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FACSIMILE TRANSMISSION SYSTEM AND THE LIKE

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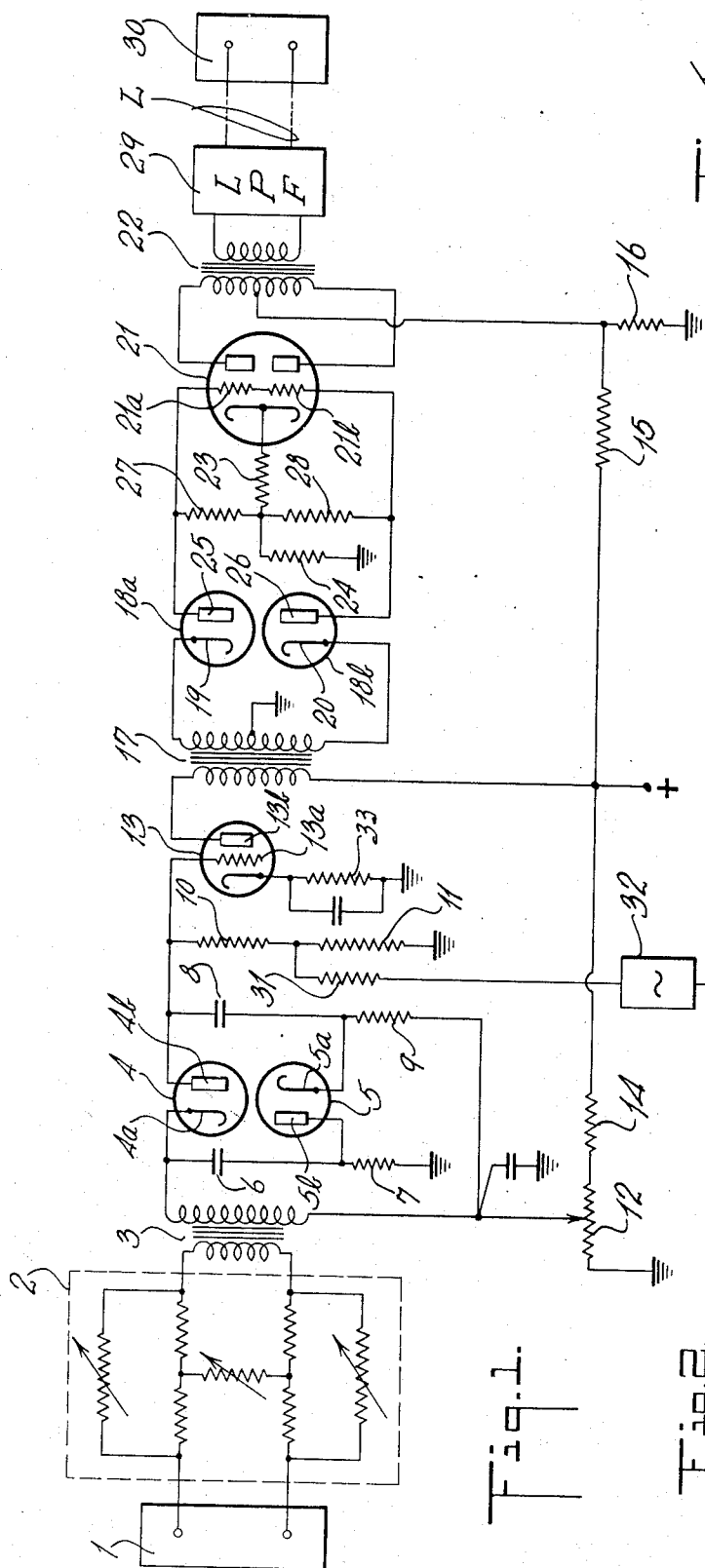


Fig. 1.

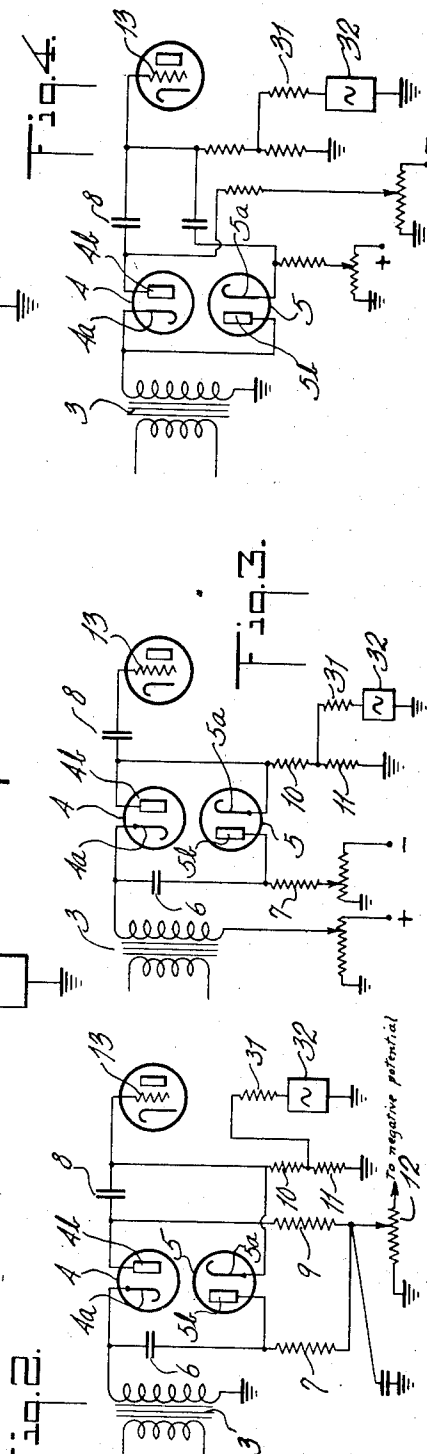


Fig. 2.

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FACSIMILE TRANSMISSION SYSTEM AND
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13 Claims. (Cl. 178-6.6)

This invention relates to electric signalling systems and more especially to control arrangements for use in telegraph systems, telefacsimile systems and the like.

Facsimile transmission can be roughly divided into two classes; one where the subject matter comprises a gradation of shades or half tones between "black" and "white"; the other where the subject matter consists only of two shades, e. g., "black" and "white." Ordinary printed or written matter, line drawings and the like, would fall within the second class. In one known system of transmitting half tones by telefacsimile, the various shade values are converted into a frequency-modulated carrier which is required to handle a range of frequencies, for example between 1800 c. p. s. representing "black" shades and 3000 c. p. s. representing "white" shades, the intervening shades being represented by intervening portions of the 1800-3000 cycle spectrum. Such frequency converters can be used to transmit either class of subject matter. However, the electrical elements of the converter introduce the equivalent of a time lag, for example in scanning sudden changes from "black" to "white" and vice versa.

Accordingly, it is a principal object of this invention to provide a system for transmitting facsimiles of "black" and "white" subject matter wherein the switching of the conversion from one frequency to another is effected instantaneously.

A feature of the invention relates to a simple, efficient and improved keying control arrangement which is particularly useful in telefacsimile transmission although its utility is not necessarily limited to that type of system.

Another feature of the invention relates to a novel method of translating two different shade values of a facsimile subject into two separate representative frequencies.

Another feature relates to a novel system of transmitting "black" and "white" shade values of a facsimile subject, whereby the facsimile machine proper produces a signal in response to one shade value, while the other shade is represented by a separate injected signal which is independent of the facsimile machine.

Another feature relates to a keying arrangement for transmitting spacing and marking telegraph signals wherein the subject matter is scanned by facsimile methods to produce a signal for marking conditions only, while the intervening spacing conditions are represented by a local source which is independent of the facsimile scanner.

A further feature relates to a keying control arrangement for transmitting marking and spacing signals, wherein one signal is raised to a very much higher level than the other and both are passed through a special limiting device so that in the output only one signal is present even though both signals are present at the input.

A further feature relates to a keying arrangement employing two sources of oscillations, one representing marking condition and the other representing spacing condition, or vice versa and with the relative levels of the two signals greatly different; in conjunction with a power limiting arrangement whereby switching from spacing to marking and vice versa is controlled by the "swamping" action of one signal on the other in passing through the limiter.

A further feature relates to a novel form of "threshold" and power-limiting arrangement.

A still further feature relates to the novel organization, arrangement and relative interconnection of parts whereby a simple and efficient transmission of "black" and "white" facsimile subjects can be effected.

Other features and advantages not specifically enumerated will be apparent after a consideration of the following detailed descriptions and the appended claims.

In the drawing which shows one preferred form,

Fig. 1 is a schematic wiring diagram of a facsimile transmission system embodying features of the invention.

Figs. 2, 3 and 4 represent modifications of a portion of the system of Fig. 1.

Referring to the drawing, numeral 1 represents any well-known form of signal generator such for example as a facsimile transmitting machine of known type having means to scan the successive elemental areas of the subject matter to be transmitted whereby the shade values of such areas are translated into a corresponding electrical signal, e. g., an audio frequency carrier signal. For a detailed description of such a device, reference may be had to Patent No. 2,209,719. The generator 1 is connected through an adjustable resistance "pad" 2 to a coupling transformer 3. In the case of "black" and "white" subject matter, devices 1 and 2 are adjusted so that the facsimile signal is of some predetermined fixed maximum level when a "black" area is being scanned, and this level drops substantially near to zero when a "white" area is being scanned. In other words, for "black" areas there appears at the primary winding of transformer 3 an audio

frequency signal, e. g., 1800 c. p. s. of high level, e. g., 30 decibels, whereas for "white" areas there is substantially no signal applied to transformer 2, or if there is, it is of the lowest possible amplitude.

In the event the signal from device 1 corresponding to "white" areas is not at the desired minimum amplitude, for example because of leakage conditions in the facsimile equipment, the signals are passed through a threshold limiter. This limiter comprises a pair of diodes 4, 5, which may be in separate tubes or they may be mounted within the same tube but electrically isolated from each other. The signal from transformer 2 is applied to cathode 4a directly, and to anode 5b through condenser 6 and resistor 7. For negative half cycles the space between cathode 4a and anode 4b is conductive thus applying the signal to grid 13a of the triode 13. On the positive half cycles, diode 5 becomes conductive between cathode 5a and anode 5b applying the signal through the condenser 8 and resistor 9. Resistors 10 and 11 are merely grid return resistors for a tube 13. The anode 13b is supplied with steady positive potential from a suitable power supply, the positive terminal of which is indicated in the drawing. A potentiometer 12 and voltage divider resistor 14 are connected across the power supply source, and another set of voltage divider resistors 15, 16, are connected across the power supply for purposes to be described.

When a positive bias is applied from potentiometer 12 through the secondary of transformer 3 to cathode 4a and through resistor 9 to cathode 5a, each diode is non-conductive until the applied signal from transformer 3 is greater than this bias. This condition obtains during the negative half cycles on diode 4 and for the positive half cycles on diode 5. Thus the diodes act as threshold limiters for both the negative and positive half cycles of the signal waves. Instead of providing the cathodes 4a and 5a with a positive bias and tying the respective anodes to ground, the cathodes can be tied to ground and a negative bias applied to anodes 4b, 5b; or in the alternative the cathode of one diode may be positively biased while simultaneously a negative bias is applied to the anode of the other diode. These two alternative arrangements are schematically illustrated in Figs. 2 and 3.

The tube 13 is coupled through a transformer 17 to a pair of balanced diodes 18a, 18b, for full-wave rectification, the cathodes 19 and 20 of the two diodes being connected in balanced relation across the secondary of transformer 17 whose electrical midpoint is grounded.

Since maximum output is desirable from tube 13, transformer 17 should be a step-up transformer and tube 13 should be biased by grid bias resistor 33 so that tube 13 operates as a "class A" amplifier or as a "class AB₁" amplifier. Tubes 18a and 18b feed a tube 21 which is of the double-triode tube, the triodes being arranged to cutoff plate current to their respective anodes for relatively low grid-bias voltages on their respective grids 21a, 21b. The plates of tube 21 are connected in balanced relation to the primary of transformer 22 and the plate voltage is applied through voltage divider 15, 16, so that tubes 21 operate at a much reduced plate voltage. The common bias resistor 23 is adjusted so as to provide a bias for grids 21a, 21b, approximately half way between zero bias and plate-current cutoff bias. Resistor 24 is pref-

erably of the same value as resistor 23 and plates 25 and 26 of the diodes are connected in balanced relation through resistors 27 and 28. The positive bias on the anodes 25 and 26 of the two diodes will equal the negative bias on the grids 21a and 21b thus providing a balanced and symmetrical arrangement.

Therefore, on positive half cycles the diodes 18a, 18b will be respectively conductive up to the point of grid current flow in tube 21 thus limiting the signal waves in the positive direction. On negative half cycles the diodes 18a, 18b, are conductive, but the grids of tube 21 are driven beyond plate current cutoff, thus limiting the signal waves in the negative direction. Consequently, the peak limiter is symmetrical to both halves of the signal wave cycles, as well as being balanced because of the push-pull arrangement. This symmetry has the advantage that only odd harmonics are generated and filter 29 may be made to attenuate only the third and higher harmonics so that even the poorest filter will have little effect on the fundamental frequencies. The signals from the filter 29 are therefore substantially sinusoidal and can be transmitted over any channel such as a radio channel to the receiving apparatus 30. If the apparatus 30 is a facsimile receiving machine, it will be operated in synchronism with the machine 1 as is well understood in the art and will be provided with a recording mechanism which is selectively responsive to the marking and spacing signals so as to reproduce the whites and blacks of the original subject matter in the known manner.

Connected through a resistance 31 to a suitable point between resistors 10 and 11 is a source 32 of oscillations of substantially uniform amplitude but of a different frequency from the "black" facsimile signal frequency. For example, source 32 may produce a 3000 c. p. s. signal for purposes to be described. Merely for explanatory purposes the 1800 c. p. s. signal from device 1 will be called the "marking" signal, while the 3000 c. p. s. signal from source 32 will be called the "spacing" signal. The level of source 32 is adjusted to the point of limiting by the peak limiter, but not beyond. I have found that for complete squelching or blanking of the signal from source 32, the level of the signal from machine 1 must be about 20 decibels greater than the level of the signal from source 32 or in a voltage ratio of 10 to 1.

Since the local oscillator 32 is permanently connected in circuit, when the machine is in operation, two signals are applied to the peak limiter, namely an 1800 c. p. s. marking signal from machine 1 representing "black" elemental areas of the subject matter being scanned, and a 3000 c. p. s. spacing signal from oscillator 32. I have found that when the power level of the marking signal is many times higher than the power level of the spacing signal, the presence of the marking signal completely masks the spacing signal in the output of the limiter. For the best results, the marking signal should be about 20 decibels or more higher than the spacing signal. Thus the marking signal may be of the order of 30 decibels while the spacing signal may be 10 decibels or less.

The operation of the system is as follows. The spacing signal from source 32 is adjusted to such a level that it is just barely limited on its peaks by the limiter. In other words, it just reaches the saturation point of the limiter so that any drop in the spacing signal will give a drop in

the output from tube 21 but any increase of the spacing signal will give no further increase in the said output. Consequently, when no marking signal is being received from the device 1, a slightly flattened signal wave appears across transformer 22, at the spacing frequency but of a fixed maximum amplitude. When the device 1 is to be set in operation, it is adjusted so that its power level at the input to the limiter is many times the level of the spacing signal, preferably of the order of 20 decibels higher. When a marking signal is applied to tube 13 from the facsimile device 1, it is preferably at least 10 times the voltage level of the signal applied at the grid of tube 13 from source 32. Under these circumstances, at the output of the peak limiter, namely at transformer 22, there will appear substantially only the marking signal and it will be of the same amplitude as the spacing signal would be in the absence of the marking signal. With a level ratio of 10 times between the marking and spacing signals, there remains substantially no vestige of the spacing signal in the output of the limiter.

Because of the characteristics of the particular limiter described, there will be substantially no time delay or transients in the keying or switching between the marking and spacing signals, nor will there be any chance of interaction between the two signals since one is always many times the other. The spacing and marking signals are transmitted over the channel L to a suitable facsimile receiver 30 which may be of the type described in my application Serial No. 301,563, the electrical portions of which may be as described in said application and the mechanical portion of which may be as described in Patent No. 2,209,719. As a result, the 1800 c. p. s. signal is translated into a "black" area on the receiving paper or film while the 3000 c. p. s. signal is translated into a "white" area on this paper or film, it being understood that the facsimile transmitting machine and the facsimile reproducing machine are operated in synchronism as well-known in the art.

While in the foregoing, the system has been described as employing a threshold limiter between the facsimile machine 1 and the peak limiter 18a-18b-21, in certain instances, the threshold limiter may not be necessary. Thus, regardless of the actual signal level corresponding to "white" and "black" as delivered by the machine 1, if the difference between the two signals is relatively great, e. g., 40 decibels or better, the level of the signals from the facsimile machine with respect to the level of the signals from source 32 can be adjusted so that a marking signal from machine 1 will squelch or blank the signal from source 32; while on a spacing signal from machine 1 the signal from source 32 takes control. For example, if the marking signal from the facsimile machine is adjusted to 40 decibels greater than that required to reach saturation in the peak limiter, and if the source 32 is adjusted to 20 decibels greater than the said saturation level, then the marking signal from the facsimile machine being 20 decibels greater than the signals from source 32, the latter would be blanked. However, on a space signal from the facsimile machine, the source 32 would be 20 decibels greater and would then squelch the space signal from the facsimile machine. This modification however is not as desirable as that illustrated in Fig. 1 since it requires a peak limiter of much

greater range and the adjustments for the relative blanking conditions are more critical.

Various changes and modifications may be made in the disclosed embodiment without departing from the spirit and scope of the invention. While in the foregoing the tubes 13 and 21 are shown as of the triode type, it will be understood that multi-grid tubes may be employed. Furthermore, while tube 21 is shown as a single tube containing two sets of triodes, it will be understood that two separate triodes can be employed. Consequently, in the claims the expression "grid-controlled tubes" includes arrangements where the sets of electrodes, e. g., triodes, are in a single envelope or in separate envelopes. Fig. 4 shows a modification of Figs. 2 and 3 wherein the cathode 4a of tube 4 and the anode 5b of tube 5 are connected directly back-to-back, with the cathode 5a positively biased with respect to its anode 5b, and with the anode 4b negatively biased with respect to its cathode 4a.

What I claim is:

1. In a facsimile transmission system, a facsimile device having facsimile scanning means for producing a signal representing one range of shade values of a subject to be transmitted, another signal source independent of said device and scanning means representing a different range of shade values of said subject, the levels of said signals being adjusted so that one is many times higher than the other, a power limiter device, and means to impress said signals on said limiter device with such a level difference that when both signals are impressed substantially only the higher level signals appear in the output thereof.

2. In a facsimile transmission system, facsimile scanning means to scan a subject to produce a signal representing one shade of a subject while substantially suppressing signals representing a different shade, means to produce a signal independent of said scanning means to represent said different shade, the level of one of said signals being many times the level of the other, a device upon which both said signals are impressed, said device having the property of producing in its output a response to substantially only one of said signals when both are impressed on its input with said level difference, but capable of passing either signal alone.

3. In a facsimile transmission system, facsimile means to scan the subject to produce a facsimile signal of high signal level representing one shade of a subject and for producing substantially zero signal level for a different shade of said subject, a signal source independent of said scanning means but representative of said different shade, a power limiter device whose output produces a signal level of predetermined maximum amplitude substantially independently of the level of the input signal amplitude, means to apply both said signals to said limiter, the said facsimile signal having a power level at the input of said limiter which is many times the power level of said other signal so that when both signals are impressed upon the limiter only the higher power signal appears in the output, but in the absence of said higher power signal at the input the lower power signal appears in the output of said limiter.

4. In a facsimile transmission system, a facsimile device for producing a facsimile signal of frequency f_1 representing one shade of a subject to be transmitted, means separate from said fac-

simile device for producing another facsimile signal of frequency f_2 but representing a different shade of said subject, a power limiter upon whose input both said signals can be impressed, and means to adjust the level difference of said signals on the input of said limiter so that said limiter acts to suppress substantially entirely in its output the signal of lower level.

5. In a facsimile transmission system, facsimile scanning and translating means for producing a signal of frequency f_1 representing "black" areas of a subject to be transmitted while producing substantially zero signals representing "white" areas of said subject, a source of frequency f_2 apart from said translating means, a power limiter upon which both said frequencies can be impressed, and means to adjust the power levels of said frequencies prior to impression on said limiter so that one is many times the other, whereby when both are impressed on the input of said limiter substantially only the higher power signal appears in the output of the limiter.

6. In a facsimile transmission system, a facsimile machine for scanning a subject to translate the "black" areas into a signal of predetermined maximum level and to translate the "white" areas into a predetermined minimum level, a threshold signal limiter, means to impress said signals on said limiter whereby signals do not appear in the output thereof until the signal input level is above said predetermined minimum, a source of signal voltage independent of said facsimile machine but representative of said "white" areas, means to adjust the signals representing said "black" areas so that the output of said threshold limiter has a signal level many times the level of said independent signal voltage, and a peak limiter device upon which both the output of said threshold limiter and said separate signal voltage can be simultaneously impressed whereby the presence of both signals at the input causes the lower level signal to be substantially entirely suppressed at the output.

7. A system according to claim 6 in which said threshold limiter is of the full-wave type having a pair of cathodes and cooperating anodes with the cathodes normally statically biased positively with respect to the anodes.

8. A system according to claim 6 in which the threshold limiter comprises a pair of diodes on the cathodes of which said signals are impressed in opposed relation whereby both the positive and the negative half waves of the signal cycles are subject to threshold limitation.

9. A system according to claim 6 in which the threshold limiter comprises a pair of diodes, a signal input circuit having its terminals con-

nected respectively to the cathodes of said diodes, and means to impress a static bias between the cathode and anode of each diode so that neither diode becomes conductive until the input signals are above a predetermined minimum amplitude.

10. The method of telefacsimile transmission of "black" and "white" subject matter which comprises, scanning the subject to derive facsimile signals, generating two carrier frequencies, controlling only one carrier frequency in accordance with said scanning, and adjusting the power level of one of said frequencies so that it is many times the level of the other of said frequencies, subjecting both adjusted frequencies to a common peak limitation to substantially entirely suppress the frequency of the lower power level, and causing said suppression to be effected only when both frequencies are simultaneously subjected to the said power limitation operation.

11. The method of transmitting intelligence using a plurality of different frequencies each representing a corresponding signal condition which comprises, adjusting the power level of the two frequencies so that one is many times that of the other, keying one frequency only when one of said signalling conditions occurs, subjecting both frequencies to a common peak limitation to substantially entirely suppress the frequency of the lower power level, and causing said suppression to be effected only when both frequencies are simultaneously subjected to said power limitation.

12. The method of transmitting marking and spacing signals which comprises, producing two different frequencies representing respectively the marking and spacing signals, adjusting the power level of said frequencies so that one is many times the other, subjecting both said level-adjusted frequencies simultaneously to a common power limiting action to suppress the lower level frequency, and causing said suppression to be effected only when said power limiting action is effected on both frequencies simultaneously.

13. In combination, a facsimile scanner for producing an audio frequency carrier modulated in accordance with shade values, another source of audio frequency carrier of different frequency from the first carrier, means to adjust the power levels of said carriers so that one is many times that of the other, a power limiter for both said carriers, means to suppress said first carrier prior to impression on said limiter when shade values of a certain range are being scanned, and means to impress both said carriers on said limiter when shade values of a different range are being scanned.

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