of each torch.

25 31. In a device of the character described, the combination of: a torch; means supporting said torch in movable relationship to an article to be cut, and means for mechanically forming starting holes for the flames of said torches.

30 32. In a cutting machine, the combination of: a plurality of cutting torches disposed in cutting position relative to the work; means for producing relative movement between said torches and said work; and drills arranged to form starting holes in said work for the passage of the flames from said torches at the beginning of their respective cuts.

35 40 In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 20th day of September, 1923.

CLARENCE J. COBERLY.