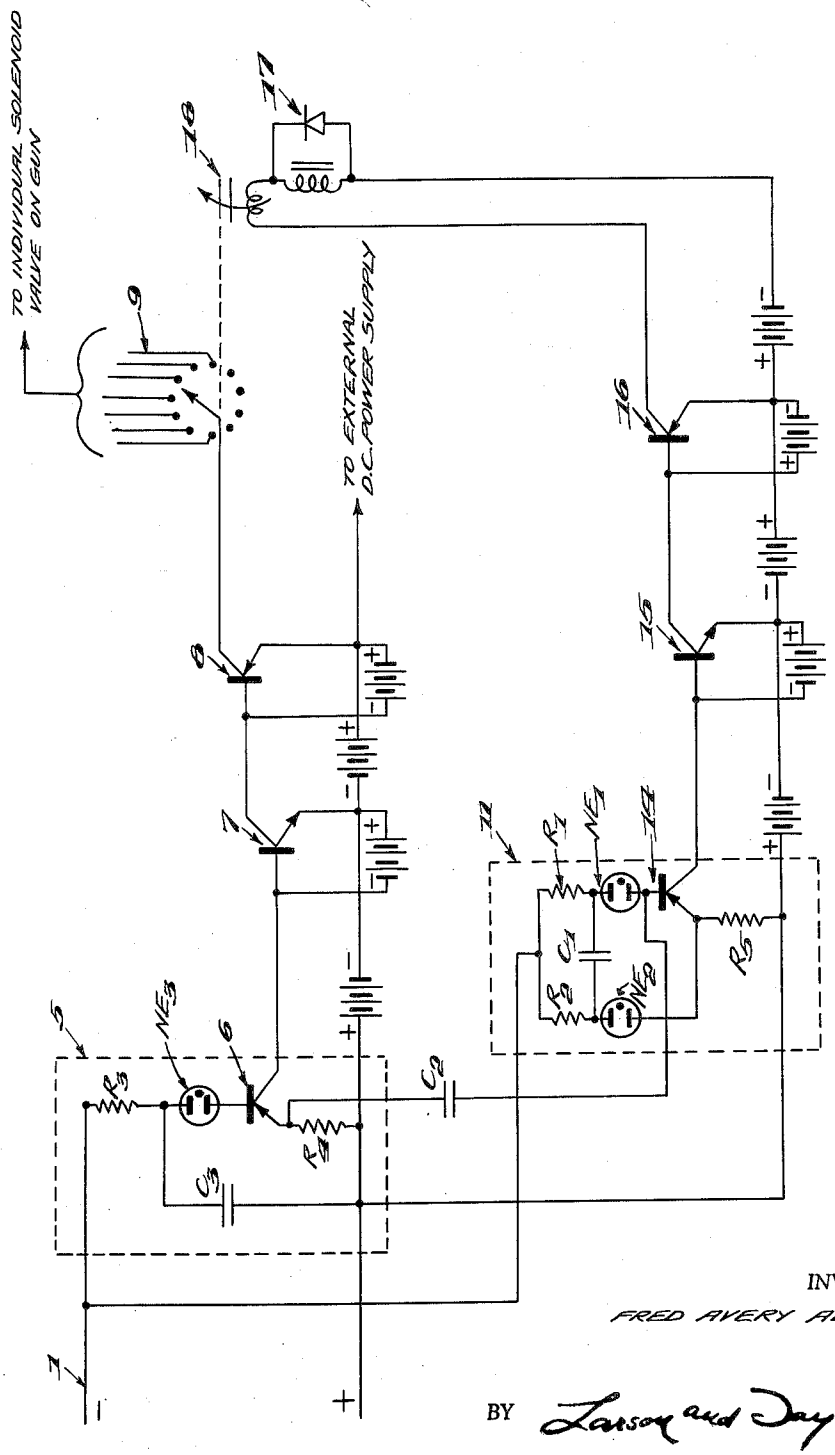
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SEMI-CONDUCTOR CONTROL CIRCUIT FOR TUYERE PUNCHER

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SEMI-CONDUCTOR CONTROL CIRCUIT FOR TUYERE PUNCHER

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This invention relates to control systems for mechanical punchers such as for example a tuyere puncher, and more particularly to a control circuit utilizing semi-conductors.

The mechanical tuyere puncher is a pneumatically powered mechanism designed to duplicate the action of man punching a converter. A converter has to be "punched" in order to keep the tuyere holes open so that the converter will "blow" adequately. Normally with man punching 3 men per shift are required to sequentially insert and retract a steel rod throughout the 48 tuyere holes. With mechanical tuyere punching, the puncher or gun inserts and retracts the steel rod. There are 48 punchers or guns mounted semi-permanently on a converter.

In the past, control systems for mechanical punchers have employed relays. However, this type of system is difficult to maintain in proper adjustment to give completely satisfactory control due to the inherent limitations of relays. First of all, the relay consists of mechanical moving parts which are subject to wear and variations due to changes in temperature, thus giving the relay changing characteristics. In addition, there is the difficulty which arises from a change in the relay contact resistance which may be brought about by vibration producing variations in the mating surfaces of the contacts, or by varying spring tension. Most important of all there is the problem of metal-oxide deposits due to constant arcing of the contacts, even though arc suppression is employed wherever possible. With the present types of relay control it is difficult to give the exact length of fire pulse required for satisfactory operation, and this is particularly true if it is desired to change the rate of operation.

It is therefore an object of this invention to provide a control system for mechanical punchers which will eliminate the need for relays with their attendant difficulties.

It is a further object of the invention to provide a control system which will have a minimum of moving parts, thus eliminating the need for frequent maintenance.

It is a still further object of the invention to provide a control system which is compact and which will provide extremely accurate control of a mechanical puncher over long and extended periods of operation.

The invention will now be described with reference to the drawing, in which the figure is a schematic drawing of a control system for a mechanical puncher according to the invention.

A regulated power supply 1 provides a constant voltage to the driven mono-stable flip-flop circuit 11 and to oscillator 5. When power is applied to oscillator 5, capacitor C3 assumes a charge through resistor R3. As soon as the voltage across C3 reaches the ignition voltage of the neon lamp NE_3, the neon conducts and dissipates the charge on capacitor C3, and the voltage across C3 will diminish. When the voltage across C3 drops to the extinguishing voltage of the neon NE_3, the neon ceases to conduct and the process starts over again. It will be appreciated that the rate of oscillation may be varied by changing

the value of the resistor R3 or the capacitor C3. In the preferred embodiment, the resistance R3 is varied by means of a potentiometer. Thus the pulse rate of the oscillator 5 may be varied so as to control the firing rate. At the same time, the length of the pulse through the neon NE_3 is determined by the length of time required for the capacitor C3 to discharge through the neon and resistor R4. Thus the pulse width may be varied by changing the caapcitor C3 or the resistance R4. Again, the resistance R4 is varied by means of a potentiometer. This serves to control the dwell time at the end of a stroke regardless of the cycling rate of the basic oscillator.

The pulse from the neon NE_3 is fed into the base of the transistor 6. This current pulse is amplified and fed into transistor 7 which by the proper bias is normally held in the cut-off state of conduction. When the current pulse from transistor 6 is amplified sufficiently to overcome the cut-off bias of transistor 7, this transistor conducts for as long as the current pulse from transistor 6 remains conducting. Likewise, transistor 8 is normally biased in the cut-off state. When transistor 7 conducts, this upsets the bias on transistor 8 so that transistor 8 conducts and energizes the solenoid valve on the appropriate air gun through the rotary twenty-four position switch 9.

The parameters of the mono-stable flip-flop circuit 11 are chosen so as to make the non-stable portion of the operation almost equal in duration to the stable portion. The resistance R1 is slightly lower than is resistor R2, so that in the normal condition of the circuit the neon NE_1 is conducting and NE_2 remains unlit. However, when a pulse of negative polarity and sufficient amplitude is applied through condenser C2 to neon NE_1, the voltage across the neon will drop below its extinguishing value. This immediately causes NE_2 to conduct until the capacitor C1 has dissipated its charge, returning the circuit to the initial condition with neon NE_1 conducting and neon NE_2 unlit.

The pulse from the neon NE_1 is fed to transistor 14 and is amplified. This pulse is further amplified through transistor 15 and transistor 16, which are connected in the same manner as described above with reference to transistors 6, 7, and 8. The pulse is then of sufficient energy to activate the motor 18 which drives the rotary switch 9. The motor 18 is of any well-known type which produces a definite angular displacement for each electrical pulse which is fed to it. However, the instant circuit 5 conducts, a pulse to circuit 11 causes conduction in neon NE_2. Thus the pulse is applied to the solenoid valve and to the motor 18 at almost the same time. Therefore, a fire pulse of any reasonable length would still be passing through the rotary switch 9 while the switch is still in operation. This would cause arcing of the contacts in the switch, so means are provided to delay the operation of the motor 18. This is accomplished by adding the inductance and diode combination 17 in series with the motor 18, which serves to delay the pulse to the motor so that the motor is energized immediately after completion of the pulse which actuates a given solenoid valve controlling pneumatic operation of the guns.

Since the pulse establishes the time for insertion and withdrawal of a punch rod, and the rod is held in the extended position for the duration of the pulse, it is important that the pulse be precise. It may be seen from the foregoing description that a control system for a tuyere puncher has been disclosed which delivers a precision pulse and which will be extremely accurate thus giving excellent control properties and eliminating the need for frequent maintenance.

It is to be understood that the arrangement shown is merely illustrative of the application of the principle of the invention. Numerous other arrangements may be de-

vised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A control circuit for actuation of mechanical punchers and the like, comprising a multi-position rotary switch, an oscillator circuit including a gaseous discharge tube having two electrodes whose breakdown and current conduction is dependent upon the potential difference impressed between said two electrodes, a source of substantially constant D.-C. potential connected through a resistor to one electrode of said tube, means including a capacitor and a resistor in series connected in parallel with said tube for causing said tube to intermittently conduct current thereby delivering a first pulse, means for amplifying said first pulse including semi-conductor devices each having a base, an emitter, and a collector, means including said rotary switch for applying said first pulse to actuate said puncher and a mono-stable multi-vibrator circuit including a pair of gaseous discharge tubes each having two electrodes whose breakdown and current conduction is dependent upon the potential difference impressed between said two electrodes, means for applying said first pulse to one electrode of one of said tubes, means including a capacitor and a pair of resistors connected across the input electrodes of said tubes for causing said tubes to alternately and intermittently conduct current when said first pulse is applied whereby a second pulse is derived, means including semi-conductor devices each having a base, an emitter, and a collector for amplifying said second pulse, and means for applying said second pulse to step said rotary switch.

2. A control circuit according to claim 1 wherein each of said resistors is variable.

3. A control circuit according to claim 1 including means for delaying said second pulse.

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