340-567

SR

XR 2,131,291

Sept. 27, 1938. C. I. MAUST 2,131,291

SIGNAL SYSTEM FOR EXCAVATORS

Filed June 16, 1936

Fig. 1

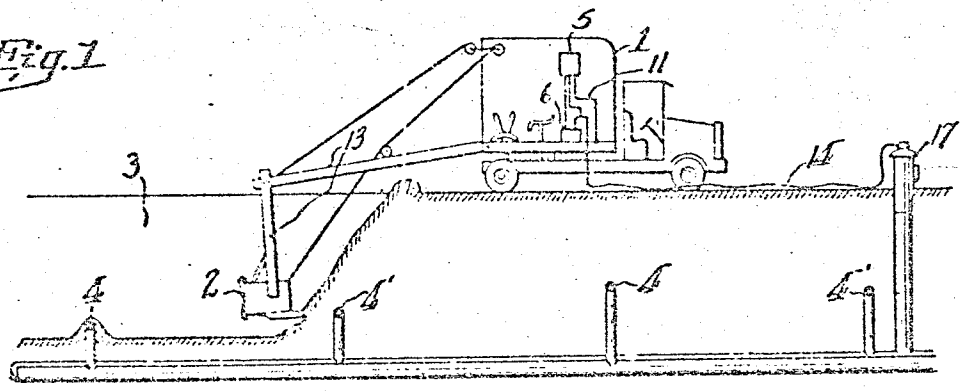


Fig. 2

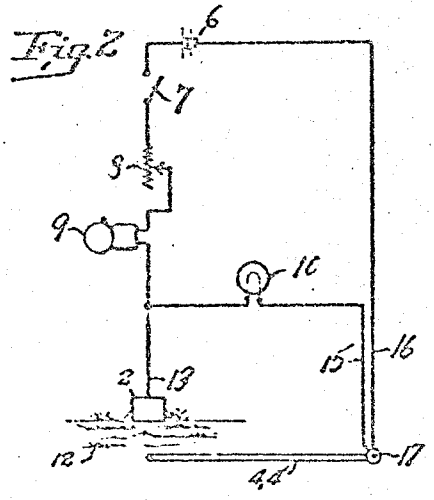


Fig. 3

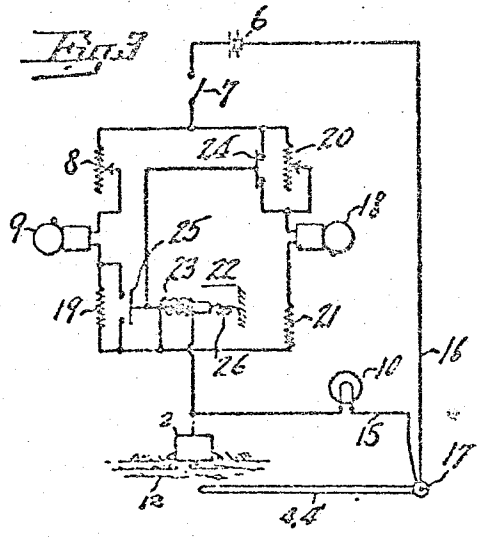
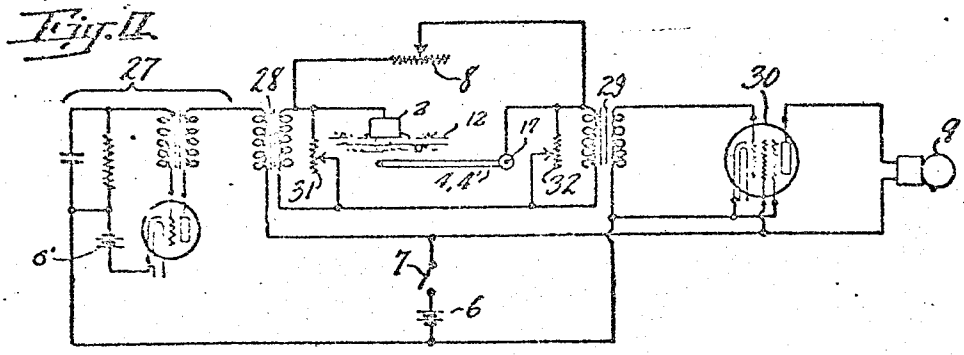


Fig. 4



INVENTOR.
Charles I. Maust,
BY Paul B. Hunter
ATTORNEY.

Patented Sept. 27, 1938 2,131,291

UNITED STATES PATENT OFFICE

2,131,291

SIGNAL SYSTEM FOR EXCAVATORS

Charles I. Maust, Summit, N. J.

Application June 16, 1936, Serial No. 85,500

12 Claims. (Cl. 177—311)

This invention pertains, generally, to electrical signal systems, and the invention has reference, more particularly, to a novel signal system adapted for use in connection with excavators used for underground work and particularly in excavating in earth and fill. The function of this invention is to indicate by signal to the operator whenever the tool part of the excavating machine approaches or contacts with existing services in the earth or fill, whereby the operator may take proper precautions to protect such services from injury.

The word service or service member, as herein contained, is intended to apply to any existing pipe, conduit, duct, wire or cable in the earth or fill useful for such services as electricity, telephone, telegraph, traffic signal systems, fire alarm systems, police communication systems, gas, water, trolley return feeds, sewers and drains. The word machine as herein contained shall be understood to apply to any machinery which is used for excavating, digging, scratching, plowing, boring, pushing or tunneling in earth and fill. The word machine shall also be understood to include such machinery as ladder type ditchers, crawler and wheel mounted types of cranes with shovels, drag line scoops, clamp shell buckets, orange peel buckets, pull scoop buckets, backhoe buckets, trench hoe buckets, post hole diggers, boring machines, tunneling machines and pushing machines. The word tool as herein contained shall be understood to apply to that part of any machine which does the actual work in the earth and fill, such as the boom and bucket, boom and shovel, or shaft and auger.

In towns and municipalities, many services generally exist under streets, walks and other plots of ground. The exact positions, directions, slopes, bends and connections of such services in most cases are not accurately known, as in some instances only general locations have been recorded and in others, records and land marks have been lost. For numerous reasons such localities must be excavated, etc., for new services, extensions, repairs, changes or replacements. Heretofore, machines for such work have been very limited in application due to the hazard of damaging existing services or due to slow, high cost operation of the machines to avoid injuring such services. This invention will permit much broader application of machines for underground work where underground services may be encountered. Some types of machines can be utilized to great advantage around services without damage thereto, providing the operator is given an indication of the approach to and contact with such services.

One object of this invention is to provide signal means for suitably indicating or signaling to the operator of the machine the relative nearness of a service as the tool approaches the same, thereby permitting fairly rapid operation of the machine until the tool gets very close to the service, whereupon the operator can exercise caution and reduce speed.

Another object of this invention is to permit an adjustment of the signal system so that the same begins to indicate at a greater or lesser distance of the tool to the services, whichever is desired, the said signal system being adaped to indicate relative distances of the tool to the services by the automatic change of sound volume, frequency or visual indication.

Still another object of this invention is to provide a novel excavator signal system that does not cause the operator to detract his attention from the operation of the tool, for whether the signal device be audible or visual, or a combination thereof, the said device is located close to and in an advantageous position for the operator, thus preventing foreign sounds such as created by the machine, trucks, trolley cars, trains, etc., from interfering with the signals.

Another object of this invention lies in the provision of a novel excavator signal system that is of simple construction and is reliable and economical in operation, the said system being adapted to be readily tested for service signal at any time to be sure that all parts are ready for operation.

Still another object of this invention is to provide for the automatic supervision of the complete circuit by way of a constant visual or audible indication.

Other objects and advantages will become apparent from the specification, taken in connection with the accompanying drawing wherein the invention is embodied in definite form.

Fig. 1 is a schematic view illustrating an excavator in use and equipped with the novel signal system of this invention.

Fig. 2 is a wiring diagram of one form of signal system of this invention.

Fig. 3 is a wiring diagram of a slightly modified form of the invention, and

Fig. 4 is a wiring diagram illustrating the preferred form of the invention.

Similar characters of reference are employed in the above views to indicate corresponding parts.

Referring now to Fig. 1 of the drawing, the reference numeral 1 designates a trench excavator having a shovel to tool 2, shown excavating the trench 3. As the tool 2 nears any of the services or service pipes 4 or 4', such as water or gas pipes or telephone cables, the novel signal system of this invention suitably indicates the same to the operator as by an audible or visible signal mounted as upon a cabinet or panel 5 within the excavator 1 in a position convenient to the operater.

In Fig. 2, showing one form of the invention, a source of electric power, such as a battery 6 or any direct current or alternating current source, is used, a battery having the advantage of permitting a self contained system mounted in a suitable box or cabinet located on the machine. A cut-off switch 7 is provided to disconnect the source of power 6 from the signal equipment for periods of idleness, while an adjustable rheostat 8 is provided for adjustment of the signal to indicate at a greater or lesser distance of the tool from the service. Resistor 8 can be replaced with voltage taps on battery 6. The signal device 9 is a low resistance, low current type of bell, buzzer, klaxon, vibrator, radio set, lamp, lamps or any device adapted to convert electric energy into audible or visible signals. A supervisory device such as a pilot lamp or a sound device 10 is provided in series with signal device 9 to indicate that the complete circuit is ready for operation. This lamp 10 is brilliant normally and reduces brilliancy as the soil resistance decreases due to the approach of the tool toward a service, and goes out when the soil resistance gets very low. A ground connection 11 for grounding the circuit to the metallic frame of the machine or excavator is provided; a part of the frame which has good metallic connection with the tool being used as the ground. Reference numeral 12 represents the resistance of the earth that is arranged in parallel with lamp 10 and which separates the tool from the near-by services 4, 4', the frame of the machine serving to conduct current from ground 11 through tool 2 to ground 12, being designated 13. A cable 14 consisting of leads 15 and 16 connects lamp 10 and battery 6 to one or more parts of the service system, such as a fire hydrant 17 or gas or water pipes in a building or street. Generally telephone cable sheaths and gas and water pipes are interconnected at many points, therefore one connection of the service to the alarm circuit is generally sufficient.

The values of voltage, resistance, current and frequency can be of numerous combination values. An example of one scheme is as follows: 6 is a 24 volt battery, 8 is a 25 ohm rheostat, 9 is a bell having a resistance of approximately 3 ohms and an operating range of .3 ampere to 3 amperes. With the rheostat 8 set at 5 ohms, the maximum current is limited to within the capacity of the bell. Lamp 10 draws but little current and hence does not cause bell 9 to operate. When the tool approaches a service to the point of reducing the soil resistance sufficiently to have an overall circuit resistance of approximately 80 ohms, the signal device is actuated and becomes audible, while the luminosity of lamp 10 decreases. As the tool approaches the service, the soil resistance of the circuit is decreased, resulting in an increase of current flow, thereby increasing the intensity and pitch of the signal device 9, and a continuing decrease in the luminosity of lamp 10. When the tool contacts with a service, the resistance of the circuit is a minimum and therefore the current and audibility of the signal equipment is a maximum, while lamp 10 goes out. Normally, actual contact of the tool with the service member is never allowed to take place because of the resultant injury to the service member. The operator lifts his tool over the service member when the signal reaches a predetermined intensity, and this usually occurs when the tool is from 1 foot to 3 inches from the service member. The reverse order follows, that as the tool is retracted the circuit resistance increases, and therefore the current and audibility of the signal equipment diminishes. This circuit can be modified to give minimum signal when the tool contacts the service and maximum signal when the circuit is open, if desired.

Fig. 3 shows an alternative scheme which contains two distinct signal devices in parallel circuits containing suitable resistors. This scheme can be broadened to any number of devices, each having different operating and sound characteristics. The additional signal device 18 is employed, such as a series type D. C. bell of 2 to 7 ohms resistance, and operates on 0.5 ampere and above. Signal device 9 in this form of the invention is similar to 18 except that 9 has a distinctively different sound characteristic, such as a cow gong or sleigh bell feature. The electrical characteristics of 9 can be the same as 18 and obtain different operating features by regulation of the resistors 8 and 19 in series with 9. Resistors 8 and 20 in the parallel circuits may be 20 ohms rheostats and resistor 19 a 25 ohm rheostat, while 21 may be a 5 ohm resistor. A series type relay 22 having an operating coil 23, a normally closed contactor 24 and a normally open contactor 25 may have the following characteristics, i. e., a 0.25 ohm resistance, one circuit closing, one circuit opening, automatic reset and operates on 1.3 amperes or more. The rheostats 8, 20, 19, 21 are set with respect to each other to give the following typical results, i. e., signal device 18 starts operating at 0.5 ampere total in the circuit, and as the tool approaches a service the total current increases with a proportionate current flowing through the two signal devices, resulting in an increase of the sound intensity of 18. When the total current reaches 1.1 amperes, device 9 starts functioning and at 1.3 amperes the relay 22 is actuated, thereby closing contactor 25 which shunts the resistor 19, and simultaneously opening contactor 24 which removes the shunt from rheostat 20. The relay operation results in a decrease of the sound intensity of device 18 and an increase of the sound intensity of device 9, and the total current increases to approximately 2 amperes. As the tool moves away from the services, the resistance of the soil part of the electrical circuit increases and the current decreases; at approximately 1 ampere the relay 22 drops out, resulting in the restoration of the original circuit by shunting the rheostat 20 due to the action of spring 26 and removing the shunt from the resistor 19.

Fig. 4 shows a preferred arrangement wherein a radio signal device is employed, consisting of a radio frequency generator, an amplifier, a microphone, a supervised volume control system and a source of electrical power. In this particular hook-up, the earth resistance acts as a part of the volume control and is located in the circuit between the generator and the ampli-

fier; however, other parts of the circuit can be used for either volume or frequency control, such as the control connected in the microphone circuit, heater circuit, or generator grid circuit. Many radio hook-ups can be made with and without tube amplification and with more stages of amplification to suit the requirements.

In Fig. 4, 6 and 6' are a source of electrical energy such as three batteries consisting of 6 volts, 22½ volts, together designated as 6, and 22½ volts, designated 6', or a 6 volt storage battery with a motor generator set for voltage conversion may be used, while 7 is a cut-off switch for the source of energy. A 200 ohm rheostat 8 is used for simulating the changes of earth resistance when adjusting the signal device for the proper signal to the desired earth resistance. Rheostat 8 contains an open-circuit point and the rheostat is normally set on this open-circuit position. A microphone or loud speaker or other sound device such as a bell 9 for conversion of electrical energy into an audible signal, or a set of relays and lamps for conversion of electrical energy into a visible signal may be employed in lieu of 9. A ground connection 11 of the control circuit to the metallic frame of the machine is used, a part of the frame which has good metallic connection with the tool being employed. The earth part of the control circuit is designated 12 and separates the tool from the near-by services. A connection of the control circuit to one or more parts of a service system, such as a fire hydrant 17 or gas or water pipe in a building or street, is employed. A conventional A. C. generator such as an audio oscillator 27 or a power driven generator is used for supplying a step-down transformer 28 in the control circuit with an audio frequency signal. Transformer 28 supplies current through ground 12 to a step-up transformer 29 in the signal control circuit. The output of transformer 29 is supplied to a conventional type of audio amplifier 30 consisting of one or more stages of amplification and having the signal device 9 in the plate circuit thereof. Resistors 31 and 32 serve for adjusting the signal volume to suit the desired indication of greater or less distance of soil separation between the tool and the services.

When the tool of the machine is not in the earth, there is enough leakage in the radio circuit to operate the device 9 or loud speaker faintly. When the tool contacts with the soil the audibility increases slightly. Under the latter condition, the operator is automatically given supervisory indication that all connections are complete and that the set is functioning. This feature is very important, as occasionally the wire connecting the signal device to the service system becomes broken or disconnected. As the tool approaches a service, the signal gets louder and louder so that, in use, the operator can tell just how near he is to a service, and hence avoid striking the same with the tool.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In combination with an excavator having a digging tool, a signal system for notifying the operator when the tool approaches a service member and the nearness of approach, comprising a signal device and a circuit for controlling the operation of the signal device, said circuit including a source of current, the excavator digging tool, the variable resistance of the layer of earth between the digging tool and the service member, and the service member, the constants of the circuit and the character of the signal device being such that the signal device is effectively operated at a predetermined distance of approach of the digging tool to the service member and is operated with increased intensity upon further approach.

2. In combination with an excavator having a digging tool, a signal system for notifying the operator when the tool approaches a service member, thereby giving the operator ample warning to prevent the tool from contacting a service member and enabling the maximum digging by an excavator without causing damage to metallic service members, the said signal system comprising a signal device and a circuit for controlling the operation of the signal device, the said circuit including a source of electrical current, the excavator digging tool, the variable resistance of the layers of earth and/or fill between the digging tool and a service member, the return connection between the said signal device and a part of the said metallic service member, and the electrical connection from the said signal device to the tool, the constants of the circuit and the characteristics of the signal device being such that the signal device is effectively operated at various predetermined distances of approach of the tool to the service member, the signal device operating continuously with increased intensity of signal as the tool moves closer to the service member, thereby signifying to the operator that the tool is working in a caution zone that may extend from a few inches to within a few feet from the service member, the range of the caution zone being predetermined by the operator, the signal device having a means of adjustment for the desired range of the zone to suit the type and condition of the earth or fill and to suit the type and speed of the excavator.

3. In a signal system for excavators having an earth excavating tool, a thermionic oscillator for producing an audio frequency signal voltage, a circuit including a transformer energized by said signal voltage, said circuit including the excavator tool, a service member and the earth extending between said tool and the service member, together with an output transformer, and an audio signal device fed from said circuit output transformer, the constants of the circuit and the character of the signal device being such that the signal is effectively operated at a predetermined distance of approach of the digging tool to the service member and is operated with increased intensity upon further approach.

4. In a signal system for excavators having an earth excavating tool, generating means for producing an audio frequency signal voltage, a circuit energized by said signal voltage, said circuit including the excavator tool, a service member and the earth extending between said tool and the service member, and an audio signal device controlled from said circuit, the constants of the circuit and the character of the signal device being such that the signal is effectively operated at a predetermined distance of approach of the digging tool to the service member and

is operated with increased intensity upon further approach.

5. In combination with an excavator having a digging tool, of a signal system for notifying the operator by means of a steadily increasing intensity of signal when the tool approaches toward a service member, said signal system comprising a signal device, means connecting one side of said signal device electrically to said tool, a source of current for said signal device, means for detachably connecting the other side of said signal device through said source of current to a service member, a conductor for connecting said one side of said signal device also to said service member, and a pilot lamp connected in said conductor due to the connection of said one side of said signal device through said tool and the earth to the service member in parallel with said lamp.

6. In a signal system for excavators, a source of electrical energy, a signal circuit connected to be energized therefrom, a signal device included in a part of said circuit, said circuit also including conducting means for connection to a service member and additional conducting means for connection to the tool of the excavator, the earth between the tool and the service member also being included in said circuit, the current in said signal circuit being gradually increased as said tool approaches the service member, whereby the signal intensity of said signal device also gradually increases, the signal commencing audible operation when the tool is at a substantially predetermined distance from the service member.

7. In a signal system for excavators, a source of electrical energy, a signal circuit including means for producing electrical alternations supplied from said source, said circuit having a portion thereof including conducting means for connection to a service member, together with a connection to the tool of the excavator, the earth between the tool and the service member being included in said circuit portion, said portion of said circuit being energized from said means for producing electrical alternations, and a signal device controlled from said circuit portion, the constants of the circuit and the character of the signal device being such that the signal is effectively operated at a predetermined distance of approach of the digging tool to the service member and is operated with increased intensity upon further approach.

8. In combination with an excavator having a digging tool, of a signal system for notifying the operator when the tool approaches a buried service member, said signal system comprising a pair of signal devices having differing operating characteristics, circuit means for electrically connecting said signal devices to said tool, a source of current for said signal devices, and means for electrically connecting said signal devices to a service member, the earth between said tool and the service member completing the circuit for said signal devices, relay means for varying the flow of current through said signal devices to cause the indication of one of said devices to predominate when the tool is relatively remote from a service member, the signal output of said device continuing with increased intensity upon further approach of the tool until the latter is at a predetermined distance from the service member, whereupon the signal output of said one device falls off sharply and the signal output of the other device predominates when the tool continues to advance relatively close to the service member.

9. In combination with an excavator having a digging tool, of a signal system for notifying the operator when the tool approaches a buried service member, said signal system comprising a pair of signal devices of differing operating characteristics, a series multiple circuit having said signal devices respectively connected in the respective parallel legs thereof, a source of current connected in the series portion of said circuit, said circuit series portion having one side thereof arranged for removable connection to a service member and the other side thereof connected to said digging tool, the earth between said tool and the service member completing the circuit for said signal devices, the constants of the circuit and the character of the signal devices being such that the signal devices are effectively operated at predetermined distances of approach of the digging tool to the service member, said signal devices operating with differential intensities upon further approach.

10. In combination with an excavator having a digging tool, of a signal system for notifying the operator when the tool approaches a buried service member, said signal system comprising a pair of signal devices, a series multiple circuit having said signal devices respectively connected in the respective parallel legs thereof, a source of current connected in the series portion of said circuit, said circuit series portion having one side thereof arranged for removable connection to a service member and the other side thereof connected to said digging tool, resistors arranged to be included in said parallel legs, and relay means, responsive to the current flow in the series portion of said circuit, and operating, when the current therethrough reaches a predetermined value, for shunting a resistor of one of said legs while inserting a resistor of the other leg therein.

11. In combination with an excavator having a digging tool, of a signal system for notifying the operator when the tool approaches a hidden service member, said signal system comprising an oscillator, circuit means energized from said oscillator, said circuit means including said digging tool and an available service member in series therein, the earth between said digging tool and the service member constituting a part of said circuit means, a thermionic amplifier controlled from the A. C. output of said circuit means, and a signal device connected in the output of said amplifier.

12. In combination with an excavator having a digging tool, of a signal system for notifying the operator when the tool approaches a hidden service member, said signal system comprising an audio oscillator, circuit means including said digging tool, an available service member and the intervening earth in series therein, a transformer for supplying energy from said oscillator to said circuit means, an amplifier having an audible signal device in the output thereof, and a transformer for coupling the A. C. output of said circuit means to said amplifier.

CHARLES I. MAUST.