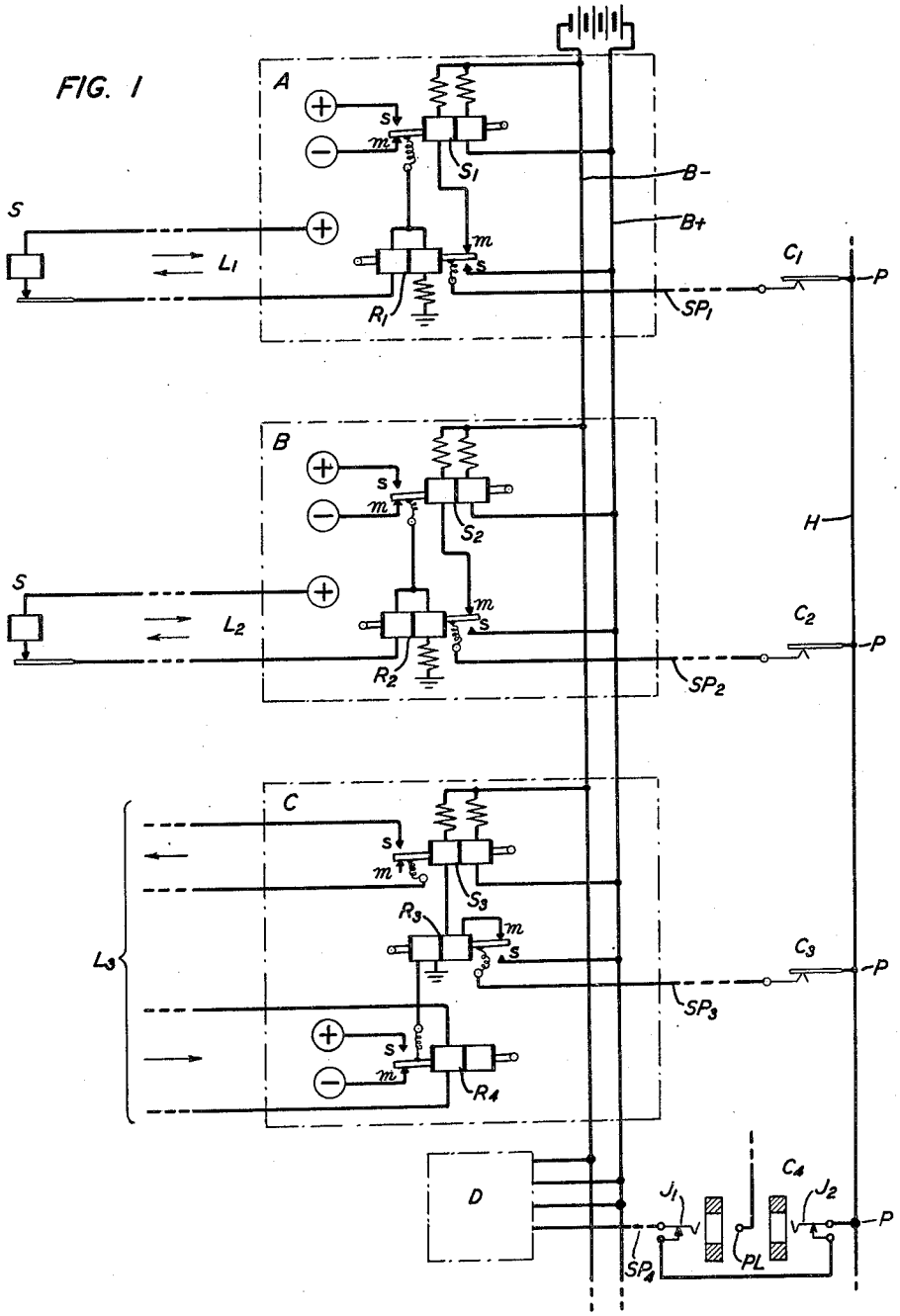
Oct. 6, 1936. F. S. KINKEAD ET AL 2,056,277

TELEGRAPH REPEATING SYSTEM

Filed July 24, 1935 2 Sheets-Sheet 1

FIG. 1



INVENTORS F. S. KINKEAD
G. A. LOCKE

BY J. W. Schmied

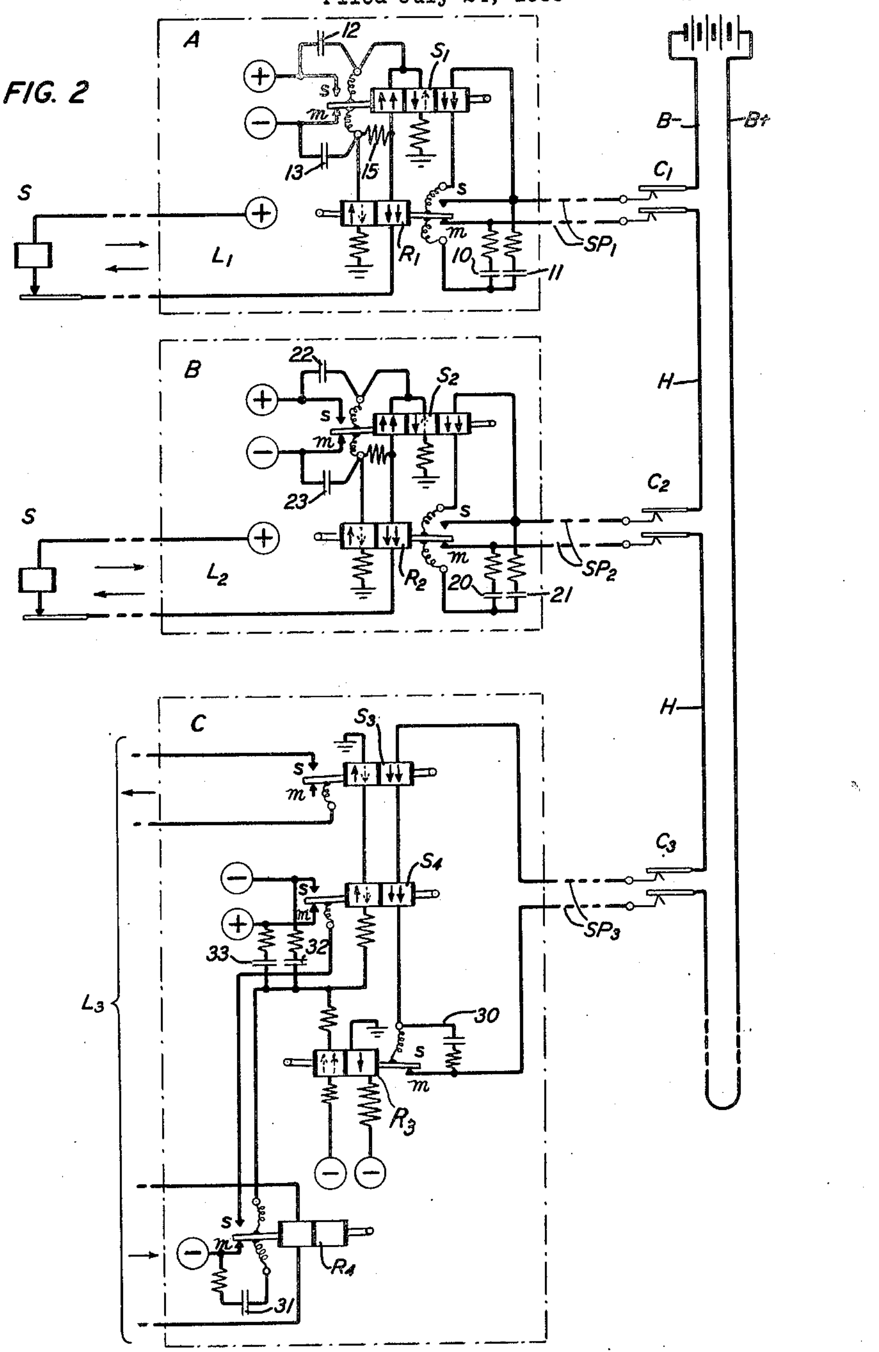
ATTORNEY

Oct. 6, 1936. F. S. KINKEAD ET AL 2,056,277

TELEGRAPH REPEATING SYSTEM

Filed July 24, 1935 2 Sheets-Sheet 2

FIG. 2



INVENTORS F. S. KINKEAD
G. A. LOCKE

BY J. W. Schmied

ATTORNEY

Patented Oct. 6, 1936 2,056,277

UNITED STATES PATENT OFFICE

2,056,277

TELEGRAPH REPEATING SYSTEM

Fullerton S. Kinkead, Ridgefield Park, N. J., and George A. Locke, Glenwood Landing, N. Y., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application July 24, 1935, Serial No. 32,866

13 Claims. (Cl. 178—73)

This invention relates to telegraph repeating systems and more particularly to systems of this type in which a plurality of stations are connected together for intercommunication between them.

It is an object of the invention to provide greater flexibility in repeating systems in the interconnection of lines of similar or different characteristics than has hitherto been available.

It is a further object to provide a repeating arrangement whereby a large number of lines may be interconnected in a simple manner and without introducing signal distortion or reducing the speed of operation.

It is a further object of the invention to provide a repeating arrangement whereby lines may be added to or disconnected from an established set-up between a plurality of lines which remain in circuit and without the necessity for making adjustments to prevent disturbances.

It is a still further object of the invention to standardize the appearance of all lines and loops of greatly differing characteristics at a repeater station so as to facilitate their interconnection.

It is a still further object of the invention to reduce to a minimum or eliminate altogether the adjustment of repeaters for bias and balance correction when two or more circuits are being interconnected.

In accordance with the invention, all line circuits and all loop circuits appearing at a repeater station are permanently terminated in individual two-way repeaters and two or more lines or loops are interconnected by interconnection of their repeaters.

In accordance with a feature of the invention, one side, the line side of each repeater circuit is adapted for and initially adjusted to the particular requirements of the line circuit to which it is permanently assigned and the other side, the local side, is adapted for interconnection with the local sides of one or more other repeaters.

In accordance with another feature of the invention, the local side of a repeater is connected in circuit with the local side of one or more other repeaters in such a manner that during marking condition all of the interconnected repeaters establish a marking condition in their associated line or signaling circuits and any one of the repeaters, when operated to spacing by its associated line circuit, will operate the remaining repeaters to establish a spacing condition in their respective line circuits. Provision is furthermore made for preventing the repeater from interfering with the signals incoming thereto. Provision is also made whereby a break signal may be applied to all of the interconnected repeaters and their associated lines for well-known purposes.

In accordance with a more specific feature of the invention, the local sides of two or more repeaters are interconnected by a one-wire signal circuit and in a preferred embodiment of the invention this circuit constitutes a multiple, which appropriately may be termed the "hub", since it has a common point or center from which the connections may be said to radiate like spokes to the individual repeaters. It should however be understood that the local sides may be interconnected by a one wire series circuit for two-way communication between the signaling circuits.

It is a further specific feature of the invention that the common multiple connection, or hub, is normally connected to equipotential points in the various repeaters and thus is without signaling current during an all-marking condition. When any one repeater, by the contacts of its receiving relay, applies spacing potential to the hub circuit, signaling current will flow therein and the remaining repeaters will be operated in multiple to repeat the spacing condition into their line circuits by means of their transmitting relays.

It is a further feature of the invention that the circuit elements in the local side of each repeater are of fixed value and require no adjustment when connection is made with one or more other repeaters, since the local circuit is of negligible impedance and the windings of the transmitting relays are connected in multiple during spacing condition. The circuit elements in the line side of the repeater may also be fixed except that provision may be made for keeping the normal line current constant when necessary; this is possible since the repeater is permanently associated with its line circuit.

The invention in its preferred form is particularly adapted for interconnection of a comparatively large number of line or loop circuits. In view of the fact that only a single conductor of each repeater needs be connected to similar single conductors of other repeaters makes it obvious that such interconnection can be made by very simple means.

Thus, in the case of a so-called "lease" set-up, the single wire connections or spokes may be directly soldered or clamped together; by means of a simple jack in the spoke of each repeater, the repeater may be disconnected from the interconnection or hub and through a patching cord connected to any other circuit, such as a line circuit or a monitoring circuit.

In the case of the ordinary appearance of a line in a switchboard, the interconnection with another line, made on request to an operator, may be established by the plugging in of a single-wire patching cord, and connection to other lines may be simultaneously set up through simple multiple jacks and other patching cords or in any other convenient manner.

The arrangement is particularly suitable for automatic set-up of interconnections, as by relays or by more complicated switching means, since only a single connection need be established for each line and its repeater. It is furthermore evident that the interconnection of a great number of lines for broadcast purposes would be greatly facilitated by the use of the invention.

The invention will now be described in one of its preferred forms and reference will be made to the accompanying drawings, in which:

Fig. 1 illustrates a telegraph repeater system for interconnection of a plurality of signaling circuits by means of a multiple circuit, and

Fig. 2 shows an example of a similar circuit in which the signaling circuits are interconnected by a series circuit.

Referring particularly to Fig. 1, an interconnecting system is shown which comprises a line circuit L_1 connected through a repeater A, a line circuit L_2 connected through repeater B, and a line circuit L_3 connected through repeater C to an interconnecting circuit or hub H.

The lines L_1 and L_2 are two-way loop circuits connected to subscribers' stations S, which usually would be equipped with teletypewriters having a polarized receiving winding and transmitting contact means. The repeaters A and B are each equipped with receiving relays R_1 and R_2 and sending relays S_1 and S_2, respectively. A suitable source of positive and negative potential is connected to the line side of the repeaters A and B.

For the transmission of signals into the line circuit L_1, the relay S_1 is operated to its marking and spacing contacts, thereby applying negative and positive potential alternately through the differentially wound relay R_1, which remains unaffected. The signals continue over the line circuit through the subscriber's station and back to positive potential at the repeater A. Signals originating at the subscriber's station are transmitted by opening and closing the line at the keyboard contacts. In this case, the line winding of relay R_1 becomes alternately deenergized and energized and the relay is operated to its spacing and marking contacts by its biasing winding in a well-known manner.

The local side of the repeaters is supplied with current from a suitable source, which may be a battery, over the common conductors B+ and B—. It is, of course, possible for this purpose to use the same source as is used for the line side of the repeater.

Referring particularly to the repeater A, the sending relay S_1 has a normally energized winding connected to conductors B+ and B— for operating the relay to its marking contact. The other winding on relay S_1 is connected from conductor B— over the marking contact of the receiving relay R_1 and the spoke connection SP_1 to the hub H. The repeater B has a similar connection for the left-hand winding of relay S_2, over the marking contact of relay R_2 and spoke connection SP_2 to the hub H. Similar connections may be traced through the repeater C and any other repeater which may be associated with this system, each connection beginning at conductor B— and ending at the hub H.

It will thus be seen that when all the repeaters are in marking condition, the hub H will be connected to the same potential in each repeater and that no signaling current will be flowing in the windings of the sending relays or in the hub circuit so long as this condition is maintained.

When a spacing signal arrives over line L_1 to operate relay R_1 to spacing, the circuit through the winding of relay S_1 will be opened so that this relay will remain unaffected. In spacing position of relay R_1, a circuit is closed from conductor B+ to the hub H, which thus applies positive potential to all the windings of sending relays in other repeaters, such as B and C, thereby operating those sending relays for transmission of a spacing impulse over their associated line circuits. To trace one of these circuits, the B+ conductor is connected over spacing contact of relay R_1, spoke connection SP_1, hub H, spoke connection SP_2, marking contact of relay R_2, winding of sending relay S_2 to conductor B—.

When line L_1 is again closed, relay R_1 returns to marking, disconnecting conductor B+ from the hub circuit and thereby deenergizing all the left-hand windings of the sending relays in the other repeaters which then will be operated to marking by their biasing windings. In repeater A, the sending relay S_1 will again be connected into the hub circuit ready for reception of signals from another repeater.

It is evident that each station may continue to send until another station applies a break signal which will connect the hub H to conductor B+ for its duration and thus cause all of the sending relays to operate to spacing for transmission of similar break signals to their associated lines.

The repeater C is a modification of the repeaters A and B, adapted for four-wire operation on its line side. The line conductors L_3 may be connected through one-way repeaters to cable pairs, or to a single cable pair through a hybrid circuit, or the line conductors L_3 may be directly connected to cable pairs or to any other desired arrangement. Signals incoming over the line circuit L_3 will operate the receiving relay R_4 to, in turn, operate receiving relay R_3 which will impress corresponding impulses upon the hub circuit. Signals from the hub circuit will operate sending relay S_3 to retransmit signals over the outgoing circuit of the line L_3.

With the repeater C in marking condition, relay S_3 is normally held to marking by its biasing winding; the left-hand winding of relay S_3 is continuously energized from conductor B— through right-hand winding and marking contact of receiving relay R_3, spoke conductor SP_3 to the hub H. With the other repeaters also in marking condition, no current will flow in this circuit. As soon as spacing potential from conductor B+ is applied to the hub by any other repeater, the right-hand winding of relay R_3 becomes energized to prevent this relay from being operated to spacing by the line circuit and the left-hand winding of relay S_3 becomes energized for transmission of a spacing impulse over the outgoing circuit of the line L_3.

From the description given above, it will be apparent that all signaling between the local side of all repeaters takes place over a single conductor circuit comprising the spokes SP_1, SP_2, etc. and the hub conductor H, and that, therefore, all switching operations for adding repeaters to a hub circuit or for removing them there-

from will be confined to a single conductor for each repeater. This makes it possible to arrange all repeaters on bays and to arrange the apparatus necessary for making the interconnection on a switchboard or testboard, removed from the repeaters, without resort to an excessive number of wires. The spokes SP may, of course, be soldered directly to the hub at points P for the permanent interconnection of certain lines as in the case of a lease set-up. However, in this case it is convenient to arrange contact means C_1, C_2, C_3, respectively, for disconnection of any repeater from the hub circuit, and temporary connection, for example, to a monitoring equipment, or to some other line circuit upon special request. The switching means C_1, C_2, C_3 may each comprise a jack on a switchboard for connection by means of suitable patching cords to one or more other line circuits; or the switching means may be the contacts of a relay or of a more complex switching device for manual remote control of the set up.

A convenient arrangement of such a switching means is shown at C_4 in connection with a repeater D which may be of the same type as repeater A or repeater C. In this arrangement, two jacks, J_1 and J_2, are provided with normally closed tip contacts included in the spoke circuit SP_4. By insertion of the plug PL in jack J_1, the repeater D with its line circuit will be separated from the hub H and may be connected through a cord attached to the plug to another jack for monitoring purposes or for communication with another line and repeater circuit. By insertion of the plug PL in jack J_2, the repeater D will also be separated from the hub and the cord will be connected to the hub, as for test purposes.

It should, of course, be understood that one-way line circuits also may be connected through a simple one-way repeater, such as a polar relay corresponding to the sending relay illustrated in the drawings, for transmission of impulses from the hub circuit into the line circuit; in the case of a short line, the line may even be connected directly to the hub circuit through a suitable network.

It should, furthermore, be understood that any one of the line circuits may be replaced by a local operator's circuit, which thus may be adapted for one-way or two-way operation as desired.

As has already been stated above, the assignment of a repeater to each line circuit has the basic advantage that lines of different characteristics may be properly equipped by provisions in the line side of the individual repeaters, and that the local side of the repeaters will be practically independent of the line requirements and may be unified for cooperation with a great number of other repeaters over a local circuit.

The arrangement shown in Fig. 2 is an example of how the local sides of permanently assigned repeaters may be interconnected in a series circuit which includes a winding and a contact of each repeater and is normally closed by all the contacts during marking condition and opened for deenergization of all windings by the opening of any one of the contacts during spacing condition.

The circuit shown in Fig. 2 is analogous to that shown in Fig. 1 and shows lines L_1 and L_2 from subscribers' stations S interconnected through repeaters A and B to the hub circuit H. The four-conductor line L_3 is connected through what may be termed a terminating interconnecting repeater C to the hub circuit.

The local sides of the repeaters are, in this instance, serially included in the hub circuit. This circuit may be traced from battery over conductor B+, marking contact of receiving relay R_3, right-hand winding of sending relays S_3 and S_4, hub conductor H, marking contact of relay R_2, right-hand winding of relay S_2, hub conductor H, marking contact of relay R_1 right-hand winding of relay S_1, hub conductor H marking contact and winding of other repeaters in similar series circuits, and conductor B— back to battery.

With this series hub circuit in all-marking condition, current will flow in this circuit to operate the S relays into marking position for application of marking potential to their respective line circuits. When any one of the receiving relays is operated to spacing in response to an incoming spacing signal, the series circuit is opened and all the S relays will be operated to spacing by their bias windings.

Considering now one of the subscriber's repeaters and referring particularly to repeater A of Fig. 2, the sending relay S_1 normally receives an operating current to marking in its right-hand winding and an operating current to spacing in its left-hand winding, the ampere turns of these two windings being such that they, in marking condition, neutralize one another; the center or biasing winding receives a holding current of a direction depending upon the position of the armature but always in a direction to hold the armature in its position. Thus, under marking conditions, the biasing winding has sole control of the relay and is holding it to marking.

When a spacing signal is transmitted over the line L_1 by opening of the contact at the substation, the receiving relay R_1 is operated to spacing by its biasing winding. Immediately upon opening of the line, the current in the left-hand winding of relay S_1 is reduced to zero; this winding is shunted by resistance 15 and thus carries less current than the right winding of receiving relay R_1, for which reason the current in the left winding of relay S_1 will reduce to zero sooner than the current in the right winding of relay R_1, or before relay R_1 reaches its spacing contact. When the marking contact of relay R_1 opens, the current in the right-hand winding of relay S_1 reduces to zero; this reduction will be delayed by the spark protection condenser 11 which tends to maintain this current for a short time. By this arrangement, the relay S_1 may be prevented from operating to spacing when a spacing signal is received over the line.

When a spacing signal is received over one of the other repeaters to render the hub circuit currentless, the right-hand winding or relay S_1 in repeater A will become currentless; the line current in the left-hand winding of relay S_1 then is strong enough to overcome the biasing winding and operate relay S_1 to spacing. When the marking contact opens, the line current is reduced; however, due to the spark protection condenser 13, the current will be temporarily maintained in the left-hand winding of relay S_1 to insure that the armature will continue its travel and engage the spacing contact of S_1. With the armature in spacing position, the current is reversed in the biasing winding of relay S_1 for holding the armature in position. A similar condition obtains in relay R_1 where the current in the right-hand winding will be maintained until relay S_1 reaches its spacing contact; by that time, the current in the left-hand or biasing

winding of relay R_1 will be reversed to aid the line current in maintaining the armature in marking position.

When a marking condition is established in the hub circuit, the current will again flow in the right-hand winding of relay S_1, and will be sufficient to overcome the biasing current in the center winding and operate the relay to marking. As the armature of relay S_1 leaves the spacing contact, a charging current through condenser 12 will temporarily maintain the biasing current towards marking in relay R_1 until the armature of relay S_1 reaches marking position, when the line current will hold relay R_1 to marking and permit the biasing current to reverse without affecting the relay. When the armature of relay S_1 reaches marking position, the current in its biasing winding is reversed, simultaneously with the establishment of current in the left-hand line winding, to aid the right-hand winding in holding the relay to marking.

Referring now to the repeater station C shown in Fig. 2, a spacing signal incoming over the lower branch of line L_3 will operate relay R_4 to spacing, which in turn will operate receiving relay R_3 to spacing and reverse the current in left-hand or biasing winding of sending relays S_3 and S_4.

When relay R_3 opens the hub circuit through the right-hand windings of sending relays S_3 and S_4, these relays will be held in marking position by the reversed biasing current. When relay R_4 is again operated to marking, relay R_3 will operate to marking and close the hub circuit to hold relays S_3 and S_4 in marking position; the biasing current in these relays will be temporarily maintained due to the charging of condenser 33 when the spacing contact of relay R_4 is opened; in this manner false operation of relays S_3 and S_4 before relay R_3 reaches its marking contact may be prevented.

When the hub circuit is opened at some other repeater the relays S_3 and S_4 will be operated to spacing by their biasing windings; relay S_3 transmits a spacing signal over the upper portion of line L_3 and relay S_4 applies negative potential to the spacing contact of relay R_4 to prevent operation of relay R_3 at this time.

Even though the spoke circuit from each repeater comprises two conductors, the contact of switching means C_1, C_2 and C_3 for associating the repeaters with the hub circuit may be arranged in the same manner as described for the circuit shown on Fig. 1.

What is claimed is:

1. A telegraph signaling system comprising a plurality of at least three telegraph lines each having terminating repeating means, and a multiple connection between all of said repeating means for intercommunication between said lines through their associated repeating means.

2. A telegraph signaling system comprising a telegraph line having two-way terminating repeating means, a plurality of other telegraph lines each having terminating repeating means, a signaling connection from the repeating means for said one line connecting the repeating means for said plurality of lines in multiple for passing of signals between said one line and said plurality of lines.

3. A telegraph signaling system comprising a plurality of at least three signal repeating means each having a line side and a local side for two-way transmission, line circuits each connected to one of said line sides, and a common multiple connected to the local side of all of said plurality of repeating means for two-way communication between all of said line circuits through said repeating means.

4. A telegraph signal repeating system comprising a plurality of at least three two-way repeating means each having a line side and a local side, a common multiple having a plurality of at least three taps, and switching means for connecting each of said taps to a corresponding one of said local sides for two-way intercommunication between at least any three of said repeating means.

5. A signal repeating system comprising a one-wire multiple, a plurality of at least three relays each having an operating winding connected to said multiple for response to a spacing potential from said multiple, and contact means connected and operable to apply said spacing potential to said multiple and simultaneously disconnect one of said operating windings from said multiple to prevent response by its relay.

6. A telegraph signal repeating system comprising a local single conductor, a plurality of relays each having a winding connected to said conductor, and a plurality of contact means each operable to disconnect a respective one of said windings from said conductor and connect a source of potential to said conductor for operating the other of said windings.

7. A local single conductor, a plurality of signal transmitting relay means each having a winding in a circuit connected to said conductor, and a plurality of signal receiving relay means each having contact means operable to connect a source of potential to said conductor and simultaneously open one of said circuits thereby operating the transmitting relays in all the other circuits.

8. A one-wire signaling connection, a first telegraph signal repeater having a first relay and a source of marking potential connected through a winding of said relay to said connection, a plurality of telegraph signal repeaters each having a second relay and a source of marking potential connected through a contact of said second relay to said one-wire connection for establishing a low current condition in said winding for non-operation of said first relay, and each having a source of spacing potential connected through the alternate position of said relay contacts to establish a high current condition in said winding for operation of said first relay.

9. A signal repeating system comprising a one-wire multiple connected to normally be at marking potential, a plurality of at least three relays each having an operating winding connected to said multiple to normally remain in marking position, a plurality of contact means each operable to disconnect one of said windings from said multiple to prevent operation of its relay and connect said multiple to alternately be at a spacing potential for operation of the other of said plurality of relays.

10. A two-way telegraph repeater comprising a receiving relay having repeating contacts for applying alternately a marking potential and a different spacing potential to a circuit, and a transmitting relay having an operating winding connected to said circuit through said contacts only when said marking potential is applied.

11. A two-way telegraph repeater comprising a receiving relay having repeating contacts for applying alternately a marking potential and a

different spacing potential to a circuit, and a transmitting relay biased permanently in one direction and having an operating winding connected to said circuit only when said marking potential is applied.

12. A telegraph repeater having a line side and having a local side for multiple operation with the similar local side of a plurality of other repeaters for two-way intercommunication between the lines connected to said repeaters, the local side of said repeater comprising repeating contacts of a receiving relay having a marking and a spacing position, operating winding of a transmitting relay, and a local repeating circuit connected by said contacts in marking position through said winding to marking potential, said contacts being operable to spacing position for disconnecting said winding from said circuit and connecting spacing potential to said circuit.

13. A telegraph signal repeating system comprising a plurality of at least three two-way repeaters each having a line side and a local side, a single-wire multiple having a tap for each of said repeaters and including switching means in each of said taps for normal connection of said taps to the corresponding ones of said local sides for two-way intersignaling between said repeaters and alternate disassociation of any one of said local sides from said multiple.

FULLERTON S. KINKEAD.
GEORGE A. LOCKE.