

May 8, 1923.

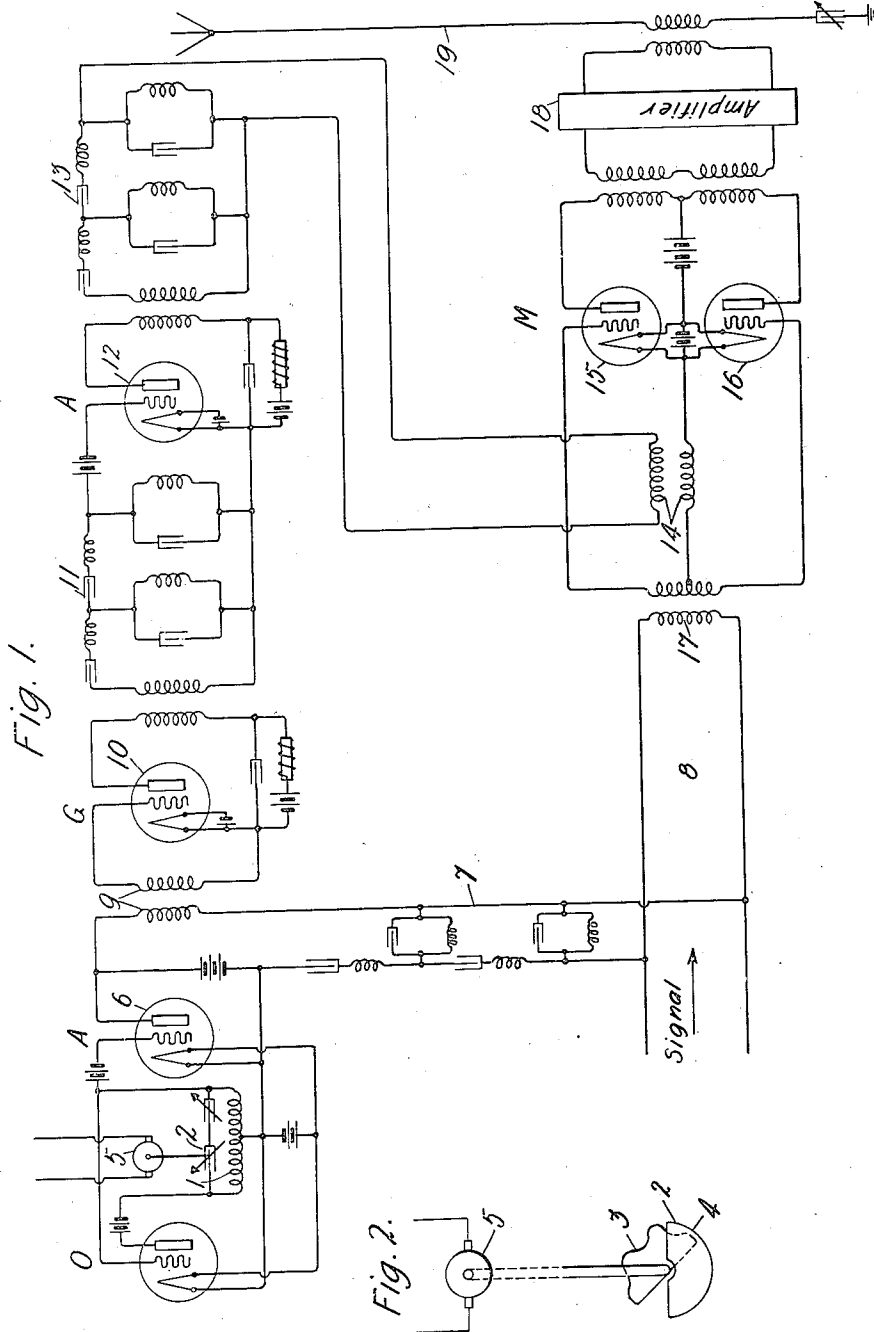
1,454,532

W. E. BEATTY

METHOD OF AND MEANS FOR SECRET SIGNALING

Filed Aug. 1, 1917

2 Sheets-Sheet 1



Inventor:
William E. Beatty.
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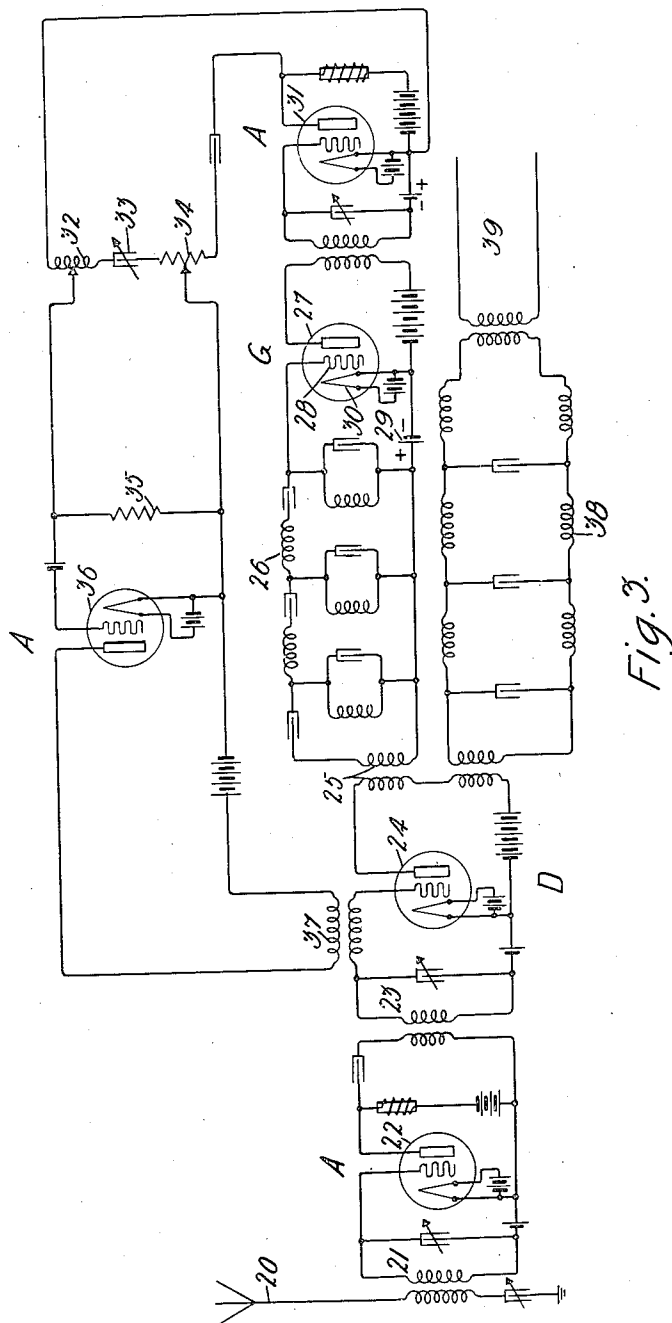
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METHOD OF AND MEANS FOR SECRET SIGNALING

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Inventor:
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UNITED STATES PATENT OFFICE.

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METHOD OF AND MEANS FOR SECRET SIGNALING.

Application filed August 1, 1917. Serial No. 183,875.

To all whom it may concern:

Be it known that I, WILLIAM E. BEATTY, a citizen of the United States, residing at Bayside, Long Island, in the county of Kings and State of New York, have invented certain new and useful Improvements in Methods of and Means for Secret Signaling, of which the following is a full, clear, concise, and exact description.

10 This invention relates to carrier wave signaling in which messages are transmitted as modulations of a carrier wave.

An object of the invention is to transmit the modulated carrier wave in such a form that it will be unintelligible unless received by specially designed apparatus, such as disclosed herein.

When a message in the form of a carrier wave is sent out from a radiating antenna system, this message is liable to be intercepted by anyone who has a radio receiving system at his disposal. It was early recognized as being desirable to send a radio message in such a form that it would be unintelligible, or would not be received at all, unless specially designed receiving apparatus were used. Former carrier wave secrecy systems, for the most part, are open to the objection that the specially designed receiving systems include a motor which must be kept in synchronism with a similar motor at the sending station.

This objection is not applicable to the present invention, according to which a method of and means for secret signaling are provided, in which a proper phase relation between the currents at the sending and receiving stations is maintained without the use of synchronously driven moving parts.

40 In order to get the modulated wave into a form that cannot be handled by ordinary receiving apparatus, advantage is taken of a previously proposed scheme, according to which the unmodulated components having carrier frequency p may be suppressed, so that a pure modulated component having only the side frequencies $p+a$ and $p-a$ may be transmitted. In this case a is the instantaneous frequency of the modulating currents. If only the side frequencies $p+a$ and $p-a$ are transmitted, this gives an element of secrecy, as this message is unintelligible unless combined at the receiving station with locally generated oscillations of

frequency p . In a manner analogous to 55 the production of beats in sound waves, the combination of currents of frequency p with currents of frequency $p+a$ for instance, gives the difference frequency a corresponding to the signal which was sent. 60

According to the present invention the unmodulated currents are likewise suppressed, so that only the side frequency $p+a$ or $p-a$ or both are transmitted. Instead of keeping the carrier frequency p constant, however, as previously proposed, the present invention provides for continually changing the value of the carrier frequency p , while signals are being sent. 65

If in this case an interceptor attempts to 70 get the message by combining the received waves with the locally generated oscillations of a constant frequency, he will hear in the receiver a noise produced by currents having a varying frequency equal to the difference 75 between the frequency of the locally generated oscillations and the frequency of the side band $p+a$ or $p-a$, where p is continually changing. Currents of this character give rise to a siren effect in the receiver and the signal is not intelligible. The value of the carrier frequency p transmitted is varied rapidly and in an irregular manner, so that an interceptor would be confronted with the problem of similarly varying the frequency of the locally generated 80 oscillations before the received message wave could be rendered intelligible. 85

The manner in which the present invention provides for varying the locally generated oscillations at the receiving station in the same manner as the frequency of the carrier oscillations at the sending station, without the use of synchronous motors, will be described in connection with the drawings, in which: 90

Fig. 1 illustrates a radio signaling station; Fig. 2 discloses the motor-driven condenser blade, having an irregular shape, that may be used in connection with an oscillator to provide a carrier frequency which varies in an irregular manner; Fig. 3 shows a station adapted to receive signals transmitted from the station shown in Fig. 1. 100

In Fig. 1 the oscillation generator 0 of the audion type supplies currents of a frequency which depends on the tuning of the resonant circuit 1. The condenser 2 forms a part of 105

the resonant circuit 1. The condenser 2, as shown in Fig. 2, has a movable blade 3 which is adapted to be adjustably interleaved with the stationary blade 4. The movable blade 3 is rotatable through a complete circle and may be given an irregular outline as shown, so that the resonance of the circuit 1 will be varied in an irregular manner as the blade 3 is rotated by the motor 5. The oscillations supplied by the oscillator 0 are hereinafter termed "control" oscillations, in order to differentiate them from the carrier oscillations which are modulated in accordance with the signal. This scheme of generating variable frequency currents is claimed.

The oscillations supplied by the oscillator 0 may be sent to the amplifier 6 of the audion type and after being amplified are transmitted through the filter 7, which comprises a system of tuned circuits for transmitting the narrow band of frequencies corresponding to the frequency of the control oscillations supplied by the oscillator 0. The filter 7 and the other filters shown herein may be designed in accordance with the showing in the patent to Campbell 1,227,113, May 22, 1917, electric wave filter. The filter 7 is connected to the line 8 and passes only control oscillations, the control oscillations as well as the signal oscillations coming in over line 8 being supplied to the input circuit of the modulator M.

The amplifier 6 is coupled, by means of transformer 9, to a harmonic generator 10. The harmonic generator 10 comprises an audion which is considerably over-loaded, so that the control oscillations supplied to it are distorted as much as possible, thereby producing harmonics in the output circuit of this harmonic generator. One of the harmonic frequencies supplied by the generator 10 is used as a carrier wave and the harmonic selected is passed through a band filter 11, amplifier 12, filter 13, similar to 11, and then by means of transformer 14 to the input circuit of the modulator M. The filters 11 and 13 pass only a band of frequencies corresponding to the carrier frequencies. This modulator comprises two audions 15 and 16 connected in opposition and having divided input and divided output circuits. The transformer 14 is connected between the points of division of the input circuits, so that currents supplied by this transformer make both of the audions 15 and 16 of like potential at any one moment. The signal and control currents supplied by the transformer 17, however, make one of these audions positive when the other is negative. Under this condition the modulator M is the source of a completely modulated wave, this modulator serving to suppress unmodulated currents of the carrier frequency. This modulator forms no part of the present invention and its operation is described fur-

ther in detail in U. S. Patent No. 1,449,382 to Carson, issued March 27, 1923. The currents supplied by the modulator M may be amplified by any suitable amplifier, such as represented by 18 and then sent to the radiating antenna 19 or other high frequency line. In this case the radiating antenna 19 supplies carrier oscillations which are modulated in accordance with both the signal and the control currents. The carrier frequency depends upon the control frequency, and since the latter is continuously changing at a rapid and irregular rate, the frequency of the former is similarly varying.

In order to translate the modulated wave sent out from the station in Fig. 1 into an intelligible signal, the apparatus shown at the receiving station in Fig. 3 may be provided. The system in Fig. 3 and the use of a control current generator at the sending station as in Fig. 1 are described and claimed in British Patent No. 131,426. In this figure the transmitted wave is received by the antenna 20 which is coupled to a circuit 21, broadly tuned to the band of frequencies to be transmitted. Frequencies selected by the circuit 21 may be amplified by the amplifier 22, transmitted to a tuned circuit 23 similar to 21, then to detector 24, which may be of the audion type as shown. It has been pointed out that the modulator M is a source of a completely modulated wave, the unmodulated currents of the carrier frequency being suppressed. It results that only the side bands, comprising the sum and difference frequencies, are transmitted to the receiving station, all as has been pointed out in the above mentioned Carson application. It has further been shown in the above mentioned patent that these side bands interact in the detector in such a manner that a component of double modulating frequency (in the present case double control frequency) is included in the output of the tube. The output circuit of detector 24 is coupled by means of transformer 25 to the filter 26, which selectively transmits the currents of the control frequencies. The filter 26 selectively transmits the control oscillations to the power limiting tube and harmonic generator 27, which comprises a three-element vacuum tube of the audion type. The potential of the grid 28 of the power tube 27 is maintained positive by means of the battery 29. The positive charge on the grid attracts the electrons emitted by the filament 30 and when the potential supplied to the device 27 reaches a sufficiently high positive value, the electrons will be attracted to the grid to such an extent that no further increase in the current in the plate circuit occurs. The minimum value of the space current in 27 being zero, it is evident that the power delivered by this tube is limited and such limitation is necessary in order to

prevent "singing" in the circuit comprising the elements 25, 26, 27, 31, 36 and 37 which couple the input circuit of the detector 24 to its output circuit. Any other form of power limiting device may, however, be used, such for example, as shown in the Patent No. 1,200,796 to Arnold, issued October 10, 1916, in which a resistance limits the current in the output circuit of the thermionic device.

The device 27 operates as a harmonic generator by reason of the fact that it is overloaded, as noted above. This device is similar in type to harmonic generator 10, above described, in that it generates harmonics of the control frequencies supplied to it. In general, waves of the first and second even harmonics would be included in the output of said generators. Accordingly, if a second or higher even harmonic of control frequency has been selected from the output of tube 10 to determine the carrier frequency, locally generated oscillations of the changing carrier frequency from tube 27 will be supplied to the amplifier 31. Such a result may readily be accomplished by selecting the second even harmonic from tube 10 to determine a carrier frequency, to which will correspond the first even harmonic from tube 27. The phase of the amplified locally generated oscillations is properly adjusted by means of the variable inductance 32, variable capacity 33, and variable resistance 34. Amplified locally generated oscillations of the same phase as that of the carrier frequencies received by antenna 20 are supplied to the resistance 35, which serves as a source of potential for the input circuit of the amplifier 36, the output circuit of which is coupled to the input circuit of detector 24 by means of the transformer 37. Oscillations from the transformer 37 cannot, however, be transmitted through the amplifier 22 to the antenna 20, since amplifier 22 is asymmetrically conducting and only permits the passage of currents in the direction from the antenna to the detector 24.

The wave received by antenna 20 is amplified and detected and the control oscillations are selected by means of the filter 26. These control oscillations, of course are varying in frequency in the same manner as the oscillations supplied by the generator 10 at the sending station. The locally generated oscillations of the carrier frequencies supplied by the device 27 after being amplified and adjusted in phase are transferred to the input circuit of detector 24, where the locally generated oscillations combine with the received oscillations to produce currents of the signaling frequency in the output circuit of detector 24. It has been indicated above that if the sending station transmits a frequency $p+a$ for instance, then at the receiving station locally generated oscillations of

frequency p must be combined with the received wave to reproduce the signal. The signal is reproduced in the same manner here, except that the frequency p , of the transmitted wave and of the locally generated wave, is continually changing while signaling. The signaling currents may be selected from the output circuit of detector 24 by means of the low frequency filter 38 which transmits to the line 39 a band of frequencies corresponding to the signaling currents.

While this invention has been described as applicable to signaling, it is apparent that the so-called "signaling currents" at the transmitting and receiving stations may be control currents to operate relays or translating devices for any desired purpose.

What is claimed is:

1. The method of wave transmission which comprises producing a carrier wave, cyclically varying the frequency of said wave, and varying the amplitude of said wave in accordance with a signal.

2. The method of wave transmission which comprises simultaneously modulating a carrier wave, suppressing the unmodulated component, transmitting the modulated carrier wave and continuously varying the carrier frequency.

3. The method of speed transmission which comprises generating a carrier wave, gradually varying the frequency of said carrier wave and modulating said wave in accordance with speech.

4. The method of wave transmission which comprises generating a carrier wave and simultaneously modulating said wave by varying its amplitude and gradually varying its frequency.

5. The method of signaling which comprises generating a carrier wave, modulating said wave in accordance with a signal by varying its amplitude, and in gradually varying the carrier frequency while signaling.

6. The method of speech transmission which comprises generating a carrier wave, modulating said wave in accordance with speech, and simultaneously gradually varying the frequency of said wave over a desired range of frequencies.

7. The method of signaling which comprises generating a carrier wave, modulating said wave in accordance with a signal, suppressing the unmodulated component of said wave, and in varying said carrier frequency while signaling.

8. The method of wave transmission which comprises producing and transmitting a wave which has been modulated by varying its amplitude and continuously varying its frequency.

9. The method of signaling which comprises transmitting a voice modulated wave

and continuously varying the carrier frequency thereof.

10. The method of signaling which comprises cyclically and continuously varying the frequency of the carrier waves and in modulating said waves by varying their amplitudes in accordance with a signal.

11. The method of signaling which comprises generating carrier waves, continuously varying the frequency of said waves, and varying the amplitude of said waves in accordance with a signal.

12. The method of signaling which consists in supplying control oscillations and carrier waves, the frequency of said carrier waves being dependent on the frequency of said control oscillations, modulating said carrier waves in accordance with a signal and with said oscillations, and in varying the frequency of said control oscillations while signals are being sent, thereby also varying the frequency of said waves while signaling.

13. The method of signaling which comprises cyclically varying the frequency of the carrier waves, modulating said waves in accordance with a signal, transmitting the modulated wave and receiving the same at a distant station, locally generating at said station oscillations which vary in frequency in the same manner as said carrier waves, and in combining the received modulated wave with the locally generated oscillations to reproduce the signal.

14. The method of signaling which comprises supplying control oscillations, changing the frequency thereof to provide carrier oscillations, modulating said carrier oscillations in accordance with said control oscillations and with a signal, changing the frequency of said control oscillations while signaling and thereby changing the frequency of said carrier oscillations, transmitting the modulated wave and receiving the same at a distant station, detecting the received wave thereby producing detected control oscillations, changing the frequency of said detected control oscillations in the same manner as the frequency of said control oscillations is changed at the sending station to produce locally generated oscillations which vary in frequency as said carrier waves, and in combining the received wave with said locally generated oscillations to reproduce the signal.

15. The method which comprises generating a wave of low frequency, obtaining a wave of higher frequency from said wave of low frequency, modifying said wave of higher frequency in accordance with said wave of low frequency, and simultaneously varying said wave of low frequency.

16. The method which comprises generating a wave of low frequency, obtaining a wave of higher frequency from said wave

of low frequency, modifying said wave of higher frequency in accordance with said wave of low frequency, and simultaneously varying the frequency of said wave of low frequency.

17. The method of carrier wave transmission which comprises transmitting a synchronizing impulse as a modulation of a carrier wave having a varying frequency and maintaining a constant ratio of carrier and impulse frequencies.

18. A transmission system comprising means for supplying a carrier wave, means for modulating said wave at a frequency which is low as compared with the carrier frequency, and means for gradually varying both of said frequencies while modulating.

19. A signaling system comprising means for supplying a carrier wave, means for modulating said wave at a frequency which is low as compared with the carrier frequency, and means for gradually varying both of said frequencies while signaling.

20. A signaling system comprising means for supplying an undamped carrier wave, means for modulating said wave by varying its frequency characteristic in accordance with a signal, and means for cyclically varying the frequency of said wave over a range of at least three frequencies while signaling.

21. A signaling system comprising means for supplying an undamped carrier wave, having a continuously varying frequency, means for varying the amplitude of said wave in accordance with a signal, and means for transmitting said modulated wave.

22. A signaling system comprising means for supplying an undamped carrier wave having a frequency which varies cyclically over a range of at least three frequencies, and means for modulating said wave by varying its frequency characteristic in accordance with a signal.

23. In a signaling system, the combination of means at a transmitting station for supplying a carrier wave, said means comprising a resonant circuit, means for cyclically varying the resonance frequency of said circuit while signaling, and means for modulating said waves by varying its characteristic in accordance with the signal.

24. In a signaling system, the combination of means at a transmitting station for supplying a carrier wave, said means comprising an oscillation generator of the audio type having a resonant circuit, a motor for varying the resonance frequency of said circuit while signals are being sent, and means for varying the amplitude of said waves in accordance with a signal.

25. A signaling system comprising means for supplying carrier oscillations, means for varying the carrier frequency over a range of three or more frequencies, means for

modulating the varying carrier frequency oscillations, and a band filter for transmitting the range of modulated frequencies.

26. The combination of a sending station comprising means for supplying a carrier wave, means for modulating said wave at a frequency which is low as compared with the carrier frequency, means for cyclically and continuously varying the carrier frequency while modulating, means for suppressing the unmodulated component, and a receiving station comprising means for detecting the received modulated wave.

27. The combination of a sending station comprising means for supplying a carrier wave, means for modulating said wave in accordance with a signal, means for varying the carrier frequency while signaling, and a receiving station comprising means for supplying locally generated oscillations having the same frequency values and variations as said carrier oscillations, and means for combining the received wave with the locally generated oscillations to reproduce the signal.

28. The combination with means for generating a wave of low frequency, of means for obtaining therefrom a wave of higher frequency, means for modifying said wave of higher frequency in accordance with said wave of low frequency, and means for varying said low frequency wave while modifying said wave of higher frequency.

29. The combination with means for generating a wave of low frequency, of means for obtaining therefrom a wave of higher frequency, means for modifying said wave of higher frequency in accordance with said wave of low frequency, and means for varying the frequency of said low frequency wave while modifying said wave of higher frequency.

30. A radio transmission system comprising a radio sending station, a source of fluctuating current at said sending station, a receiving station adapted to cooperate with said radio sending station, a local source of fluctuating current at said receiving station, and common means for simultaneously varying the frequency of both of said sources during transmission.

31. A carrier current transmission system comprising a sending station, a source of carrier current at said sending station, a receiving station, a local source of fluctuating current at said receiving station, and means for automatically varying the frequency of said local source and the frequency of said carrier current during transmission.

32. A transmission system comprising a sending station, a source of carrier current at said sending station, a receiving station, a local source of fluctuating current at said receiving station, and means at said sending station for automatically and cyclically varying the frequency of both of said sources during transmission.

33. A radio transmission system comprising means for transmitting a carrier wave, means for modulating said carrier wave in accordance with synchronizing impulses, and means for simultaneously varying the frequency of the carrier wave and the frequency of the synchronizing impulses.

34. The method which comprises transmitting an uninterrupted wave, continuously varying the frequency of said wave and simultaneously modulating said wave whereby modulations of uninterrupted continuity may be transmitted.

In witness whereof, I hereunto subscribe my name this 30th day of July, A. D., 1917.

WILLIAM E. BEATTY.