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NEUTRALIZATION OF INDUCTIVE INTERFERENCE

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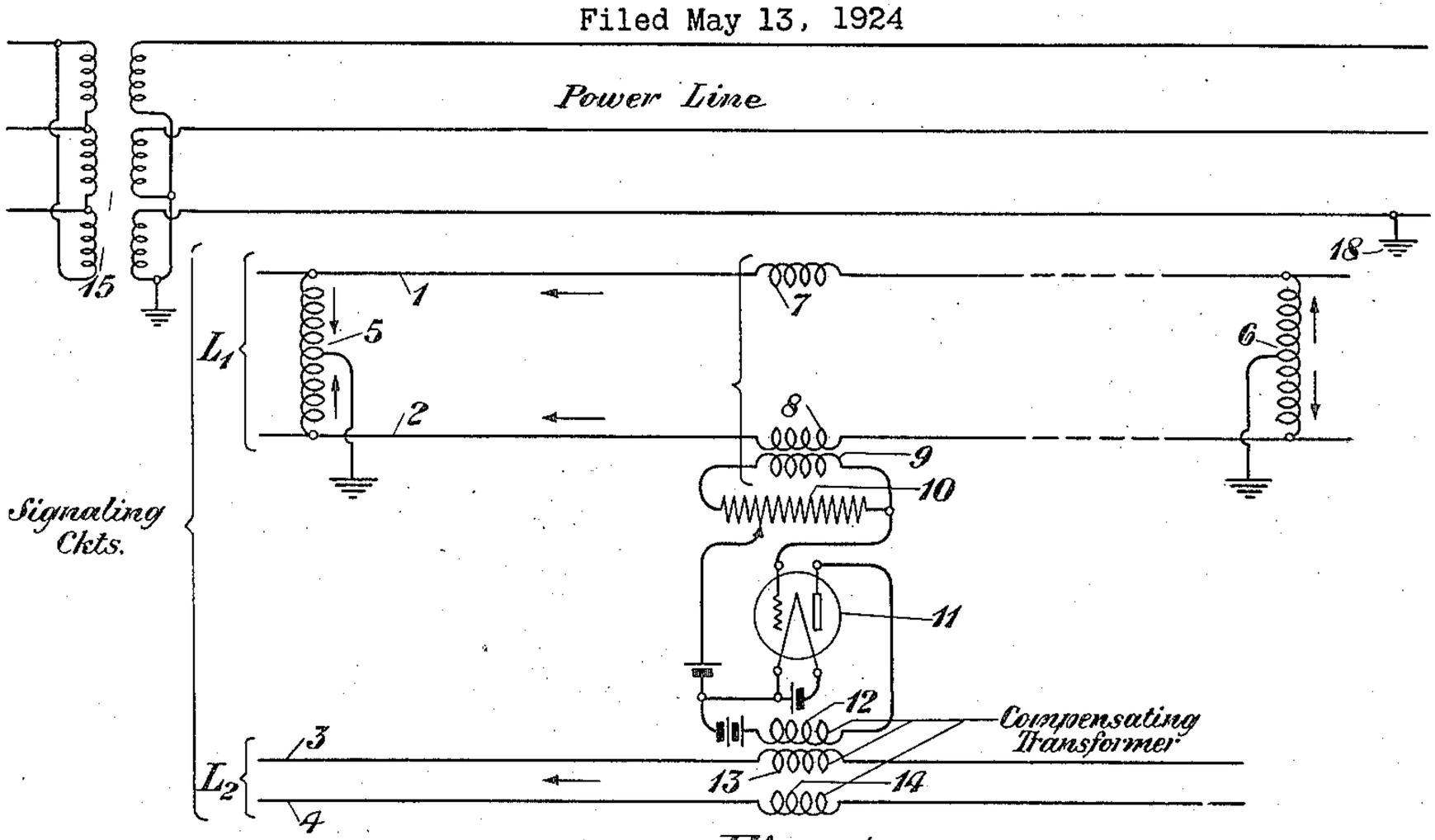

Fig. 1

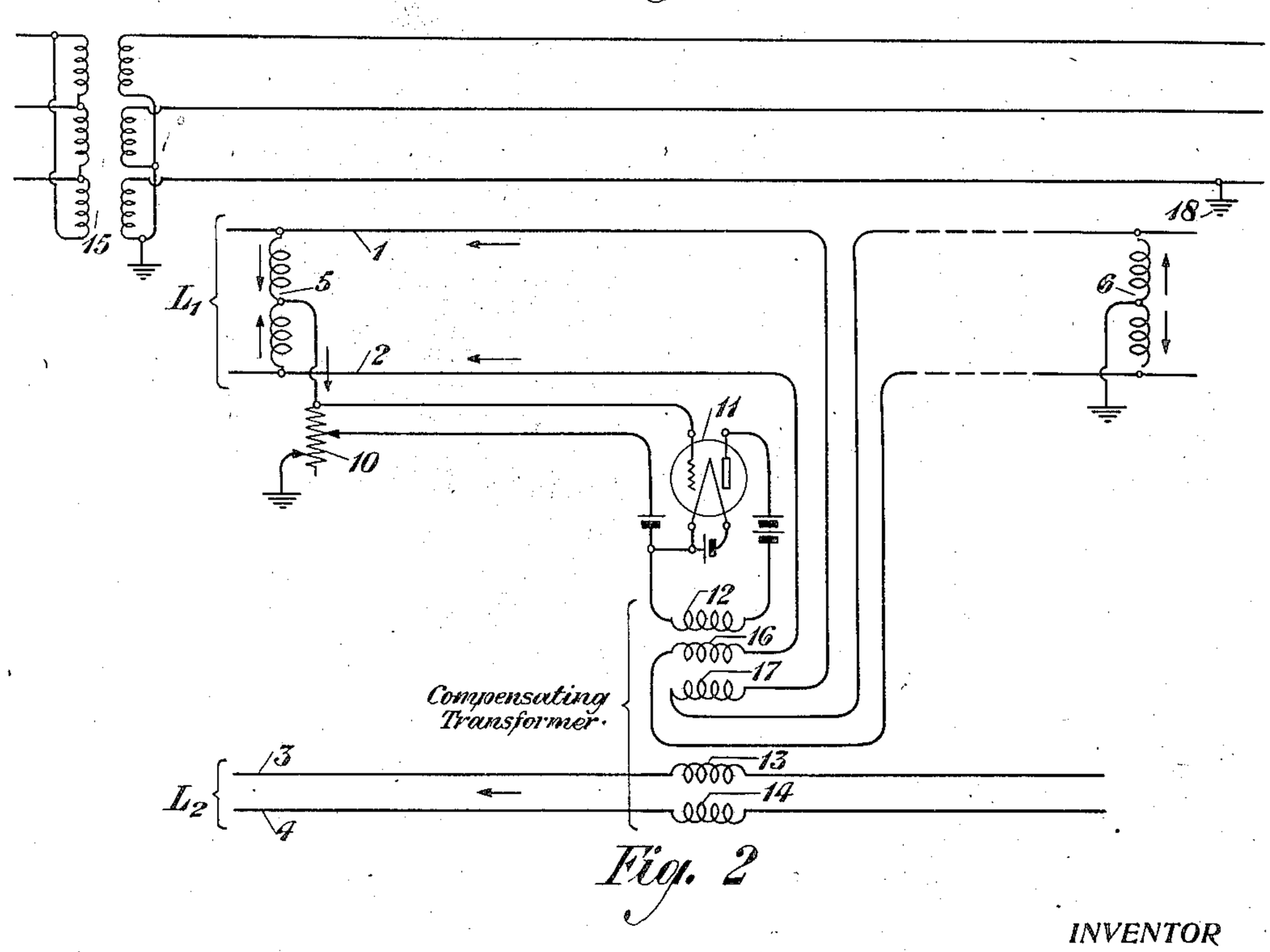

Fig. 2

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NEUTRALIZATION OF INDUCTIVE INTERFERENCE.

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This invention relates to the neutralization of interference and particularly to a method and means for the neutralization of interfering potentials that may be set up in signaling or cummunication circuits by adjacent power, railway or lighting circuits, or by any cause extraneous to the circuits themselves.

When communication or signaling circuits are exposed to power or lighting circuits interference potentials or currents are set up in the communication circuits whenever an unbalanced condition exists upon the power circuit. Unless such interfering potentials are neutralized they interfere with the reception of signals transmitted over the communication circuits, the degree of interference depending upon the relative magnitudes of the two currents. Furthermore, the interference may take the form of an actual breakdown of some part of the communication circuits. Various means have been devised for the neutralization of interfering potentials and some of these means have been used. One form of such interference reduction means which is commonly known as a compensating transformer is disclosed in the patent to J. A. Barrett, No. 940,658, dated November 23, 1909. Such neutralizing transformers are multiple-winding transformers in which a certain proportion of the windings are used as primaries and the remainder as secondaries. The primary windings are connected with certain conductors of a group of communication conductors which have set up therein an interfering potential by some source extraneous to the communication circuits. Similarly each secondary winding is connected with one of the other conductors of the communication circuits, which also have an interference potential created in them. The windings are so poled that the current flowing through the primary windings will induce a potential across the secondary windings, which is substantially equal and opposite in phase to the potential set up in each of the conductors connected with the said secondary windings. This equality may be substantially obtained by using sufficient primary conductors. These primary conductors, however, are grounded, usually by means of simplex coils, one for each pair of wires, at suitably chosen points outside of or near the ends of the exposed section of the communication circuits. Owing to the fact that these primary conductors are grounded and also due to the required method of grounding they cannot be used for grounded telegraph operation. Since it is common practice to use long communication circuits for both telephone and telegraph purposes, it will be apparent that the sacrificing of the telegraph circuits means a considerable reduction in the volume of traffic that can be handled and loss of revenue. In practice, the number of primary conductors necessary for the neutralization of interference is a relatively large fraction of the total number of conductors, this being necessary because the efficiency of neutralization requires the impedance of the circuits external to the primary transformer windings to be small compared with that of the windings themselves.

This invention consists in the provision of a method and means whereby a high degree of neutralization may be effected through the use of relatively few primary conductors.

Other and further objects of this invention will be apparent from the following description when read in connection with the attached drawing, of which Figure 1 shows a form of the invention in which one pair of primary conductors may be utilized in neutralizing the interference set up in any number of the other communication circuits and Fig. 2 shows an arrangement whereby the interference may be substantially neutralized, not only in the communication circuits other than the primary circuit but also within the primary circuit itself.

In Fig. 1, the source of disturbance is represented by a three-phase power line which is connected by the transformer 15 with a source of power. L_1 and L_2 represent signaling or communication circuits, which by the connection of well known types of terminal equipment may be adapted for the simultaneous transmission of telephone and telegraph signals. The circuit L_1 serves as the primary circuit of the neutralizing arrangement, and L_2 represents a secondary circuit in which the interfering potential is to be neutralized. It should be pointed out that although only one secondary circuit is shown, any number of such circuits might be connected with the neutralizing arrangement. The amount of energy supplied by

the amplifying apparatus, which will be described hereinafter, will, of course, depend upon the number of secondary circuits. The primary circuit L_1 comprises the conductors 1 and 2, which have bridged across them the retardation coils 5 and 6, which are located outside of or near the ends of the exposed section of the communication system. The midpoints of the coils 5 and 6 are grounded so that between the ends of the exposure the conductors 1 and 2 are effectively connected in parallel to ground. Also connected with conductors 1 and 2 are the windings 7 and 8 respectively, which constitute the primary windings of a transformer. The windings are so poled that when current flows through both in the same direction, their effect will be cumulative in setting up a potential in winding 9. The secondary winding 9 is connected with the potentiometer 10. The windings 7 and 8 are designed to have low impedance so as not to introduce serious transmission loss in the circuit L_1 by arranging them so that they are practically non-inductive to currents in opposite directions through them, such as occurs when telephone currents are transmitted over the line L_1. The potentiometer 10 is connected with the input side of the vacuum tube 11 by connecting one terminal with the grid and the other with the filament thereof. The output or plate circuit of the tube contains the primary winding 12 of the compensating transformer, the secondary windings 13 and 14 thereof being connected serially with the conductors 3 and 4 respectively of the line L_2.

The manner in which the system of Fig. 1 operates for the substantial neutralization of interference is as follows: When a field is set up by current flowing over the conductors of the power line as, for example, current from transformer 15 to a fault, such as a ground upon one of the conductors, with a return through the earth potentials will be set up in the conductors of the signaling circuits L_1 and L_2. These potentials will tend to produce a flow of current over the conductors of the said circuits which, as is well known, will be detrimental to the signals transmitted as, for example, the telegraph signals carried by the superimposed telegraph circuits. Since the primary circuit L_1 is grounded at the points where the retardation coils 5 and 6 are located, currents to ground will flow therethrough. For purpose of description, these may be assumed to be in the direction represented by the arrows. In like manner a potential will be set up in each of the conductors 3 and 4 of circuit L_2, which will tend to cause current to flow in each in the direction shown by the arrow. The flow of the disturbing currents through the windings 7 and 8 of conductors 1 and 2 will induce a potential across the winding 9, which may be applied to the grid of the vacuum tube 11. The magnitude of this applied potential may, of course, be controlled by the proper adjustment of the potentiometer 10. The current flowing through the primary winding 12 of the compensating transformer, which is in the plate-filament circuit of the tube 11, will be controlled by the grid potential, which, as we have seen, is controlled by the potential created by the current flowing through conductors 1 and 2. The windings 12, 13 and 14 are so arranged that the potentials induced across windings 13 and 14 by the output current of the amplifier will cause a potential in each of the conductors 3 and 4 which will be opposite to that created by the interfering potential set up by the power line. By properly adjusting the potentiometer 10 the interfering potentials in the conductors of the circuit L_2 and all other circuits that might be connected with other secondary windings similar to 13 and 14, may be substantially neutralized.

The arrangement shown in Fig. 2 differs structurally from that shown in Fig. 1 in several ways. In Fig. 2 the potentiometer 10 is connected between the midpoint of the retardation coil 5 and ground. Since the disturbing current set up by the power line flows, at any instant, through both conductors 1 and 2 in the same direction, as illustrated by the arrows, they will combine and flow through the potentiometer 10 to ground. The potential applied to the grid of the vacuum tube 11 may be controlled by varying the setting of the potentiometer 10. It will further be seen that the compensating transformer of Fig. 2 comprises not only the primary winding 12 and the secondary windings 13 and 14 connected with the conductors of the circuit L_2 (as in Fig. 1) but also the windings 16 and 17, which are connected with the conductors 1 and 2 of the primary circuit L_1. It will be apparent that when the disturbing power line creates a potential which will cause a current flow over the conductors of the circuit L_1 which, for illustration, may be assumed in the direction represented by the arrows, a potential will likewise be induced in the conductors of the circuit L_2, which will tend to cause a current flow in the direction represented by the arrows. The flow of current to ground from the midpoint of the retardation coil 5 in circuit L_1, which current will traverse the potentiometer 10, will control the potential applied to the grid of the vacuum tube 11. By varying the setting of the potentiometer the magnitude of the current in the plate-filament circuit, which includes the primary winding 12, may also be controlled. The windings of the compensating transformer are so arranged that the potentials induced

in the windings 13 to 17 inclusive, will oppose the potentials set up in the same circuits by the disturbing power line. It will thus be seen that by the proper adjustment of the potentiometer 10 the magnitude of the compensating potentials may be made substantially equal to the disturbing potentials which they are intended to neutralize. Neutralization of the disturbing potentials in the conductors 1 and 2 of the line L_1 will be complete except for the small residual potential necessary for the proper functioning of the amplifier.

The amplifier is shown in Figs. 1 and 2 in schematic form, and other forms may be used without departing from the scope of this invention. If, for example, the frequencies involved are low, it may be desirable to use an amplifier having a plurality of amplifying elements certain of which amplify the potential, and others the current. Such forms of amplifiers are we'l known in the art, and may be substituted for the simple type shown. In like manner other well known forms of amplifiers may be used depending upon the requirements of particular cases of interference.

Although this invention has been disclosed as embodied in a particular form it is apparent that it is not so limited but is capable of embodiment in other forms without departing from the spirit and scope of the appended claims.

What is claimed is:—

1. In an inductive interference neutralizing system, the combination with a power circuit, of a plurality of signaling circuits having interfering potentials created therein by the said power circuit, impedance coils bridged across the sides of one of said signaling circuits and having their midpoints grounded, an amplifier, means to impress upon the said amplifier a controllable part of the interfering potential set up in said grounded signaling circuit, and means to impress upon the other of said signaling circuits the amplified potential, the mode of impressing being such as to neutralize the interfering potential created therein by the said power circuit.

2. In an inductive interference neutralizing system, the combination with a circuit having an interfering potential set up therein by an external source of interference, impedance coils bridged across the sides of the said circuit, the said coils having their midpoint grounded, a potentiometer connected with one of the said grounding connections, an amplifier having its input connected with the said potentiometer and a compensating transformer having a primary and a plurality of secondary windings, the said primary being connected with the output circuit of the amplifier, and each secondary winding being connected with one of the sides of the said circuit having an interfering potential created therein so that the said interfering potential will be neutralized by a potential created in the secondary windings by the current flowing through the primary in the output side of the amplifier.

3. In an inductive interference neutralizing system, the combination with a plurality of circuits, each having an interfering potential set up therein by an external source of interference, impedance coils bridged across the sides of one of said circuits, each of said coils having its midpoint grounded, an amplifier, means to effectively apply to the input of the said amplifier a controllable part of the potential resulting from the interfering currents in both sides of said one of said circuits, a compensating transformer having a primary winding connected with the output of the amplifier and having secondary windings individual to and connected with each side of the other of said circuits.

4. In an inductive interference neutralizing system, the combination with a plurality of circuits, each having an interfering potential set up therein by an external source of interference, impedance coils bridged across the sides of one of said circuits, each of said coils having its midpoint grounded, an amplifier, means to effectively apply to the input of the said amplifier a controllable part of the potential resulting from the interfering currents in both sides of said one of said circuits, a compensating transformer having a primary winding connected with the output of the amplifier and having secondary windings individual to and connected with each side of all of said circuits.

5. In an inductive interference neutralizing system, the combination with a plurality of circuits, each having an interfering potential set up therein by an external source of interference, impedance coils bridged across the sides of one of said circuits, each coil having its midpoint grounded, an amplifier, means connected with one of the grounding connections to apply to said amplifier a controllable part of the potential created by the interfering current in both sides of the said one of said circuits, and means to couple the output of the said amplifier with each side of all of said circuits, said coupling being so poled that the potentials created by the amplifier in each side of said circuits will oppose and substantially neutralize the interfering potentials therein.

6. In an inductive interference neutralizing system, the combination with a circuit having an interfering potential set up therein by an external source, an impedance bridged across the sides of the said circuit at or beyond each end of the said source, each impedance having its midpoint grounded so that the interfering currents will flow over the two sides in parallel to ground, an

amplifier, means connected with one of the grounding connections to apply to the said amplifier a controllable part of the potential created by the interfering current in both sides of the said circuit, and a compensating transformer having its primary connected with the output of the said amplifier and having a plurality of secondary windings, each individual to and serially connected with the sides of the said circuit at a point upon the said circuit between the two impedances.

In testimony whereof, I have signed my name to this specification this 12th day of May, 1923.

HOWARD M. TRUEBLOOD.