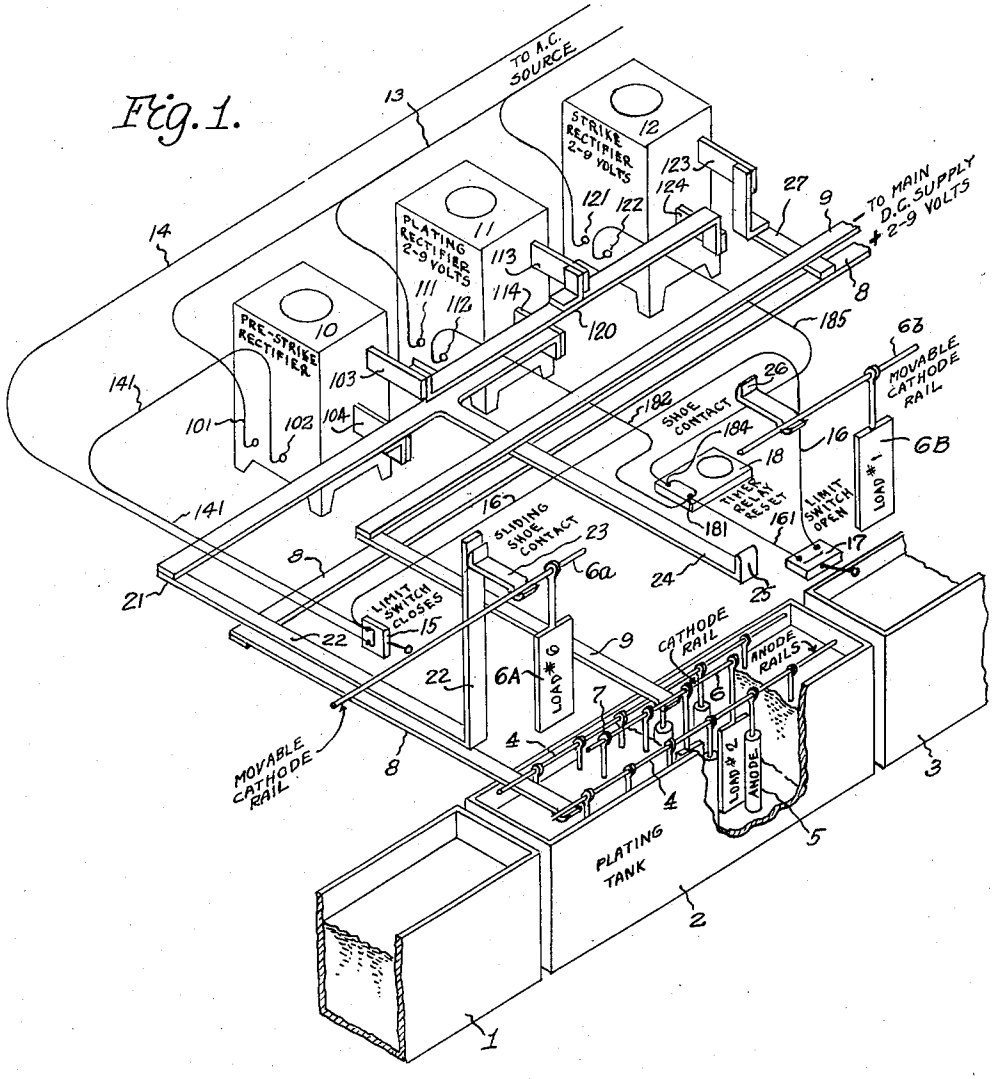
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VOLTAGE CONTROL SYSTEM

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Fig. 1.



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VOLTAGE CONTROL SYSTEM

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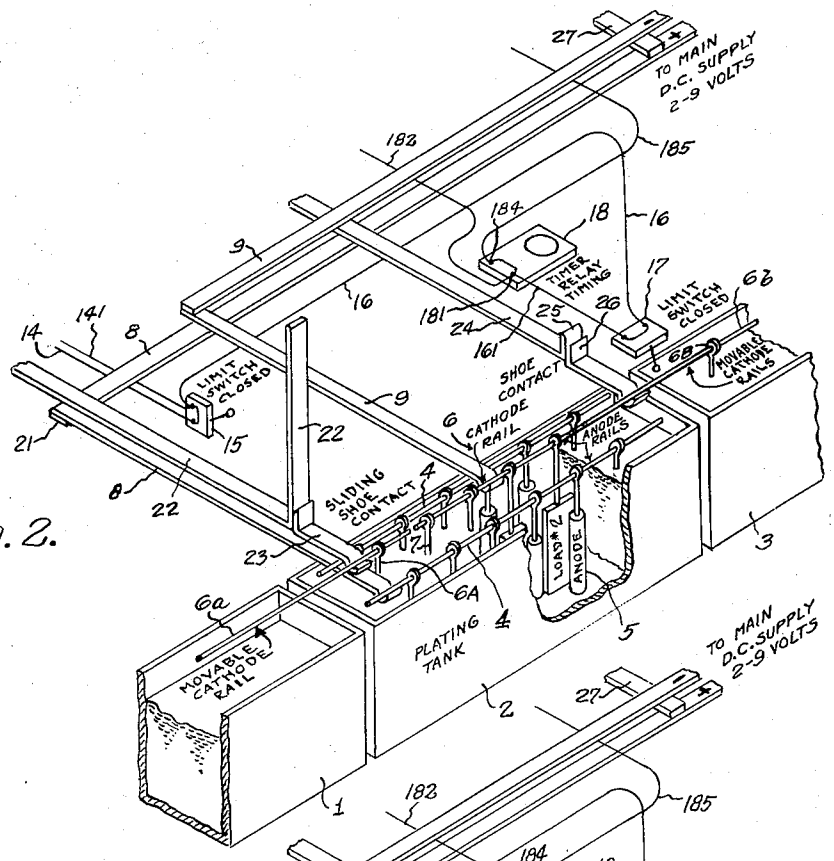


Fig. 2.

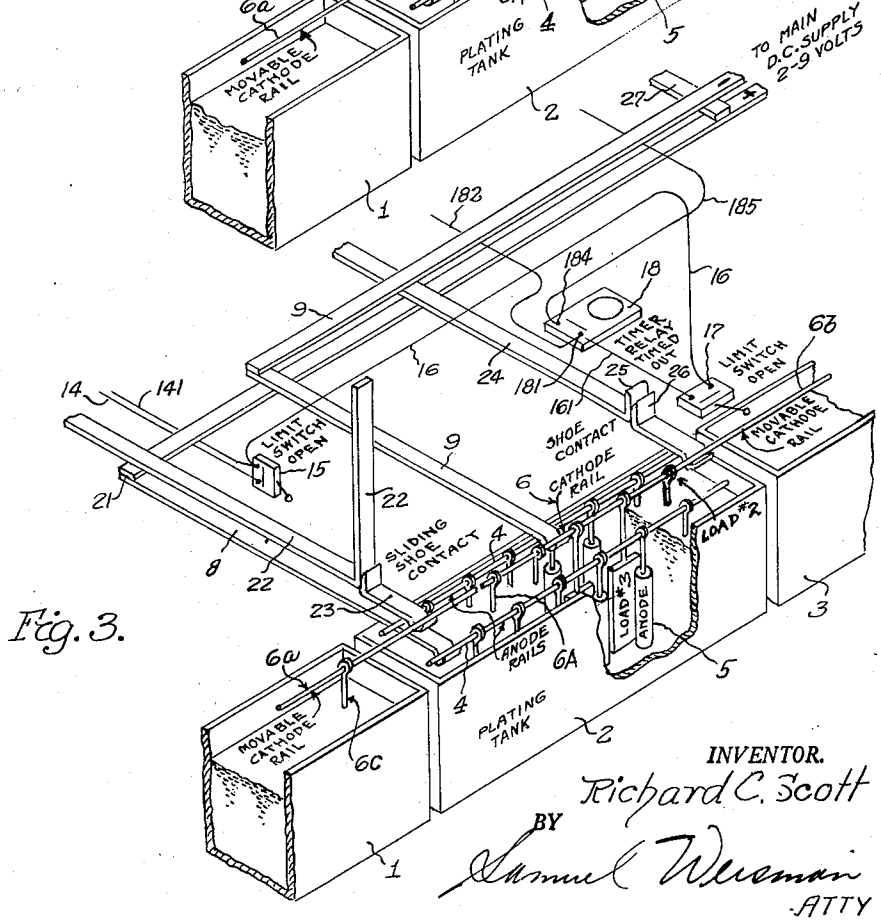


Fig. 3.

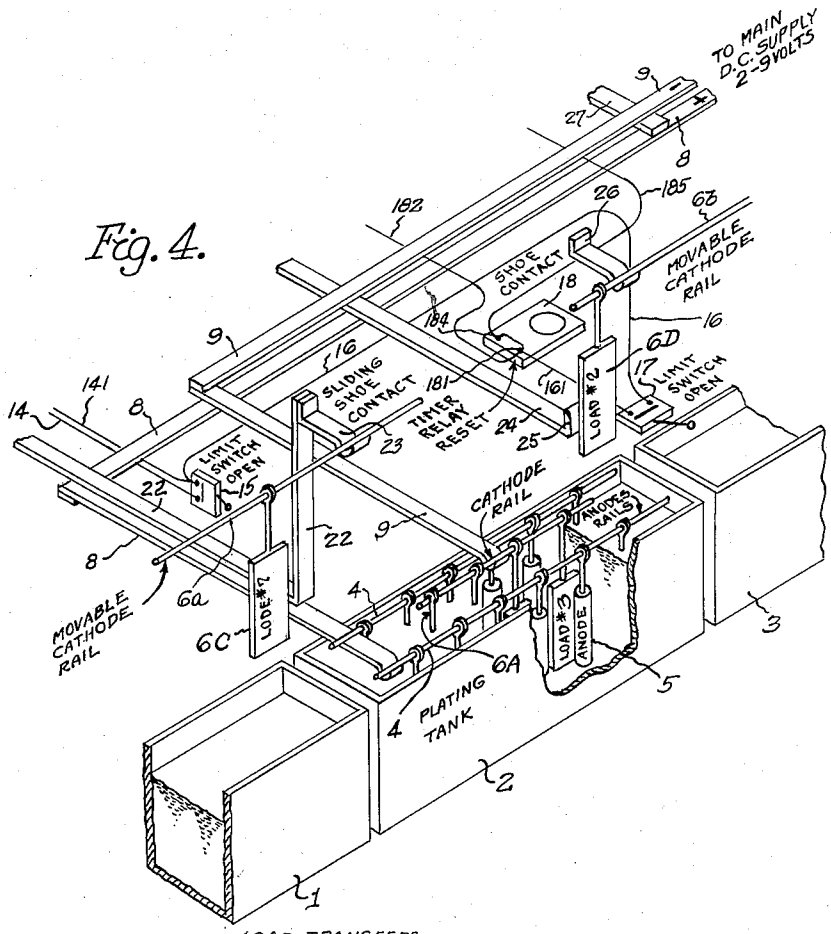
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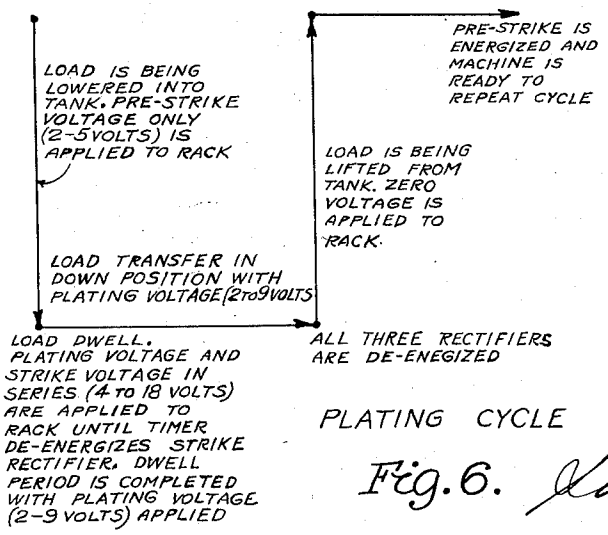
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VOLTAGE CONTROL SYSTEM

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Fig. 4.

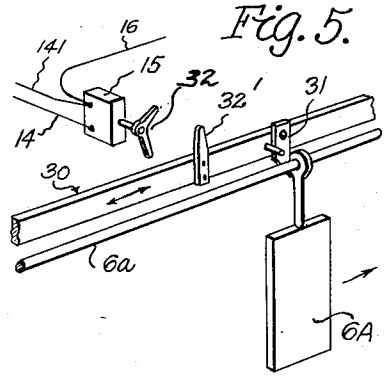




PLATING CYCLE

Fig. 6.

Fig. 5.



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2,849,392

VOLTAGE CONTROL SYSTEM

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Application June 1, 1954, Serial No. 433,655

3 Claims. (Cl. 204—198)

The present invention pertains to voltage control in plating machines, such as those disclosed in the patents identified below. The invention is especially applicable to the problems involved in chromium plating.

Plating machines of this character are equipped with vertically movable cathode rail segments to lift the work out of the bath when it is to be transferred from one tank to another. On returning the work to the bath and also on alining and disalining the movable rail segments with the fixed cathode rail segments, certain conditions occur which are detrimental to the plating. One of these conditions obviously is arcing.

Other detrimental conditions are passivisation and bi-polar effect. Although these terms are known in the art they will be defined briefly. When the work first engages the bath on being immersed, there is introduced an electrolytic cell between the work and the bath. The cell sets up a local reverse current which interferes with the plating, and this effect is known as passivisation. Also, on immersion opposite poles are formed on the work piece and bypass current on or in the piece. This action is known as bi-polar effect.

The principal object of the invention is to overcome these difficulties and is accomplished essentially by applying auxiliary voltages at selected times in the cycle of operation. The voltages are applied from preferably three auxiliary voltage sources and are of such respective values as to offset the stated difficulties at the times when they would otherwise occur. The control of the auxiliary voltages is automatic and is effected by or related to the movement of components of the plating apparatus.

Figure 1 is a perspective view of the apparatus, showing the load ready to be lowered into the tanks and only the pre-strike voltage applied;

Figure 2 is a similar view showing the load lowered into the tanks and the plating voltage applied;

Figure 3 is a similar view after the work has been transferred or shifted in the lower position and no auxiliary voltage applied;

Figure 4 is a perspective view showing the load lifted again in preparation for another cycle, and

Figure 5 is a detail perspective view illustrating the limit switch operating mechanism and the load advancing means.

Reference to these views will now be made by use of like characters which are employed to designate corresponding parts throughout.

In Figure 1 is shown a series of alined plating tanks **1**, **2** and **3** fitted with a pair of parallel anode rails **4** shown only in tank **2** for clearness. Anode bars **5** are suspended from the rails **4** in the usual manner. Between the rails **4** is a cathode rail **6** for carrying the work. The cathode rail system includes vertically movable segments **6***a* and **6***b* at the end walls of the tanks for the purpose of lifting work so that it may be transferred from one tank to the next. Mechanism for raising and lowering the segments is disclosed in the United States patents to J. V. Davis, No. 2,479,322 of August 16, 1949 and No. 2,650,600 of September 1, 1953. Work hooks **7** are slidably suspended

from the cathode rail and are advanced on the rail by a suitable means as known in the art and also shown in the aforementioned patents. A constant direct current at two to nine volts is supplied to the tanks from a suitable source by a positive line **8** connected to the anode rails **4** and a negative line **9** connected to the fixed segments of the cathode rail **6**.

Three separate sources of direct current, independently controlled, are provided for the purpose of supplementing the current from the line **8**, **9** at specific intervals in the plating cycle. These sources are represented by rectifiers **10**, **11** and **12**, which may be of the conventional dry-disc type commercially employed in the plating industry, although different sources may be used. The source **10** is known as the pre-strike rectifier (PSR) having an output voltage of two to five volts; the source **11** is known as the plating rectifier (PLR) having an output voltage of two to nine volts; and the source **12** is known as the strike rectifier (SR) having an output voltage also of two to nine volts. An alternating current source has one side **13** connected to corresponding intake terminals **101**, **111** and **121** of the sources. The other side **14** of this source passes through a limit switch **15** from which it is continued by a conductor **141** to the remaining input terminal **102** of the source **10**. Another conductor **16** from the output side of the limit switch **15** is joined to another limit switch **17** from which it is continued at **161** to a timer relay **18** at a terminal **181** thereof. The same terminal is joined by a conductor **182** to the remaining terminal **112** of the source **11**. Thus, the input to the source **11** is governed by the limit switch **15** and the limit switch **17**.

The output terminal **184** of the relay **18** is joined by a conductor **185** to the remaining terminal **122** of the source **12**. Thus, the input source **12** is controlled by both limit switches and the timer relay.

The positive output terminals of the respective auxiliary sources are designated by the numerals **103**, **113** and **123**; and the negative output terminals by the numerals **104**, **114** and **124**. The terminals **103** and **113** are permanently joined by a bar **120** which also connects with the negative terminal **124** of source **12**. The negative terminals **104** and **114** are permanently joined by a bar or conductor **21** terminating in a vertical contact **22** near the tank **2**. This contact is engaged by a sliding shoe contact **23** carried by the movable cathode rail segment **6***a* at a portion thereof directly over the tank **2**.

Assuming that the work moves from left to right in the tanks the shoe **23** is at the rear or loading end of the tank **2**. A bar **24** extends from the bar **21** toward the forward end of tank **2** where it terminates in a shoe contact **25**. The latter is engageable by a complementary shoe contact **26** carried by the movable cathode rail segment **6***b* at a point thereof directly over the forward end of the tank **2**. A prolonged interval of contact is available at the members **22**, **23** during the vertical movement but not at the contacts **25**, **26** for a purpose that will presently be described. The positive output terminal **123** of the source **12** is connected by a conductor **27** to the bar **8**. It is now evident that the outputs of the sources **10** and **11** are connected in parallel with each other, and the output of the source **12** is connected in series thereto. It is also evident that a voltage of two to nine volts is constantly impressed on the tank **2** from the source **8**, **9** and is supplemented from the sources **10**, **11** and **12** through operation of the various switching devices, as will be described.

In the operation of the device, it will be recalled that the current from source **8**, **9** is uninterrupted. It will be assumed that Figure 1 represents an arbitrary starting point in the cycle, wherein the work or load **6A** suspended from segment **6***a* is elevated and is about to be immersed in tank **2**. Limit switch **15** is closed, switch **17** is open

and timer **18** is de-energized. Therefore, additional voltage is available only from the pre-strike source **10**. The positive side of the circuit comprises terminal **103**, bar **120**, source **12** (merely as a path without addition of voltage) and conductors **27** and **8** to the anode rails **4**. The negative side comprises terminal **104**, conductors **21**, **22** and **23** to the load **6A**. However, source **10** is not effective until load **6A** engages the solution or "strikes," at which time the pre-strike voltage of two to five volts is applied to load **6A**. The effect of this pre-strike voltage which is less than plating voltage is to overcome passivisation and bi-polar effect.

When segments **6***a* and **6***b* with their loads **6A** and **6B** are fully descended as in Figure 2, switch **15** remains closed, while switch **17** closes by movement of parts and timer **18** goes into operation. Also, contact **26** comes into engagement with contact **25**. All three sources **10**, **11** and **12** are energized. Sources **10** and **12** deliver through the paths previously described. Source **11** is now active through its negative terminal **114** and bar **21** to contacts **22** and **23**. Since the sources **10** and **11** are in parallel, their voltages do not accumulate, and the higher voltage of source **11** prevails. To this is added the voltage of the series connected source **12**, so that four to eighteen volts are applied. It may be noted that timer **18** need not go on until segments **6***a* and **6***b* have actually alined with fixed segment **6**, so that there is equal voltage throughout the alined segments and hence no arcing.

There is a dwell interval here in which the work is not shifted horizontally. The so-called strike voltage of four to eighteen volts is applied only temporaliy and is timed out, after proper duration, by the timer **18**. The purpose of the strike voltage, which is approximately twice the normal plating voltage, is to cover areas that are hard to plate. The dwell interval is completed after source **12** has been timed out, thereby restoring the normal plating voltage of two to nine volts.

At normal plating voltage the work is shifted horizontally to the position shown in Figure 3 by the aforementioned mechanical means. The limit switches **15** and **17** are opened by moving parts and, with the timer **18** out, the sources **10**, **11** and **12** are de-energized. Only source **8**, **9** is effective. It will be seen that load **6A** has moved from segment **6***a* to segment **6**. Other work pieces **6C** and **6D** have been moved on to the segments **6***a* and **6***b*. Segments **6***a* and **6***b* are now raised to the position shown in Figure 4, also without arcing because of the uniform voltage throughout the cathode rail system. By pusher means of the character previously mentioned, loads **6C** and **6D** while elevated are shifted to the positions of loads **6A** and **6B** in Figure 1. This mavement closes the limit switch **15** to start a new cycle from this position.

The means for operating the limit switches and advancing the work is illustrated in Figure 5. With respect to the segment **6***a* for example, there is a reciprocating work pusher bar **30** in the elevated position and a similar bar in the lower position as in the aforementioned patents. Each such bar carries pivoted pusher fingers **31** adapted to swing only when retracted and on forward movement to engage the hooks **7**. The actuating member for the limit switch may be a rotary cog wheel **32** engageable by a switch tripper **32'** on the bar **30** to open and close the switch at proper times as described.

Although the limit switches are operated from the respective bars **30**, the timing is related functionally to the vertical movements of the segments **6***a* and **6***b* as set forth.

It is possible under favorable condition to omit the pre-strike operation, thus eliminating the pre-strike rectifier. Also by a re-arrangement of the direct current constant source, this power supply can be substituted for the plating rectifier whereby the latter may also be omitted.

Although a specific embodiment of the invention has been illustrated and described, it will be understood that various alterations in the details of construction will be made without departing from the scope of the invention as indicated by the appended claims.

What I claim is:

1. In an apparatus for chrome plating a nickel-plated workpiece, a tank, an electrode in said tank, transporting means for moving the workpiece relative to said tank including means for lowering the workpiece from a fully emersed position to a fully immersed position, first circuit means effective while the workpiece is being lowered to said fully immersed position for establishing a potential difference of a first preselected finite amplitude between said electrode and the workpiece, second circuit means for establishing a potential difference of a second and different preselected finite amplitude between said electrode and the workpiece, third circuit means for establishing a potential difference of a third and still different preselected finite amplitude between said electrode and the workpiece, and means controlled by said transporting means and effective after the workpiece has been lowered to said fully immersed position for successively enabling said second and third circuit means.

2. In an apparatus for chrome plating a nickel-plated workpiece, a tank, an electrode in said tank, transporting means for moving the workpiece relative to said tank including means for lowering the workpiece from a fully emersed position to a fullly immersed position, first circuit means effectiive while the workpiece is being lowered to said fully immersed position for establishing a potential difference of a first preselected finite amplitude between said electrode and the workpiece, second circuit means for establishing a potential difference of a second preselected amplitude greater than said first preselected amplitude between said electrode and the workpiece, third circuit means for establishing a potentional difference of a third preselected amplitude intermediate said first and said second preselected ampltudes between said electrode and the worpiece, and means controlled by said transporting means and effective after the workpiece has been lowered to said fully immersed position for successively enabling said second and third circuit means.

3. In an apparatus for chrome plating a nickel-plated workpiece, a tank, an electrode in said tank, transporting means for moving the workpiece relative to said tank including means for lowering the workpiece from a fully emersed position to a fully immersed position, first circuit means effective while the workpiece is being lowered to said fully immersed position for establishing a potential difference of a first preselected finite aplitude between said electrode and the workpiece, second circuit means for establishing a potential difference of a second preselected ampltude between said electrode and the workpiece, switch means controlled by said transporting means and actuated after the workpiece has been lowered to said fully immersed position for enabling said second circuit means, additional circuit means for establishing a potential difference of a third preselected amplitude between said electrode and the workpiece, and means controlled by said switch means for enabling said additional circuit means a preselected time interval after the enabling of said second circuit means.

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