Sept. 30, 1947. E. M. BOARDMAN 2,428,007

TELEPHONE CALL-INDICATING FACILITIES

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FIG. 1

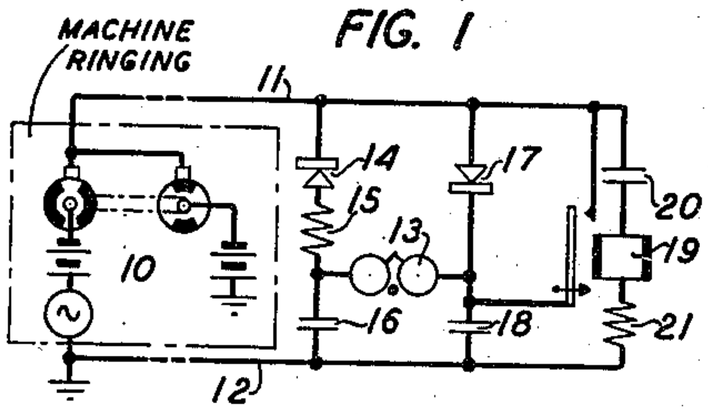


FIG. 2

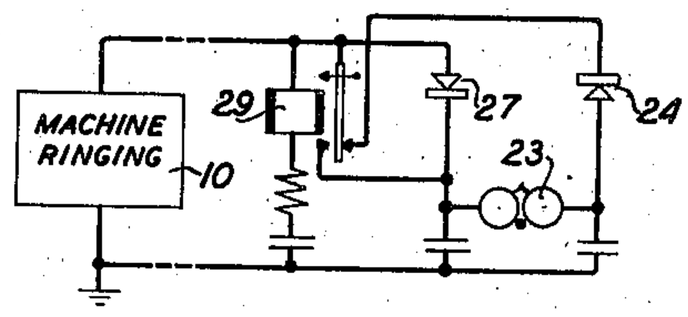


FIG. 3

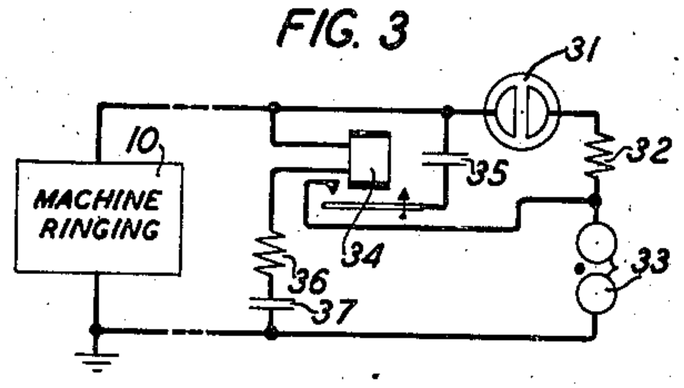


FIG. 4

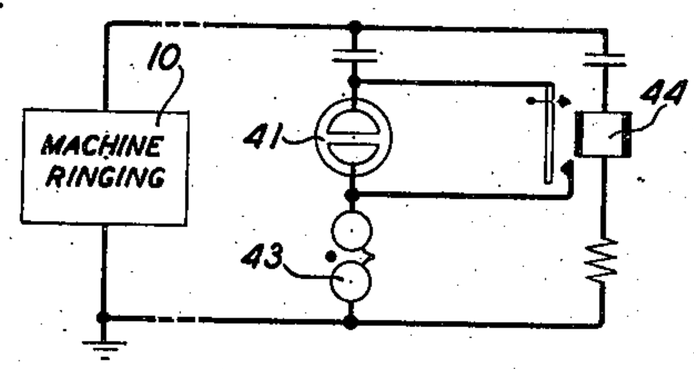


FIG. 5

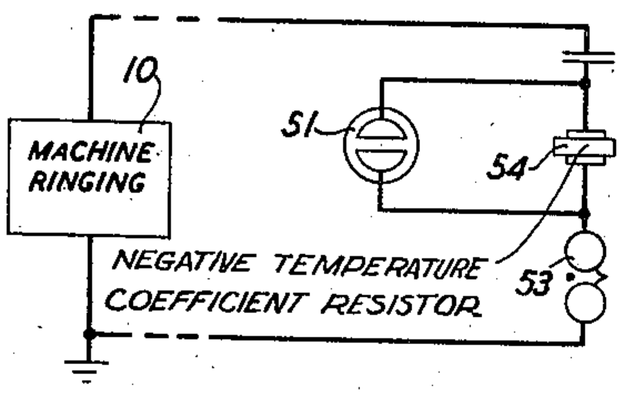


FIG. 6

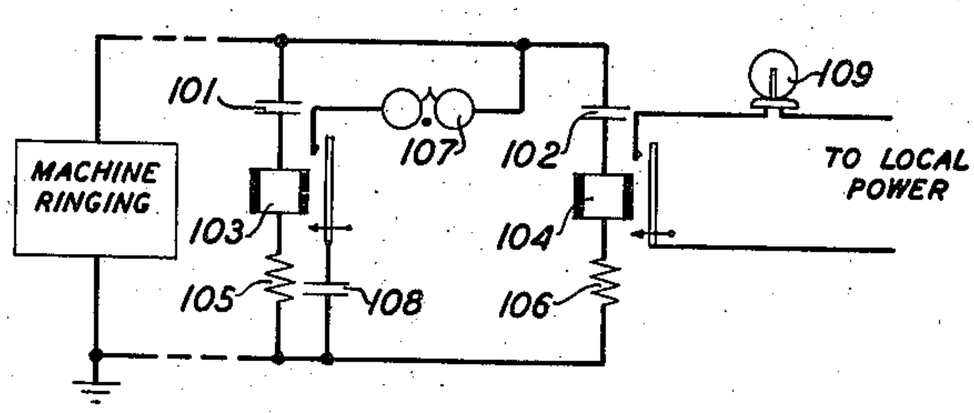
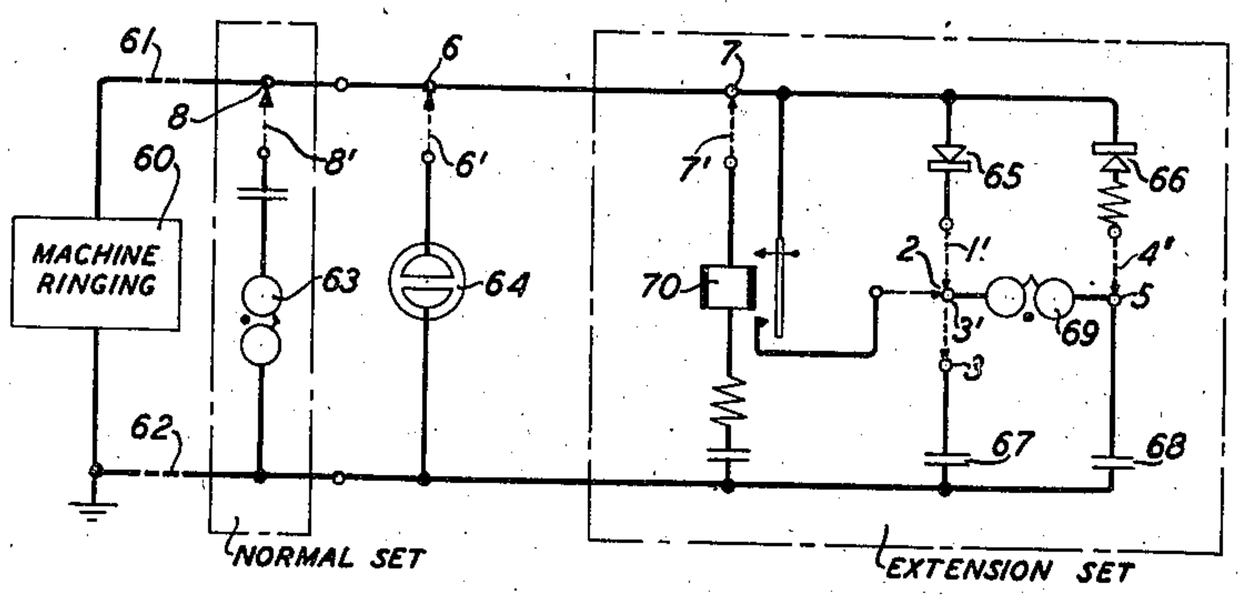


FIG. 7



INVENTOR
E. M. BOARDMAN
BY
A. F. Kane
ATTORNEY

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TELEPHONE CALL-INDICATING FACILITIES

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FIG. 8

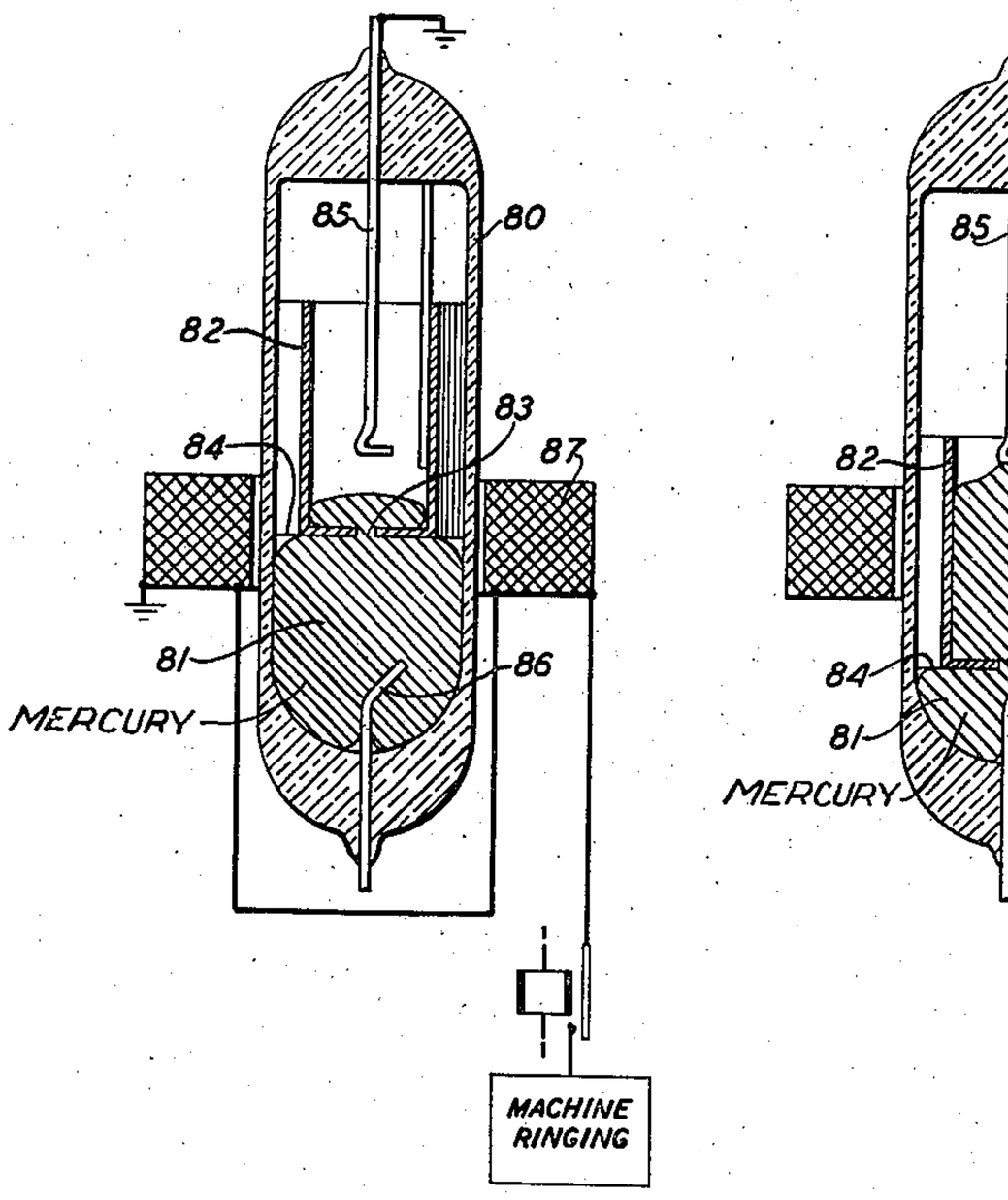
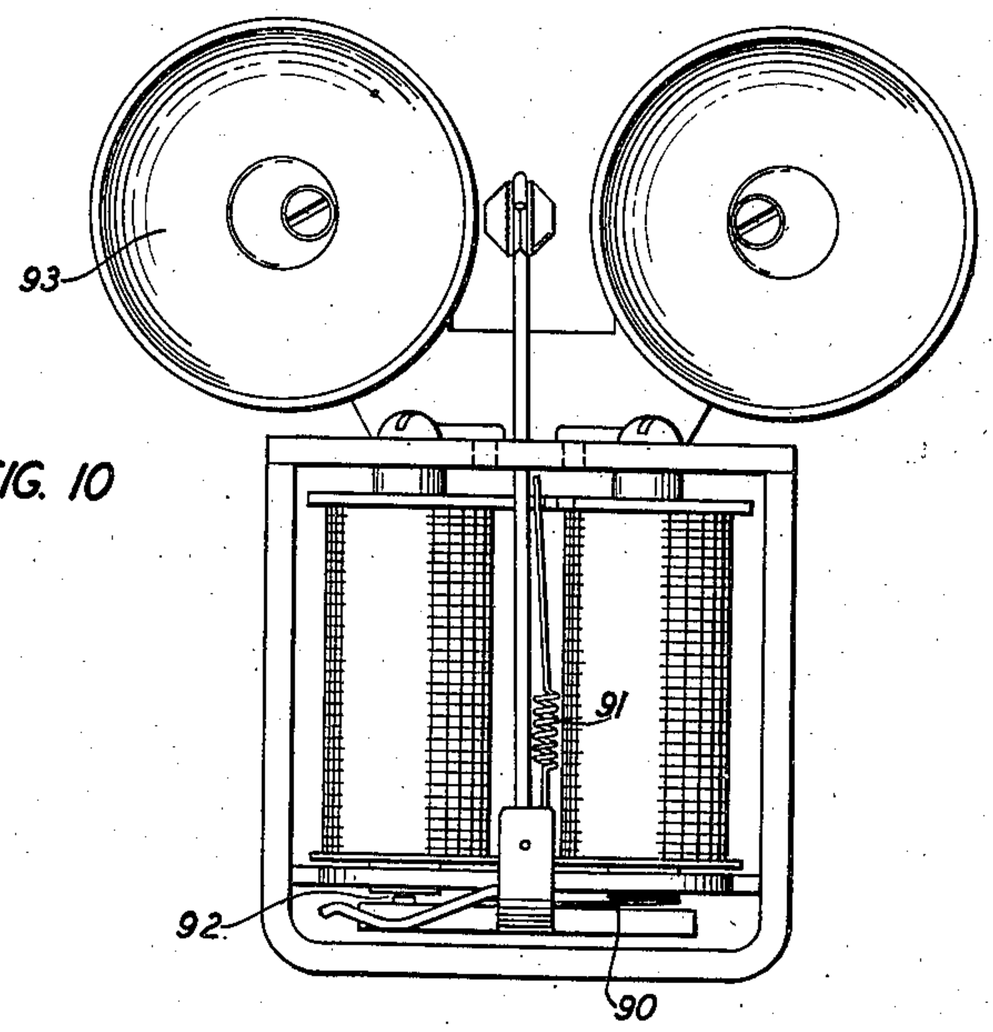


FIG. 9

FIG. 10



INVENTOR
E. M. BOARDMAN
BY G. F. Kane
ATTORNEY

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UNITED STATES PATENT OFFICE

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TELEPHONE CALL-INDICATING FACILITIES

Edward M. Boardman, Mountain Lakes, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application December 1, 1944, Serial No. 566,053

9 Claims. (Cl. 177—7)

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This invention relates to signaling facilities for use at telephone subscribers' stations and particularly to call-indicating facilities which function to indicate at a subscribers' station or at an extension set associated therewith, the arrival of a telephone call by time spaced signals of distinctive characters.

The signaling equipment commonly used at telephone subscribers' stations comprises an electromagnetic device, generally characterized as a ringer, which responds to each application of ringing current to the subscriber's line to produce sound signals of uniform intensity. While such signals function satisfactorily, it has been found desirable in some instances to furnish a call signal at subscribers' stations which is less startling in its attention-arresting quality. Obviously, such a requirement could be met by the simple expedient of muffling the sound signal at the subscriber's station or by designing a ringer having a relatively low sound output. Such a solution of the problem, however, introduces the possibility that the tone signals would be of such a subdued character as to be useless in arresting the attention of the subscriber when located at any appreciable distance from the telephone with the inevitable result that numerous calls incoming to the station would go unanswered and would be lost.

It is the object of this invention to provide call-indicating equipment for use with a telephone subscriber's telephone set or as an extension set associated therewith, which responds to the application of signaling current to the subscriber's line so as to indicate the arrival of a call first by a signal, at the telephone set, of low attention-arresting quality, and subsequently, either at the telephone set or at an extension set by a signal of higher attention-arresting quality.

This object is attained in accordance with a feature of the invention by the provision of signaling facilities which render it possible for a single audible signaling device to operate and emit sound signals of different characters at time spaced intervals at a telephone subscriber's station, or to supplement the regular audible signal at a subscriber's station with either visual or audible signals at an extension set, the latter signals having a higher attention-arresting quality than the regular signal associated with the subscriber's telephone set.

The signaling facilities contemplated by this invention are desirable not only at subscribers' premises which are equipped with a single telephone, but also find particular utility in many

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locations at which there are located a plurality of independent telephones, in that the supplementary signal of higher attention-arresting quality affords a positive identification of the line on which a call has arrived. In the latter case the supplementary signaling equipment may be furnished as an extension set and located either in close proximity with the telephone set or at a distance therefrom so that positive identification of the called line may be given the subscriber when he is located at a point remote from his telephone.

The invention will be readily understood from the following detailed description made with reference to the accompanying drawings in which:

Figs. 1, 2, 3, 4, 5 and 6 illustrate diagrammatically several embodiments of the invention which provide two distinct types of call signals at time-spaced intervals;

Fig. 7 is a circuit diagram showing a number of signaling facilities arranged for mounting in an extension set, and indicates a plurality of possible connections which may be effected to produce different signaling arrangements;

Fig. 8 is a schematic representation of a slow-to-operate switching device which is particularly suitable for use in the circuits shown in Figs. 1, 4, 5 and 6;

Fig. 9 shows the switch of Fig. 7 fully operated; and

Fig. 10 illustrates a ringer design which is particularly suitable for use as the audible signal in the circuit shown in Fig. 3.

It is to be understood that the signaling facilities illustrated in Figs. 1, 2, 3, 4, 5 and 6 may be used not only as replacements for the regular ringer equipment located at a subscriber's station, but also may be housed in a separate container as an extension set and located at a point remote from the subscriber's telephone, if conditions warrant it.

In Fig. 1 there is shown at 10 a source of machine ringing current which is generally located at a central office. The telephone line extending from the central office to a subscriber's station comprises the tip and ring conductors 11 and 12, respectively. The equipment shown to the right of the source 10, as hereinbefore indicated may replace the regular ringer equipment at the subscriber's station or may be housed in a separate container and located elsewhere on the premises as an extension set. For descriptive purposes only, it will be assumed that this equipment replaces the usual ringer equipment. As the station a ringer 13 of well-known design is connected across two

branch circuits each of which is bridged across the tip and ring conductors 11 and 12 of the subscriber's line. One circuit includes a dry rectifier 14, a resistance 15 and a condenser 16. The other circuit includes a dry rectifier 17 and a condenser 18. One ringer terminal is connected to a point between the resistance 15 and the condenser 16, while the other terminal of the ringer is connected to a point between the rectifier 17 and the condenser 18. The rectifiers 14 and 17 are poled oppositely. A slow-to-operate switch 19 is connected across the tip and ring conductors 11 and 12 of the subscriber's line in series with a condenser 20 and a current limiting resistance 21. The armature and contact of the switch or relay 19 are so connected in the circuit that they effectively short-circuit the rectifier 17 when the relay is fully operated.

The rectifiers 14 and 17 and the condensers 16 and 18 are so interconnected with respect to the ringer 13 that they function as a voltage doubling arrangement. In accordance with the theory of operation of the voltage doubling arrangement, the condensers 16 and 18 are alternately charged from the alternating current from source 10 to the same polarity through the rectifiers 17 and 14, so that voltages approximately equal to the peak value of the alternating current source are maintained across each condenser. Since the condensers 16 and 18 are in series with respect to the ringer 13, the ringer is subjected to an operating direct current voltage substantially equal to twice the voltage of the alternating current source and this voltage is maintained as long as the alternating current is applied. Since, by design, the ringer is the well-known polarized type of device, it operates upon the application of the machine ringing source to the line to cause its clapper to strike one of its associated gongs. When the signaling current is interrupted, the ringer is deenergized and the biasing spring of the ringer restores the clapper to its normal position against the other gong causing the said other gong to be actuated. Thus, if the ringing current is connected to the line for two (2) seconds and disconnected therefrom for four (4) seconds in accordance with usual practice, each gong of the ringer will be struck once every six (6) seconds. This operation of the ringer produces an audible signal of low attention-arresting quality.

Before proceeding further with the description of the operation of the circuit shown in Fig. 1, it may be well to refer to Figs. 8 and 9 which illustrate a preferred form of slow-to-operate switch which may be used as the slow-to-operate switch conventionally illustrated at 19 in Fig. 1.

The switch shown in Figs. 8 and 9 functions to effect a circuit closure in response to a predetermined number of spaced impulses impressed on its winding.

The structure of this switch includes a sealed vertical tube 80 having a pool 81 of mercury in the bottom and a hollow cylindrical armature 82 open at the top and closed at the bottom except for a small orifice 83. In its normal position, as shown in Fig. 8 the bottom of the armature is forced down against the surface of the mercury pool 81 by means of a limiting stop 84 so that a small portion of the mercury rests within the armature 82 and in physical communication, through the small opening 83 in the bottom, with the remainder of the mercury mass in the tube below. One terminal 85 of the switch projects down from the top of the tube into the interior

of the armature while the other switch terminal 86 projects up from the bottom of the tube into the mercury mass 81. When the operating coil 87 of the switch is energized for an interval by a pulse of current from the machine ringing source the armature 82 is forced down against the mercury pool 81, causing a corresponding amount of the mercury to flow up through the orifice 83 into the armature. On the next open period of the coil, the forces of surface tension in the mercury cause it to flow back through the orifice, moving the armature upward toward its normal position. By choosing the length of the current impulses and the length of the spacing between them, the level of the mercury within the armature may be made to rise and fall successively, each rise exceeding somewhat the succeeding fall, thus causing the surface of the mercury within the armature to approach stationary terminal 85. After the desired number of impulses have been received, the surface of the mercury engages the end of the contact 85 and clings thereto by adhesion. On the succeeding fall of the mercury level, the force of adhesion causes the mercury body to become displaced so as not to break the contact that has been established. On the next few succeeding interruptions in the operating current the level within the armature may fall somewhat below the stationary terminal, but the adhesion of the mercury to the terminal serves to maintain constant engagement until the general level of the mercury rises above the end of the terminal and the armature reaches its full downward position. Thus the circuit once established is safeguarded against opening. Obviously, when the energizing source is disconnected for any appreciable time the armature restores to its normal position and the circuit is opened.

Reverting back to Fig. 1, the slow-to-operate switch just described responds in a step-by-step manner to the successive applications of signaling current to the line and after a predetermined number of such applications, the switch contacts are closed to effectively short-circuit the rectifier 17. Thus, the ringer is subjected to periodic impulses of one polarity which traverse the rectifier 14, resistance 15, ringer 13 and condenser 18, whereupon each gong of the ringer is struck once for each half-cycle of current passed by the rectifier 14. One gong is struck upon the application of each half-cycle of current to the line and the other gong is struck between successive half-cycles of the same polarity by virtue of the clapper restoring action of the ringer biasing spring.

Thus the ringer 13 is operated to emit a preliminary audible signal of low attention-arresting quality and, after a predetermined interval of time, that is, when relay 19 operates, it is operated to emit a secondary audible signal of greater intensity. When the subscriber responds to the signal, the ringing current is tripped in the well-known manner whereupon the ringer 13 is silenced and the switch 19 restores to normal.

The condenser 20 in series with the winding of the switch 19 is used for direct current blocking purposes. The resistance 15 is provided to reduce the over-all shunting effect of the condenser 16 when the switch 19 operates to short-circuit the rectifier 17.

For purposes of simplicity, the telephone sets at the subscribers' stations of Figs. 1, 2, 3, 4, 5 and 6 have not been illustrated.

The circuit of Fig. 2 is substantially identical to that of Fig. 1, except that the slow-to-operate re-

lay 29 is provided with a transfer contact arrangement so that when the relay operates, the circuit to rectifier 24 is opened, the rectifier 27 is short-circuited and the ringer 23 is connected directly across the line by way of the front contact and armature of relay 29.

The preliminary signal emitted by the ringer 23 is identical to the preliminary signal emitted by ringer 13 (Fig. 1), but the secondary signal is produced by both half cycles of applied current since both rectifiers 24 and 27 are rendered ineffective by the operation of switch 29.

While the switch illustrated in Figs. 8 and 9 is not shown equipped with a transfer contact and therefore would not function in Fig. 2, it is to be understood that any slow-to-operate switch having armature controlled front and back contacts will serve in its place. The particular design of slow-to-operate switch does not, of itself, constitute a part of the present invention and the design illustrated in Figs. 8 and 9 has been described merely as an example of one type of switch particularly suitable for use in the circuits of Figs. 1, 4, 5 and 6.

Fig. 3 illustrates an arrangement whereby the preliminary ring is at a twenty-cycle rate on only one gong of the ringer, twenty cycles being the frequency of the alternating current source included in the machine ringing supply 10. For this purpose a ringer of the design illustrated in Fig. 10 may be used. This ringer is similar in design to the ringer illustrated in United States Patent 2,269,108 to J. D. Hubbell and C. F. Wiebusch and differs therefrom in that the leaf spring 90 is placed on the stop side of the armature air-gap; in other words the spring 90 is positioned on the ringer structure to oppose the normal bias spring 91 and to leave a small space at 92 available on the stop side.

A gas-filled tube 31 is connected in series with the ringer 33 by way of a current limiting resistance 32 and is poled to pass pulses through the ringer in such a direction as to pull the armature up on the stop side, that is, so as to cause the clapper to strike gong 93 (Fig. 10). This produces a low volume ring on this gong as a preliminary signal of low attention-arresting quality. The relay, or switch 34, functions after a predetermined interval of time to effectively short-circuit the rectifying tube 31 and to connect the ringer 33 directly to the line by way of the condenser 35. The ringer then functions in a manner such that both gongs are struck by the ringer clapper. The tube 31, when activated also acts as a preliminary visual signal.

The resistance 36 and condenser 37 in circuit with the winding of switch 34, serve the same purposes as do resistance 21 and condenser 20, respectively, of Fig. 1.

While Fig. 4 is substantially identical to Fig. 3, it is intended to illustrate the use of a glow lamp 41 which is non-rectifying in its operating function, whereas the tube 31 of Fig. 3 functions as a rectifier to control the sound signal emitted by the ringer 33. In Fig. 4 the tube 41 is connected in series with ringer 43 and functions as a visual signal when the ringing source 10 is connected to the subscriber's line. After a predetermined time interval the delay switch 44 operates to short-circuit the visual signal 41 and to connect the ringer 43 directly to the line whereupon the ringer operates in a normal manner to give forth a secondary audible signal. It will be noted that the current which traverses the visual signal 41 also passes through the ringer so that the ringer may function as a preliminary audible signal if the magnitude of the current is sufficient to cause the operation of the ringer clapper. However, the ringer under this condition will operate only in a subdued manner. By adjusting the value of the tube current the operation of the ringer as a preliminary audible signal may be prevented, if desired.

Fig. 5 distinguishes from Fig. 4 essentially only in the substitution of a resistor 54, having a negative temperature coefficient of resistance, for the slow-to-operate switch 44 of Fig. 4. The resistor 54 is connected in parallel with the lamp 51 and in series with the ringer 53. The characteristics of this resistor are such that when it is cold its resistance is so high as to prevent sufficient current to pass through the ringer 53, but with the passage of time, its resistance drops to a negligible value and the ringer operates at full intensity. When the resistance of resistor 54 reduces to a negligible value the lamp 51 is effectively short-circuited. The same types of signals are obtained from the circuit arrangement of Fig. 5 as are obtained from the circuit arrangement of Fig. 4.

In some cases it may be desirable to provide a preliminary visual signal of greater intensity than can be obtained with the visual signal devices mentioned hereinbefore. The circuit of Fig. 6 provides such a service. In this showing the subscriber's line is bridged by two ringing current responsive circuits each including a condenser 101 or 102, a slow-to-operate relay 103 or 104, and a current limiting resistance 105 or 106. Relay 103, when operated, connects the ringer 107 in series with condenser 108 across the line. Relay 104, when operated, connects the lamp signal 109 to a local source of power. The relays 103 and 104 may be of the type shown in Figs. 8 and 9 and adjusted so as to have different time operate characteristics. With the relay 104 adjusted to operate quicker than relay 103 it is obvious that upon the application of ringing current to the line for a brief interval of time the lamp 109 will be lighted as a visual signal of relatively high intensity. Subsequently, relay 103 operates to connect the ringer to the line causing it to give a secondary audible signal. When the call indicated by the operated signals is answered the ringing current is tripped in the well-known manner and the signals are rendered inoperative.

The signaling arrangement shown in Fig. 6 may be modified in accordance with the requirements of the subscriber to provide, for example, the usual ringer signal followed by a visual signal. In this case the extension set would supplement the normal set and would include the condenser 101, slow-to-operate relay 103, current limiting resistance 105, all connected across the line, a lamp signal 109 and a power circuit control relay. The normal ringer would respond to the incoming signaling current to give the usual audible signal and the slow-to-operate relay 103 would, after a predetermined interval of time, operate to connect the power circuit control relay to the line so as to subject it to the incoming signaling current. This relay responds to the incoming signaling current to complete a local power circuit which includes the lamp signal 109. Thus, if the normal ringer signal is not answered within the predetermined interval of time, the lamp signal would be actuated to provide a secondary visual signal. Such a lamp signal could be located at some distance from the telephone with which the normal ringer is associated, if desirable.

Obviously, the signaling arrangement of Fig. 6,

as well as those of the preceding figures may be used as substitutes for the regular signaling device at a telephone station or may be housed in separate containers as extension sets for location elsewhere on the subscriber's premises and to supplement the regular ringer at the subscriber's station. In the latter case, the regular ringer would respond immediately to the ringing current applied to the line and if the call is unanswered, the ringer signal would be followed by the operation of the visual signal 109 and of ringer 107 in that order at the locality of the extension set. It is to be understood that the extension sets may be located anywhere in the subscriber's premises and need not be closely associated with the subscriber's telephone.

The arrangements thus far described illustrate various means for obtaining time-spaced telephone call signals of different attention-arresting qualities. It is apparent that the various signals may be combined in manners other than those described. It is also apparent that the facilities described are particularly suitable for installation as extension sets and also as substitutes for the regular signaling equipment located at a subscriber's station.

In Fig. 7 several of the ringing facilities previously described are illustrated as housed in a separate housing constituting an extension set with switching means for connecting the various elements to the subscriber's line in different combinations. The arrangement illustrated serves primarily as a means for conveniently demonstrating to a prospective subscriber several different types of signals which are available to him and which embody the idea of providing a preliminary signal of low attention-arresting quality followed by a signal of greater intensity. The manual switching devices are represented by broken lines terminated by an arrow-head.

To the left of the broken line box shown in Fig. 7 there is indicated the regular machine ringing source 60 which is located at a central office and which, in a well-known manner, is connected to the line conductors 61 and 62 extending to a subscriber's station. The manually operable switching devices are designated 1', 2', 3', 4', 5', 6', 7' and 8'. If it is desirable that the subscriber's station be furnished with the regular audible type of signal only, the switch 8' would be closed to the point 8 on the line conductor 61 and all other switches illustrated would be opened. Under this condition the ringer 63 would respond to the application of signaling current from the source 60 to the subscriber's line 61—62, in the well-known manner, and its operation would cease when the ringing current was tripped in the usual manner when the subscriber answered the call.

Should it be desired that a visual signal be provided which responds to the incoming ring at the same time that the ringer 63 operates, then the switch 6' would be closed to the point 6 on the line conductor 61 to effectively connect the gas tube 64 in parallel with the ringer 63 across the line. Obviously, both the ringer 63 and the tube 64 respond simultaneously to the signaling current from the source 60 to provide both audible and visual indications of an incoming call.

To provide a subdued audible signal only, switch 1' is operated to the point 2, switch 3' to the point 3 and switch 4' to the point 5, and all other switches are opened. Under these conditions the rectifiers 65 and 66, condensers 67 and 68 and the ringer 69 are connected across the line 61—62, as a voltage doubling arrangement similar to that shown in Fig. 1, except that the slow-to-operate switch 70 is not connected to alter the signal after the elapse of a predetermined interval of time. This circuit arrangement results in the operation of the ringer 69 in a manner such that each ringer gong is struck once every six seconds, assuming the ringing current to be connected to the line for two seconds, and disconnected therefrom for four seconds, as described in connection with Fig. 1.

The subdued signal described in the preceding paragraph may be followed by a sound signal of greater attention-arresting quality by operating switch 7' to the point 7 and switch 2' to the point 2. Thus with switches 1', 2', 3', 4' and 7' operated, the circuit arrangement shown in Fig. 1 is effected, and as described in connection with Fig. 1, the ringer functions first, to emit a sound signal of low attention-arresting quality as a preliminary signal and then, after a predetermined time interval, it functions to give forth a signal of greater intensity.

With switch 6', switch 7', and switch 2' closed to their respective contact points 6, 7 and 2 and all other switches open, the tube 64 would function as a preliminary visual signal and after a predetermined time interval, switch 70 would function to connect the ringer 69 and condenser 68 across the line to cause the ringer to emit an audible signal.

By operating switch 8' in place of switch 6' in the previous paragraph, the ringer 63, which may be adjusted to produce a signal of reduced sound intensity would operate as a preliminary audible signal of low attention-arresting quality and after a predetermined time interval the switch 70 would function to connect the ringer 69 in circuit.

The ringer 63 is illustrated in Fig. 7 as being connectable to the line through the medium of a switch 8' merely for purposes of simplification of the description of the various combinations of signals obtainable. Actually this ringer would be permanently connected to the line at a subscriber's station in the well-known manner, and in demonstrating the possibilities of the extension set and of the signal combinations obtainable thereby the normal connection of the ringer at the telephone set would be opened or closed as desired.

What is claimed is:

1. The combination, in a signaling system, of a line, a source of current, a signal device, means connecting said signal device to said line by way of a branch circuit having electric characteristics such that said signal device is caused to operate in a particular manner as a preliminary signal when said source of current is connected to said line, and electromagnetic time delay means responsive to current from said source for altering the electric characteristics of said connecting means, whereby said signal device is caused to operate in a different manner by current from said source, as a secondary signal.

2. In a telephone signaling system, a line circuit, a station thereon, a signal device at said station, a source of signaling current, a circuit normally connecting said signaling device to said line and in which said signaling device operates in a particular attention arresting manner upon the application of current from said source to said line, and electromagnetic switching means responsive to the application of current from said source to said line and effective a predetermined interval of time after the said application

for altering the electric characteristics of said normally connected circuit, whereby said signaling device is operated in a different attention arresting manner by current from said source.

3. In combination, a station, an audible signal device at said station, a line on which said station is located, a source of signaling current, a current rectifying device, a circuit bridged across said line including said signal device and said current rectifying device, and time delay means responsive to current from said source when applied to said line, for effectively excluding said current rectifying device from said bridged circuit.

4. In combination, a station, an audible signal device at said station, a line on which said station is located, a source of signaling current, a circuit connecting said signal device to said line comprising a pair of parallel arms connected across said line, each arm including a half-wave rectifier and a condenser and each having a point intermediate its respective rectifier and condenser to which opposite terminals of said signal device are connected, a time delay device responsive to current from said source when applied to said line, and means controlled by said time delay device for effectively connecting said signal device to said line independent of said rectifiers.

5. In combination, a line, an audible signal having an operating winding, a source of signaling current, means connecting said audible signal to said line comprising a voltage doubler of the rectifier type consisting of two series circuits each including a unidirectional current conducting device and a condenser connected across said line with the winding of said signal device connected between said circuits to a point in each circuit between its respective unidirectional current conducting device and condenser, and means responsive to the application of current from said source to said line for a predetermined interval of time for short-circuiting one of said unidirectional current conducting devices.

6. The combination, in a signaling system, of a line, a ringer comprising a pair of gongs, a striker, a restoring spring for said striker and an operating winding, a source of alternating signaling current adapted to be connected to said line at repeated time intervals, circuit means connecting the operating winding of said ringer to said line and including rectifying means which function to cause the operating winding of said ringer to be energized once for each application of current from said source to said line, whereby said striker actuates one of said gongs for each application of current to said line and actuates the other gong, under the restoring action of said spring, for each disconnection of said source of current from said line, and means operating in response to a predetermined number of applications of current from said source to said line to disable the rectifying means of said circuit connecting means whereby said striker functions to repeatedly actuate both said gongs during each application of current from said source to said line.

7. The combination, in a telephone signaling system, of a telephone line, an electromagnetically operated ringer connected to said line, a source of signaling current, rectifier means connected in circuit with said ringer for causing said ringer to operate in a particular attention arresting manner in response to the application of current from said source to said line, and other means responsive to current from said source for altering the connection of said rectifier means to said ringer whereby said ringer is caused to operate in a different attention arresting manner in response to an application of current from said source to said line of a predetermined time duration.

8. In combination, a line, a source of machine ringing current connected to said line for intermittently applying signaling current therefrom to said line, a signal on said line, circuit means connecting said signal to said line and having characteristics such that said signal operates in a characteristic attention arresting manner on each application of signaling current to said line, and electromagnetic switching means responsive to a predetermined number of applications of current from said source to said line for altering the characteristics of said circuit connecting means whereby said signal operates in a different characteristic attention arresting manner on applications of current from said source to said line in excess of the said predetermined number.

9. The combination, in a signaling system, of a line, an audible signal device associated with said line, a source of signaling current, a circuit connecting said audible signal device to said line and including an element normally electrically in circuit with said audible signal device to cause said signal device to operate in a distinctive manner as a preliminary signal upon the application of current from said source to said line, a slow operating electromagnetic switching device connected to said line so as to be subject to current from said source, and means controlled by said switching device when operated for abruptly altering the normal connection of said element with said signal device whereby said signal device is caused to operate in a different distinctive manner as a secondary signal.

EDWARD M. BOARDMAN.

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