

General Electric Company

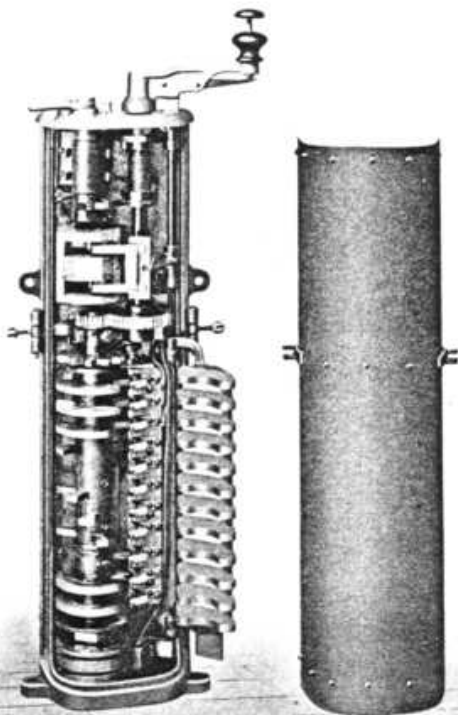
RAILWAY DEPARTMENT

February 11, 1902

Bulletin No. 4281

THE GENERAL ELECTRIC TYPE M CONTROL SYSTEM.

The General Electric Type M Control is especially adapted for use on motor cars in a service which requires either that the cars be operated alone, or that two or more be coupled together as a train and operated simultaneously. When several cars are coupled as a train, the circuit connections are so arranged that the motors on all of the motor cars may be controlled from either end of any motor car. The cars may be coupled into a train without reference to their relative positions and either end of any car may be coupled to any other car on the train.



C-6 MASTER CONTROLLER--OPEN.

The Type M System of Control consists in general of two parts: First, a series parallel motor controller composed of a number of electrically operated switches called "contactors," and a separate electrically operated reverse switch called the "reverser." The contactors make the different combinations of the motors and vary the starting resistance in the circuit with them. Second, two master controllers, one located at each end of each motor car, which operate the motor controlling contactors and reversers. A cable which connects each master controller with the motor controllers runs the entire length of the train, connecting the control circuits of the several motor cars together by means of suitable couplers between the cars. It is therefore necessary to continue this control circuit cable through any trail cars which may intervene.

The synchronous action of the motor controllers on all the cars simultaneously with the movement of the master controller handle insures similar resistance connections and motor combinations on all the cars at all times. The position of the master controller handle indicates to the operator the exact position of the motor controllers on all of the cars. The rate of movement of the motor controllers and consequently the amount of current taken by all of the motors is, therefore, under his immediate control and the motorman may instantly utilize the full power of the motors in either direction in an emergency.

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In case the power circuit is momentarily interrupted for any reason, the system of control provides for the immediate restoration of the motor and resistance connections which were in effect immediately preceding such interruptions. In this respect it is equivalent to the ordinary hand controller. All current for the operation of the motor controllers on each of the different cars passes through the single master controller under the immediate control of the motorman. If desired, the master controller can be so arranged that in case the motorman removes his hand from the operating handle, the control circuit will be interrupted and the motor controllers opened, thus shutting off the power from all the motors. The master controller supply circuit is protected by a fuse.

The interruption of current to the motors in the off position of the motor controller is insured by providing three separate contactors connected in series, any one of which has sufficient capacity to open the circuit. If the train should break in two, the current would automatically and instantly be cut off from the motors on that part of the train not under the control of the motorman, while his ability to control the front part of the train would not be affected.

When the master controller is thrown off, both "line" and "ground" connections are cut off from the operating coils of important contactors and none of the wires in the train cable are "alive."

For reversing the motors the master controller is provided with a separate reversing handle, and a mechanical interlocking device prevents this reversing handle from being thrown, unless the main handle is in the off position. Moving this reverse handle either forward or backward makes connections for throwing the reverser to either "forward" or "reverse" position. The reverser is electrically interlocked, so that it cannot be thrown when the motors are taking current.

The operating circuit is so arranged that unless the reverser is thrown for the direction of car movement indicated by the master controller reverse handle, it will be impossible to operate the contactors and get current through the motors on that particular car.

A cut-out switch for the control is provided on each car, so that in an emergency all of the contactors and the reverser on that car may be disconnected from the control circuit.

The control operating current per car at 550 volts line potential is about 2.5 amp. for an equipment for two 160 H.P., or four 80 H.P. motors.

The operating coils in the controlling apparatus, unless otherwise specified, are wound for working at a maximum potential of 600 volts without undue heating, and will successfully operate on a minimum of 300 volts.

The total weight of control apparatus for this equipment is approximately 2200 lbs.

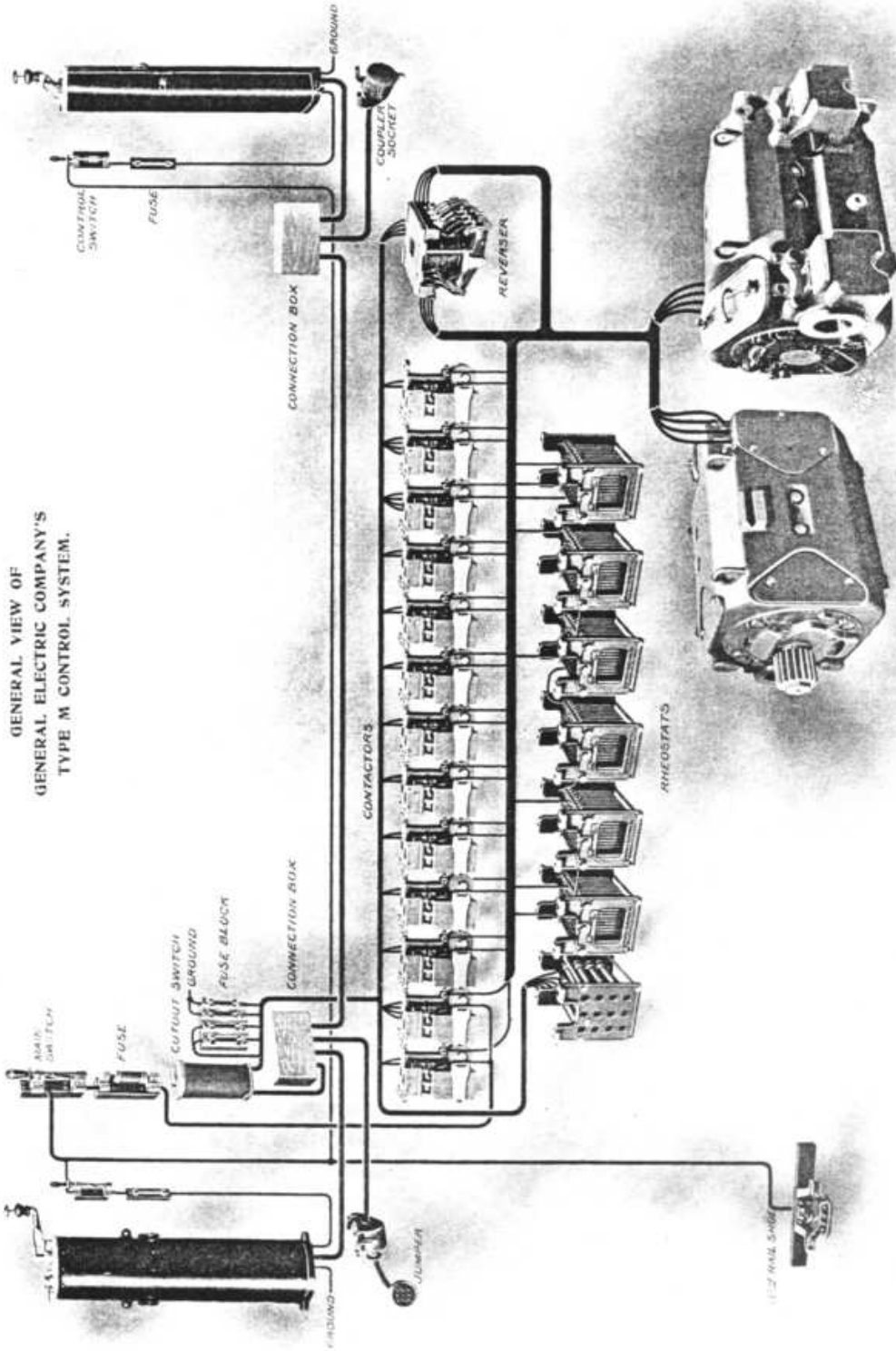
The following is a brief description of the various parts which make up a control equipment.

MASTER CONTROLLER.

The master controller although considerably smaller than the ordinary street car controller is similar in method of operation and appearance. Separate power and reverse handles are provided, as experience has led to the general use of this arrangement in preference to the movement of a single handle in opposite directions.

All current for the operation of the contactors is taken directly from the line and passes through the single master controller in use. A magnetic blow-out is provided similar to that used on standard street car controllers.

An automatic safety open circuiting device will generally be provided in the master controllers, whereby in case the motorman releases the master controller handle, the control circuit for the motor controllers will be opened on auxiliary contacts. This result is obtained by



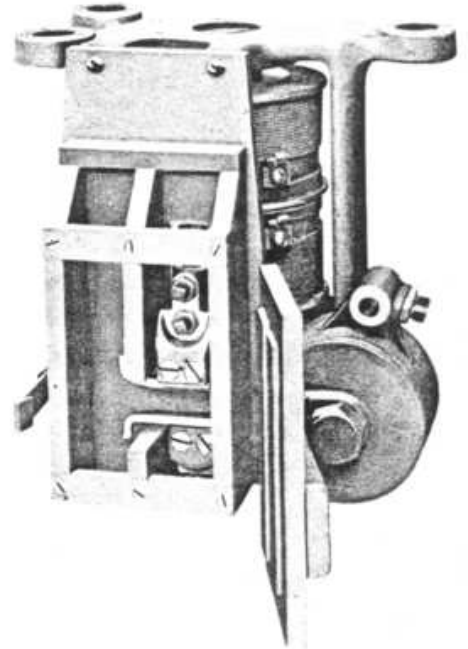
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mounting the operating mechanism for the auxiliary safety device loosely on the main shaft and returning it to the "off" position by a spring when released without necessitating the movement of the entire cylinder or handle; thus the device is entirely separate and distinct in its action from the main cylinder.

The handle for operating the reverser can be removed only in the intermediate or off position. As the power handle is mechanically locked against movement when the reverse handle is removed, it is only necessary for the motorman to carry the reversing handle when leaving the car.

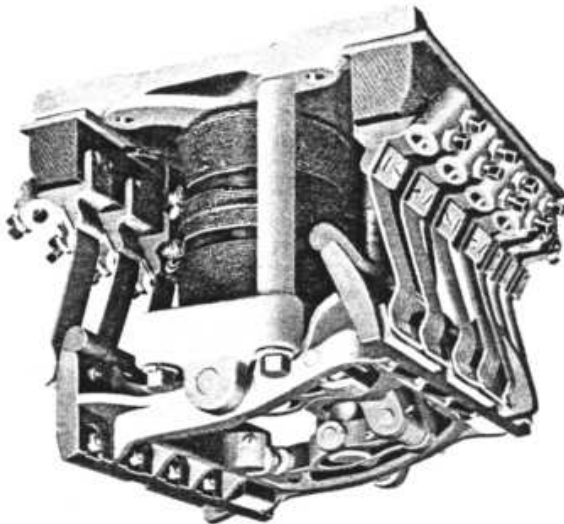
CONTACTORS.

Each contactor consists of a movable arm carrying a removable copper tip which makes contact with a similar fixed tip, and a coil for actuating the arm when supplied with current from the master controller. The contactor is so designed that the motor circuit is closed only when current is flowing through the coil; and gravity, combined with the spring action of the finger, causes the arm to drop and open immediately when the master controller circuit is interrupted. The contactor has an efficient and powerful magnetic blow-out, which will effectually disrupt the power circuit under conditions far exceeding normal operation. The different contactors are practically identical, and the few parts which are subjected to burning and wear are so constructed as to readily be replaceable. They should preferably be located under the car floor at one side, and are so designed as to be readily inspected.



DB-15 CONTACTOR.

REVERSER.



DB-20 REVERSER.

The general design of the reverser is somewhat similar to the ordinary cylindrical motor reversing switch with the addition of the electro-magnets for turning it to either the forward or reverse position. The operating coils are similar to the ones used on the contactors. The reverser should preferably be placed under the car floor, and may be inspected in the same way as the contactors.

CONTROL CUT-OUT SWITCH.

This switch is provided so that it may be possible to cut-out on any car all of the control operating coils, and it should be located in a convenient position on the car.

A number of small enclosed fuses are placed in the control circuit at such points as to efficiently protect the control apparatus.

SWITCH FOR MASTER CONTROLLER.

A small quick break single-pole switch and separate fuse are provided in the supply circuit for the protection of each master controller. When this switch is open, all current is cut off from the entire control system through the particular master controller.

CONTROL CABLE COUPLERS.

The coupler, connecting between the control cables on adjacent motor cars, or motor car and trailer, consists of a socket, attached to the car, containing a number of insulated metallic contacts connected to the train wires, and of removable plugs containing corresponding insulated



DA-24 COUPLER SOCKET AND DC-22 COUPLER PLUGS.

contacts. The two plugs joined by a flexible cable (the whole being called a "jumper") connect corresponding terminals in the sockets on adjacent cars. The parts subject to wear are readily replaceable.

The coupler sockets are provided with spring catches which hold the plugs in contact under normal conditions, but permit them to automatically release in case the train breaks.

CONTROL CABLE.

A special flexible cable made up of different colored individually insulated conductors is used whenever possible to make control circuit connections between the various pieces of apparatus, a similar cable having an outside rubber covering being used for the "jumper" connection between the coupler plugs.

CONTROL CIRCUIT RHEOSTAT.

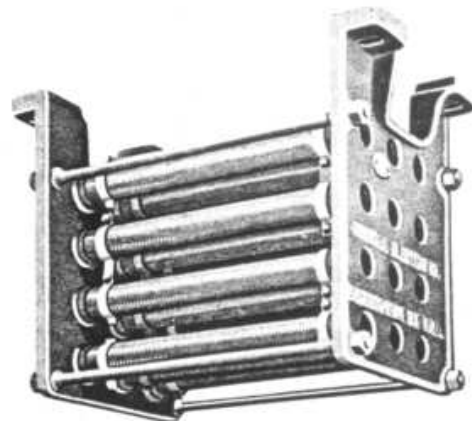
A special high resistance rheostat is required for introducing consecutively the various operating coils of the contactors producing the motor rheostatic steps.

CONTROL CIRCUIT CONNECTION BOARD.

Connection boards are provided for connecting the control cables at junction points without splicing and small copper terminals are provided for attaching to the ends of the wires. The connection board should be located preferably above the floor of the car.

MOTOR CIRCUIT SWITCH AND FUSE.

For the purpose of disconnecting the motors on any particular car, a switch is provided for opening the main circuit between the third-rail shoes or trolley and the motor controller. Between this switch and the motor controller there is also provided for the protection of the apparatus, either an automatic circuit breaker or an enclosed fuse, depending upon the character of the service.



T-101 CONTROL CIRCUIT RHEOSTAT

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NOTES ON INSTALLATION.

As nearly all of the control apparatus is located under the car floor, it is quite essential that particular care be taken to arrange all appliances such as air brake mechanism, reservoir and compressor, to the best advantage. The control apparatus is supported by heavy planks, attached to the car framing, which must be laid out to suit the particular conditions of each case.

Suitable protecting covers must be provided for the contactors and reversers when the conditions of service require it.

TRAIL CAR EQUIPMENT.

The only apparatus necessary on a trail car operated between two motor cars, consists of the control circuit coupler sockets with cables and connection boards.

If desired, a master controller can be placed on each platform of the trail car, thereby providing for the operation of the train from any platform. With this arrangement the motorman can be at the head of the train, regardless of the combination of cars.

The approximate weight of the apparatus required for each trail car is 100 lbs.

SPECIAL FEATURES.

The Type M Control being composed of individual electrically operated switches, which may be located in any available space, can be readily adapted to many other classes of service than train operation. The small space occupied by the master controller, and the ease with which it may be operated, makes this system desirable in some cases for large locomotives, heavy hoists, or other classes of severe direct current service requiring a controller easily operated, or one which may be located at a considerable distance from the motors.

In some instances the standard General Electric L-3, or other large controllers may be found to occupy too much valuable cab space, and Type M Control may be substituted with considerable saving.

The following features of Type M Control are worthy of especial attention, as they are features of extreme importance for the successful operation of any system of train or distant control.

Consisting of a number of separate switches, it is much more reliable than any system using a large cylinder operated by means of a motor or other device.

The rapidity with which the contactors operate and the blow delivered at the contacts insure the removal of any roughness due to arcing and the design provides for rubbing action, which greatly reduces the liability of sticking. On the other hand, a cylindrical controller, which must necessarily revolve at moderately slow speed, strikes the contact fingers with less force and is much more liable to weld.

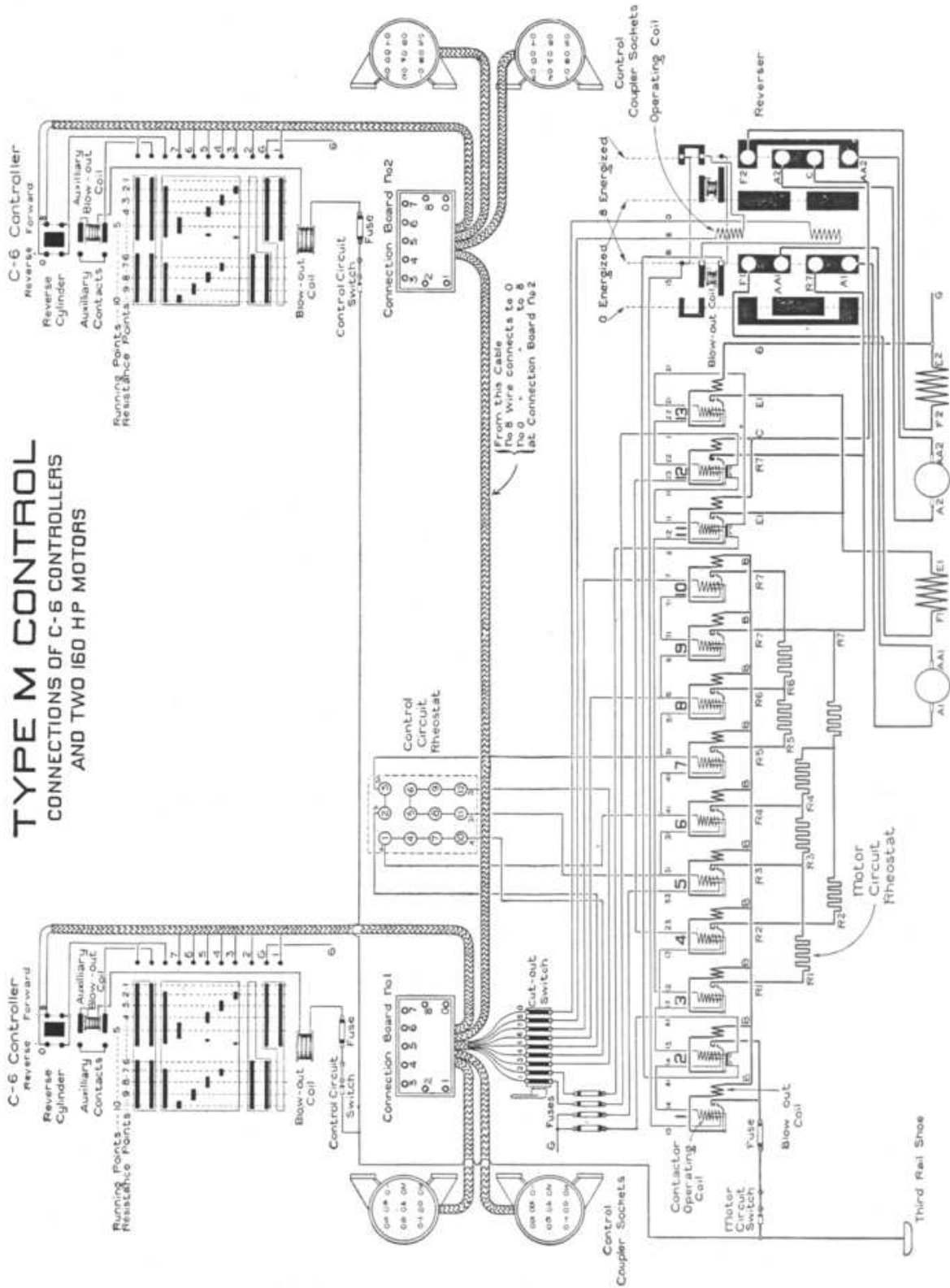
There is but one style of burning tip for both movable and stationary contacts, and the number of supply parts required is, therefore, much less than in any other form of control.

No throttle or current limiting device is used, as conditions of operation vary to a great extent, due to the variations in train load, grades and conditions of track, and provision must be made for accelerating accordingly. This system permits the same manipulation of the train as of an ordinary street car, and the motorman has direct control of the motors without the intervention of any automatic limiting devices liable to derangement.

A sufficient number of train wires is provided, so that each rheostatic step is positive and not dependent on the automatic operation of some device liable to get out of order and prevent the proper turning on or off of the controller.

As all of the power required to operate the control passes through the master controller in use, and as both sides of the principal contactor operating coils are open circuited by it, the motorman has complete control of the apparatus.

TYPE M CONTROL CONNECTIONS OF C-6 CONTROLLERS AND TWO 160 HP MOTORS



GENERAL ELECTRIC COMPANY

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