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W. H. TIDD

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CARRIER COMMUNICATION SYSTEM

Filed Jan. 23, 1936

2 Sheets-Sheet 1

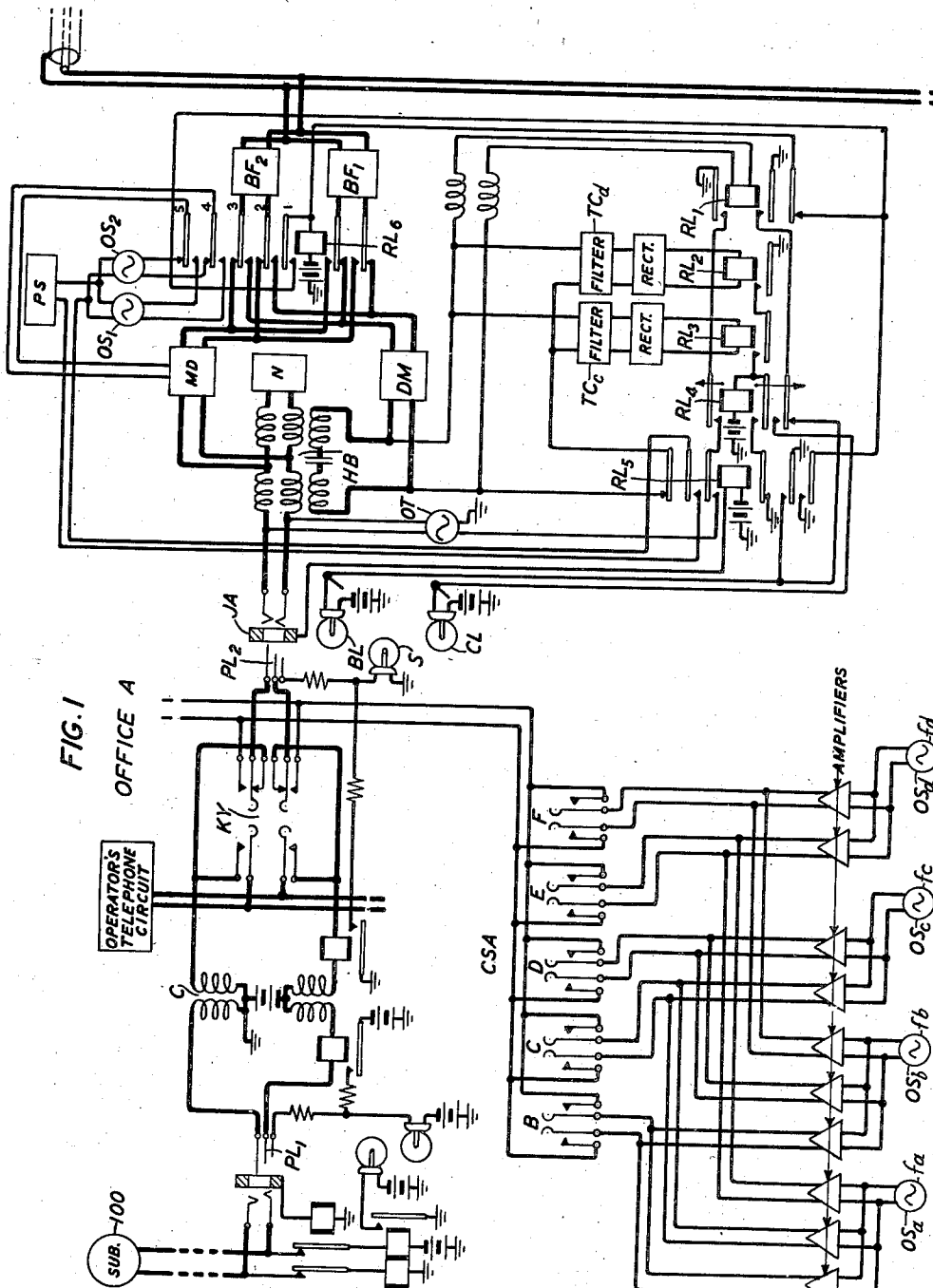


FIG. 1

OFFICE A

OPERATOR'S
TELEPHONE
CIRCUIT

SUB-100

CSA

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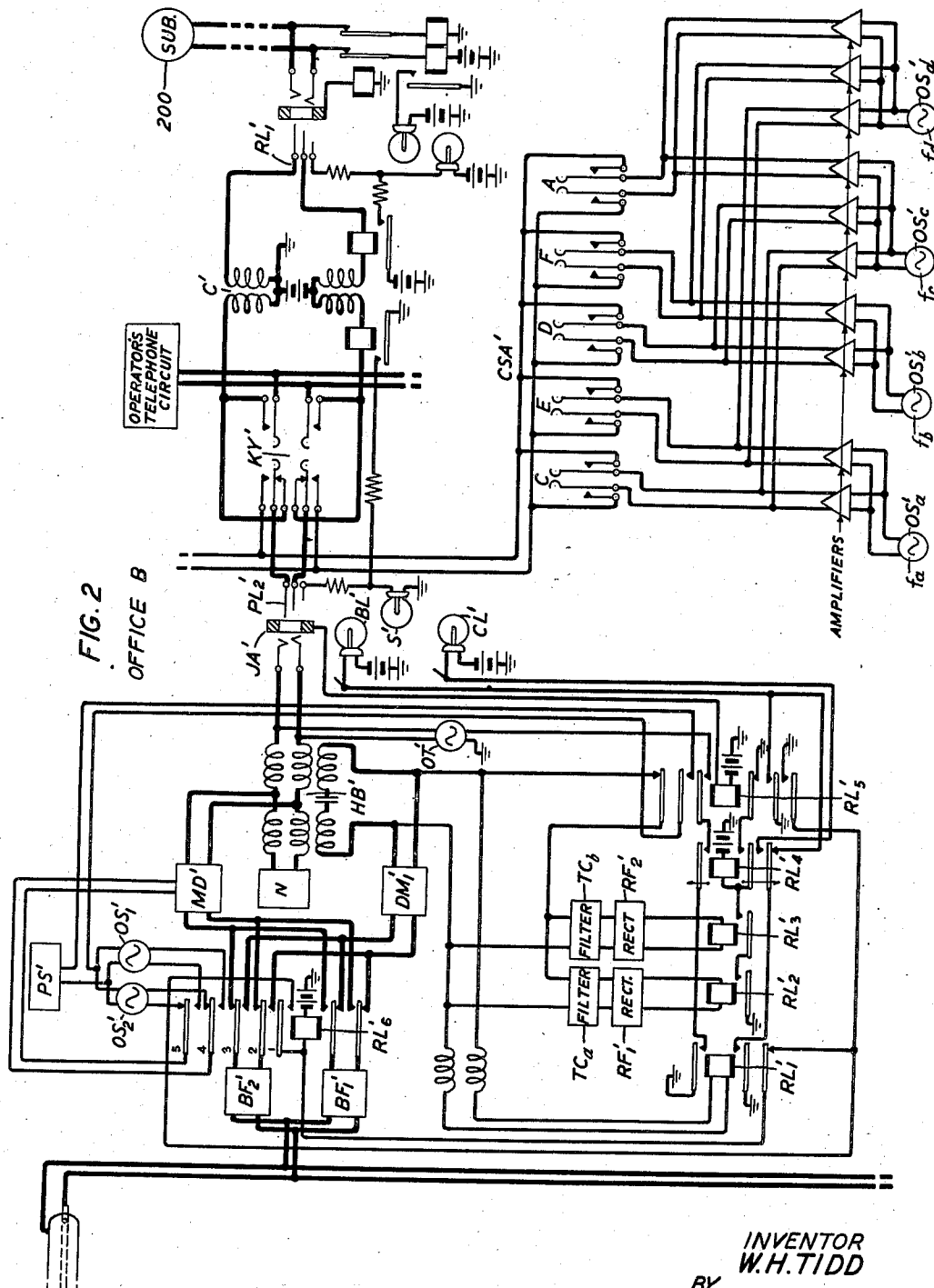
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2 Sheets-Sheet 2



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CARRIER COMMUNICATION SYSTEM

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5 Claims. (Cl. 179-43)

This invention relates to an improved inter-connecting and communicating system, and more particularly to a system of the type in which carrier waves or oscillations, either free or guided, are employed as the medium for conveying energy for effecting the operation and control of the electrical switching, signaling and communicating apparatus located at separate points of the system. The invention especially relates to a system in which carrier currents, in the form of high frequency waves guided upon wires, are used as the medium of electrical connection between the electrical devices and apparatuses located at different points in the system. These carrier currents are assigned such frequencies as to be non-interfering with one another, so that each carrier serves as a connecting medium separate and distinct from other carriers superposed upon the line or medium over which the carriers are transmitted. Each of the carriers is modulated in accordance with the voice currents or other signaling or controlling currents that are to be carried. The carriers thus modulated are transmitted over the toll or long distance line or other common transmission medium such as, for instance, a pair of coaxial conductors, and are passed through individual arrangements each of which is selective of one carrier frequency to the exclusion of the others, and each of which may have associated with it apparatus that serves to reproduce, from a modulated carrier, the voice, signal or controlling current with which the carrier was modulated at the distant station. The arrangement which is used to transmit and receive by means of any high frequency wave as distinguished from that which is used for transmitting and receiving by means of a wave of a different frequency is commonly known as a high frequency or carrier channel, or as a frequency selective channel.

The present invention is directed particularly to a high frequency system in which intercommunication between the various stations of the system is effected through the medium of a number of such non-interfering high frequency channels, each of which may be available to all of the stations. Each of the stations of the system is so organized that not only may it establish connection with any other station of the system by way of any of the high frequency channels, but it may also utilize, simultaneously, all of the channels that are not at the time in use for the interconnection of other stations of the system.

In order to simplify the system, effect economy

in the apparatus required, and realize certain advantageous features of operation, one of the objects of this invention is to provide an improved means by which each of the distant stations may establish connection with one another by the use of alternating current impulses of different frequencies whereby operators at each of the stations can transmit number or code designations in either direction. In the system of my invention all of the communication channels, in pairs, are available to every station. In order to reach a distant office an idle pair of channels is selected and a voice frequency pulse consisting of a combination of two or more such voice frequencies is superposed upon one of them to actuate signals at the desired distant office only, the call being completed thereat manually by an operator in the well-known manner.

The scope and purpose of the invention may be the more easily obtained by considering the following description in connection with the attached drawings in which

Fig. 1 shows a trunk at an originating station using high frequency channels derived from a common medium which can be used for originating a connection on a straight-forward basis, while

Fig. 2 shows a similar trunk at some terminating station connected to the common medium which can be used for completing a connection.

Each of the trunks is shown associated with cord connecting facilities having key transmitting devices connected thereto by which calling or called lines may be extended to each of the trunks and through which code impulses may be transmitted over the common medium.

In the system of my invention, all the channels of communication, in pairs, are available to every office. In order to reach a distant office, an idle pair of channels is selected and a frequency combination code is transmitted thereover to actuate signaling devices at the desired distant office only, the call being completed thereat manually by an operator.

Referring to the Figs. 1 and 2 placed in juxtaposition with each other, the operations involving the setting up of a connection will now be described, it being evident from the following description that the two trunks are perfectly symmetrical and can be used either for originating a connection or for completing a connection. It will be assumed, therefore, that the connection is to be established between subscriber 100 in office A and subscriber 200 in office B and that the trunk in office A is normally connected to re-

ceive on, say, frequency f_1 , and transmit on, say, frequency f_2 . In order to cooperate with similar trunks at other offices, these frequencies are reversed when the trunk is used for an outgoing call.

The operator at office A, having associated plug PL₁ of cord C with the subscriber's line 100, and having ascertained the called office and number of subscriber 200, inserts plug PL₂ in the jack JA of an idle trunk, indicated by the busy lamp BL being dark, as for instance, the trunk shown in Fig. 1. Upon the insertion of plug PL₂ in the jack JA, ground on the sleeve of the plug through calling supervisory lamp S completes an obvious circuit for relay RL₅ which operates. Through its middle upper contact set, relay RL₅ applies the power supply PS to the oscillator OS₁, which produces frequency f_1 , and to oscillator OS₂ which produces frequency f_2 and also to the modulator MD. It further completes a circuit for relay RL₆ extending from ground on the bottom outer contacts of relay RL₅, bottom outer contacts of relay RL₁, winding of relay RL₆ to grounded battery. Relay RL₆ operates and locks itself to operating ground through its No. 1 contacts independently of the contacts of relay RL₁, thus causing it to remain energized as long as plug PL₂ remains in the jack JA. Relay RL₆, through its Nos. 4 and 5 contacts, connects oscillator OS₁ to the modulator MD which, in turn, is connected to the band filter BF₁ over the bottom front contacts of said relay, said filter passing frequency f_1 , while over its Nos. 2 and 3 front contacts, band filter BF₂, which passes frequency f_2 , is connected to the demodulator DM. This changeover enables the trunk to transmit to and receive from any other trunk operating on these two frequencies. Inasmuch as the oscillator OS₁ is connected to the Nos. 4 and 5 front contacts of relay RL₆ and the oscillator OS₂ is connected to the back contacts of the same contact combination, carrier frequency f_1 is transmitting to the medium.

This carrier frequency f_1 indicates that the channel is in use and is effective at other trunks in the system operating on the same set of frequencies, f_1 and f_2 , as for instance, the trunk at office B, to pass through filter BF'₁, lower back contacts of relay RL'₆, the demodulator DM₁, and completing the circuit through the tertiary winding of the hybrid transformer HB₁. The demodulated current at each of the trunks causes the actuation of relay RL'₁, which is bridged across the tertiary of said transformer, thereby completing a circuit for busy lamp BL' extending from ground on the bottom inner contacts of said relay, bottom outer back contacts of relay RL'₄, lamp BL', to grounded battery. The lighting of the lamp indicates that the trunk is in use while the opening of the bottom outer contacts of relay RL'₁ makes it impossible to operate relay RL'₆ over a circuit similar to that described for relay RL₆ of the trunk in office A should an operator disregard the signal and insert a cord plug into jack JA' in preparation for using the trunk to establish an outgoing connection. The trunks at every office in the system, and operating on the frequencies f_1 and f_2 except at the originating office A when the corresponding trunk has been taken into use, are, therefore, in the condition just described, with the busy lamp BL' lighted at every position to which the trunk is multiplied. This condition is maintained at all offices except the called office as described hereinafter, until the channel is released at the calling station.

Returning, now, to the operations in the trunk

at the calling office A, relay RL₅, on operating, disconnects the voice frequency filters TC_c and TC_d from the demodulator DM while the bottom middle contacts close an obvious circuit to the busy lamps BL, which light at every position to which the trunk is multiplied to indicate that the trunk is busy.

The carrier frequency f_1 having been transmitted over the common medium and hence to the called office B as well as to every other office connected to the medium having a trunk operating on the fixed frequencies f_1 , f_2 , the operator at the calling office A depresses one of the keys in the code sending apparatus CSA, such as B corresponding to the called office. This apparatus may comprise a key-set having a key for each office associated with the common medium that may be reached by office A. To each of the keys is wired the combination of two sources of low or voice frequency currents which characterize the desired office. In Fig. 1, a code sending key device is shown having five separate keys B, C, —, F, each designating one of five distant offices. Each of these offices has a low frequency code designation made up of the combination of any two of the frequencies f_a , f_b , f_c and f_d which are derived from the oscillators OS_a, OS_b, OS_c and OS_d connected, on one side, to a suitable source of power supply (not shown) and transmitting, on the other, the produced frequencies through suitable amplifiers. It is assumed that the desired office, office B, is characterized by a code made up of frequency f_a and frequency f_b , and key B; therefore, is wired to the two amplifiers through which said two frequencies are available. Office A, the home office on the other hand, having a low frequency combination of f_c and f_d , can be reached from any of the five offices B, C, —, F so that its characteristic frequency combination is not available through any of the keys at office A. The filters TC_c and TC_d in the trunk of office A, which respond to these frequencies when present on the common medium, however, have been subscripted, respectively, with the letters *c* and *d* to indicate the fact that these filters are responsive to the code frequencies which characterize the office A and transmitted from any of the other five offices. In the same way, the filters in office B shown in Fig. 2 have been subscripted respectively, with *a* and *b* to indicate that when frequencies *a* and *b* are on the medium only the trunks in office B equipped with filters TC_a and TC_b will respond.

While the scheme of office identification is here being illustrated with a total of six offices associated with the common medium, with each office being identified by an individual combination of two separate frequencies, it is understood that the invention is not limited to the number of offices which can be identified by combinations of two out of four available frequencies. It is obvious that the number of available frequencies, and the combinations possible with such frequencies, may be expanded to suit the number of offices which may be connected to the common medium, and the key-sets at each office may be expanded to have as many individual keys as there are offices to be reached, each of the keys carrying an appropriate number of contacts for connection to the appropriate number of frequency outlets. My invention, therefore, is intended to embrace a communication system the offices of which may be identified by a combination frequency code which identifies each of

the separate offices regardless of the number of offices involved.

Assume, now, that the two frequencies for the office B are the voice frequency f_a and the voice frequency f_b . When key B is depressed and key KY in the cord is depressed to the right, these two frequencies are modulated upon carrier frequency f_1 , are transmitted over the common medium and are received at every office through the trunks thereat which are adapted to respond to carrier frequency f_1 . At office B, after demodulation, the two voice frequencies will pass the filters or tuned circuits TC_a and TC_b, respectively, and, after being rectified by the rectifiers RF'₁ and RF'₂ will operate relays RL'₂ and RL'₃. The operation of these two relays completes an obvious circuit for relay RL'₄ which locks itself up over its bottom inner contacts and the bottom inner contacts of relay RL'₅. Relays RL'₂ and RL'₃ will drop back after key B is released, that is, after the voice frequency code f_a , f_b has been transmitted. Relay RL'₄, on operating, opens the circuit of the busy lamp BL' at its bottom outer back contact and, over its bottom outer front contact, completes the circuit of the calling lamp CL' to the bottom inner contacts of relay RL'₁. The circuit now remains in this condition until an operator at the office B answers the calling signal by inserting a plug, such as PL'₂ into the jack JA', which completes the circuit for relay RL'₅ from ground through the cord supervisory lamp S', the sleeve of the plug PL'₂, sleeve of the jack JA', winding of relay RL'₅, to grounded battery. Relay RL'₅ operates and connects the power supply circuit PS' to the oscillators OS'₁ and OS'₂ and modulator MD' over its top middle contacts, opens the path of the tuned circuits TC_a and TC_b over its top outer contacts, opens the locking circuit of relay RL'₄ over its bottom inner contacts, causing this relay to release and extinguish calling lamp CL', closes the circuit of busy lamp BL' thereby lighting this lamp again to indicate the busy condition of the trunk, and further completes the path of the order tone circuit OT' extending from ground on the top contacts of relay RL'₁, top contacts of relay RL'₄, top inner contacts of relay RL'₅ to the order tone coil (not shown). Although the locking circuit of relay RL'₄ was opened at the instant relay RL'₅ operated, said relay RL'₄ does not release immediately, it having slow-release characteristics, but persists in its operated condition for some time after its locking circuit is opened. This has the effect of sending a brief signal to the calling operator at office A by way of the order tone circuit, which will be heard in the operator's telephone circuit at office A as a signal to pass the wanted subscriber's number. Upon receipt of the number the operator at office B completes the call by plugging PL'₁ of the cord C' into the jack of the wanted subscriber 200.

Communication between subscribers is now carried over the carrier frequencies f_1 and f_2 , calling subscriber 100 transmitting over frequency f_1 by virtue of the fact that relay RL'₆ is operated and putting frequency f_1 on the medium from oscillator OS₁, and called subscriber 200 transmitting over frequency f_2 by virtue of the fact that relay RL'₆ is released and putting the frequency f_2 on the medium from oscillator OS'₂. Supervision of the call is obtained by means of apparatus associated with the cord circuits in a well-known manner.

After the call has been completed, the plug PL'₂ is removed from the jack JA at the originating

office, which effects the release of relay RL'₅ and the removal of carrier frequency f_1 from the medium. Relay RL'₁ at the called office thereby releases and causes lamp CL' to be extinguished as a signal to the operator that the call is terminated. Plug PL'₂ is then removed from the jack and relay RL'₅ is caused to release. The power supply PS' is now removed from oscillator OS₂ and carrier frequency f_2 is removed from the medium, effecting the release of relay RL'₄ at office A (this relay having been operated when frequency f_2 was placed on the medium) and extinguishing lamp BL to indicate that the trunk has been released at office B thus restoring the apparatus of the trunk at office A to normal in readiness for another call.

What is claimed is:

1. In a high frequency communicating system having a plurality of stations, means at each station for transmitting the same communicating carrier wave, means at each station for receiving the carrier wave transmitted by each of the other stations, sources of voice frequency currents at each station, key-controlled means for modulating said carrier wave with a combination of voice frequency currents to indicate a desired station, and means at said desired station responsive to said modulated wave for identifying said desired station.

2. In a carrier telephone system, a plurality of stations, a group of terminals at each of said stations, corresponding terminals at each station all being adapted for operative association with the same communicating channel, a call signal for each terminal at each of said stations, key-controlled means effective upon the use of one of the terminals at a station to extend a call to another station for modulating the corresponding communicating channel with one or more lower frequency waves designating said other station, and means in the terminal at said other station which is adapted for operative association with the same communicating channel as the terminal at the calling station used to extend the call responsive to said modulated carrier wave to operate the signal of said terminal at said other station.

3. In a high frequency communicating system having a plurality of stations, means at each station for transmitting and receiving the same pair of carrier frequencies, key-controlled means at each station for modulating one of said carrier frequencies by a combination of one or more lower frequencies to designate a wanted station, and means at each station responsive to the modulated carrier said means comprising a tuned device for each lower frequency assigned to the station, a rectifier operatively associated with each of said tuned devices, a relay for each rectifier and responsive to the rectified current, and a signal device responsive to all of said relays when operated to signal the selection of the station.

4. In a high frequency communicating system having a plurality of stations, means at each station for transmitting the same pair of carrier waves, means at each station for receiving the carrier waves transmitted by each of the other stations, voice frequency means at each station for modulating one of said carrier waves to indicate a desired station, said means comprising a key for each station and sources of amplified voice frequency currents connected to the contacts of each of said keys in the combinations required by each of the stations identified by each of the keys, and means at each station responsive

to the carrier wave modulated by the combination of voice frequencies which designate its own station for operating a signal to indicate the presence of a call for said station.

- 5 5. In a high frequency communicating system having a plurality of stations, a plurality of terminals at each station and a carrier channel available for one of said terminals at each of said stations, the combination at each station
10 of key-controlled devices capable of operative association with each of the terminals thereat

for modulating the associated carrier channel with a plurality of voice frequency waves to designate any of said stations, frequency selective means responsive to the carrier channel of said terminal modulated by a plurality of voice frequencies designating the station, means for rectifying each of the high frequencies modulated upon said carrier channel, and relay devices responsive to each of said rectified frequencies for signaling the station. 5 10

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