# CONSTRUCTION OF A FABRE GLOTTOGRAPH

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## Introduction.

In the last decade a good deal of research has been done at different laboratories to develope equipment for investigation of the opening and closing movements of the glottis. In the year 1967 we have developed a photo-electric glottograph (3), and recently we have finished the prototype of an electrical glottograph according to the principles of Ph. Fabre (1), (4), (5), (6), (7).

The photo-electric glottograph registers the opening square of the glottis which probably corresponds very well to the primary voice source in the normal phonation range. The disadvantage of this type of glottograph is that not all subjects can or will insert the plastic tube with the light sensitive transducer through the nose down into the pharynx.

The Fabre Glottograph has not this drawback. This apparatus employs two electrodes which are fixed on each side of the thyroid cartilages. On the other hand some problems arise when curves are to be interpreted because of the up and down movements of the glottis and the air pressure variations in the pharynx both of which influence the glottograms. Conclusions are thus more difficult when based upon the Fabre Glottograms than when based upon the photo-electric glottograms (2).

The construction of both types of glottographs has enabled us to make comparisons between the two instruments in order to see to what extent it is possible to use the less precisely registering Fabre Glottograph instead of the better photo-electric glottograph.

## 2. The principle of the Fabre Glottograph.

The Fabre Glottograph is used for measurements of variations of the electrical impedance between the vocal cords. This impedance variation is measured by means of a high frequency alternating current which is sent through the larynx between two metal plates placed on each side of the thyroid cartilages. When the vocal cords vibrate they modulate the current between the metal plates. The modulated high frequency signal is rectified, filtered and amplified, and the resulting DC-signal which corresponds to the variations in the electrical impedance in the glottis may be recorded e.g. on an oscilloscope or on any form of recording device.

3. Requirements on our Fabre Glottograph.

When planning the construction we put up the requirements that our Fabre Glottograph

(1) should have the capability of being easily matched to the different glottis impedance of different subjects;

(2) should be able to handle frequencies from DC up to 10.000 cps (see Fig. 3);

(3) should have a low impedanced output of a few volts which would faciliate the matching to different recorders.

4. Survey of construction. (Fig. 4.)

The generator oscillates at the frequency 300 kcps. The generator consists of three stages, - a modified Hartley oscillator, a buffer stage, and an emitter follower.

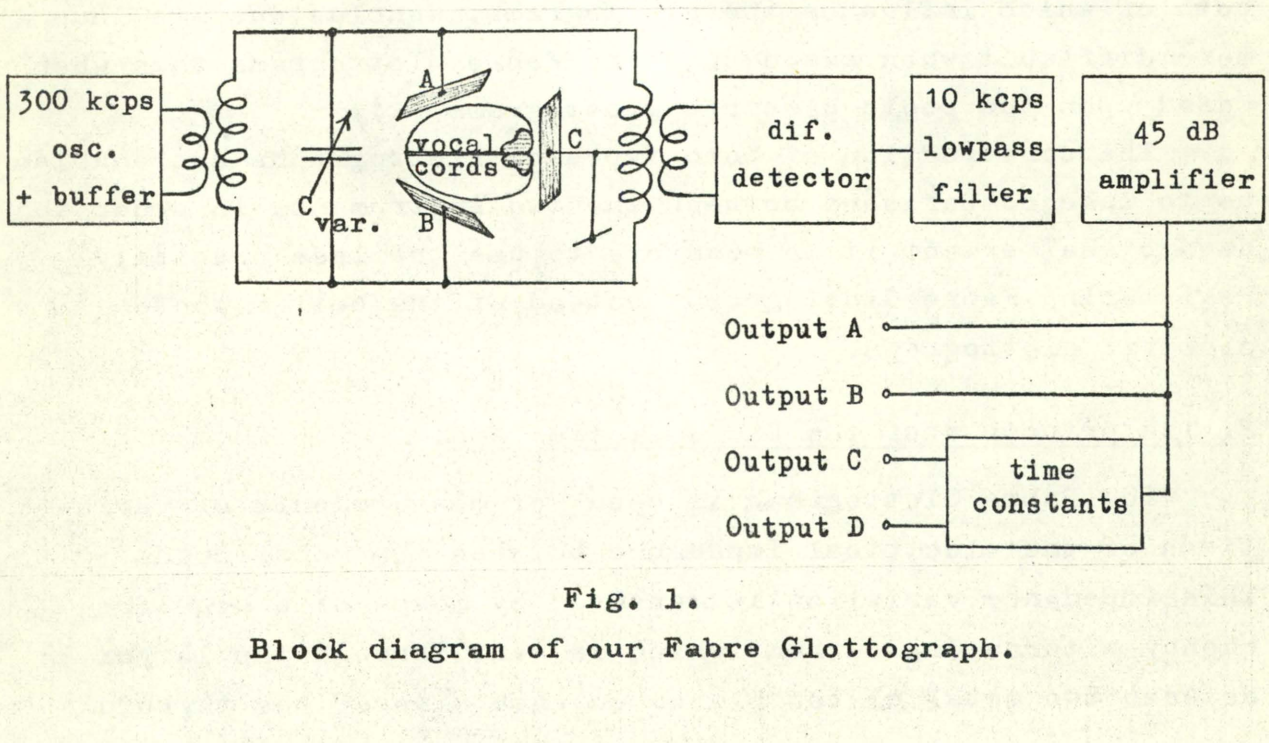


Fig. 1.

Block diagram of our Fabre Glottograph.

The changes in glottis impedance during fonation are sensed by two balanced electrodes placed on both sides of the laminae thyreoidei (Fig. 1). By balancing the electrodes it has been possible to cancel out interferences from electro-magnetic fields such as our local broadcast station.

Some trouble may arise when the glottograph is to be used by many different subjects, because both the electrical parallel-shunting resistance of the fat tissues between the electrodes and the electrical series-resistance of the fat tissues and the laminae thyreoidei vary considerable from one subject to another. This causes a reduction of the effective degree of modulation produced by the glottis which in turn results in a loss in the total sensitivity of the glottograph. In order to avoid some of these physiologically conditioned problems, we have designed the "glottis-circuit" in such a way that it is possible to adjust the circuit for best matching to the glottis impedance. A variable condenser is connected between the electrodes. By means of this condenser it is possible both to adjust the glottis circuit for maximum output (correct matching impedance) and with the same control to adjust the output level to zero volts DC, which is indicated by the meter in the output circuit. An electrical analog to the physiological part of the system is shown in Fig. 2.

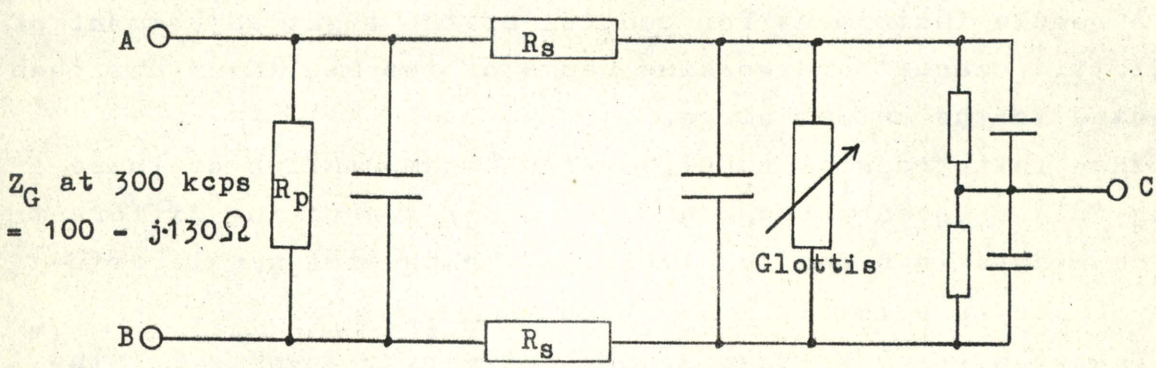


Fig. 2.
An electrical analog simulating the complex impedance of the larynx. (Subject Poul Thorvaldsen. Size of electrodes 2 $cm^2$ each. Conducting jelly has been applied to the electrodes.)

The resistors called $R_p$ and $R_s$ are represented by short-circuiting and resistive fat tissues which reduce the signal level.

The balanced output from the glottis is fed to a transformer with two symmetrical primary coils which is followed by a differential detector where the two transistors alternate between cut off and active conditions. This detector type is preferred because of its hum and noise rejection. The collectors of the double transistor are limited to a variation between ±8 volts by means of two zener diodes. This is necessary in order to avoid an excessive collector/emitter-voltage in the off condition.

The detector is followed by a 10.000 cps lowpass filter and an integrated amplifier (Philco type PA7709C). The input of this amplifier is also limited to ±8 volts to avoid damage. The condenser of 1 nF limits the frequency response of the amplifier to maximum 15 kcps.

The output stage is able to drive recorders which require some power. When short-circuited the output stage can deliver maximum 150 mA peak to peak. The maximum output voltage is 25 volts peak to peak.

The frequency response of the total electronic circuits from the electrodes to the output terminals is shown in Fig. 3. The frequency response has been controlled by means of a 300 kcps sine wave modulated with the low frequency oscillator in the spectrum analyzer.

A needle instrument for control of the right adjustment of the glottis circuit and working range of the amplifier has been connected to the output stage.

The glottograph is supplied with 4 outputs: two of these having full frequency range and the other two having different time constants in order to stabilize the physiological variations of the zero level.

The stabilized voltage supply delivers ±15 volts for the amplifier stage and for the reference voltages, whereas the generator unit and detector work at +80 volts.

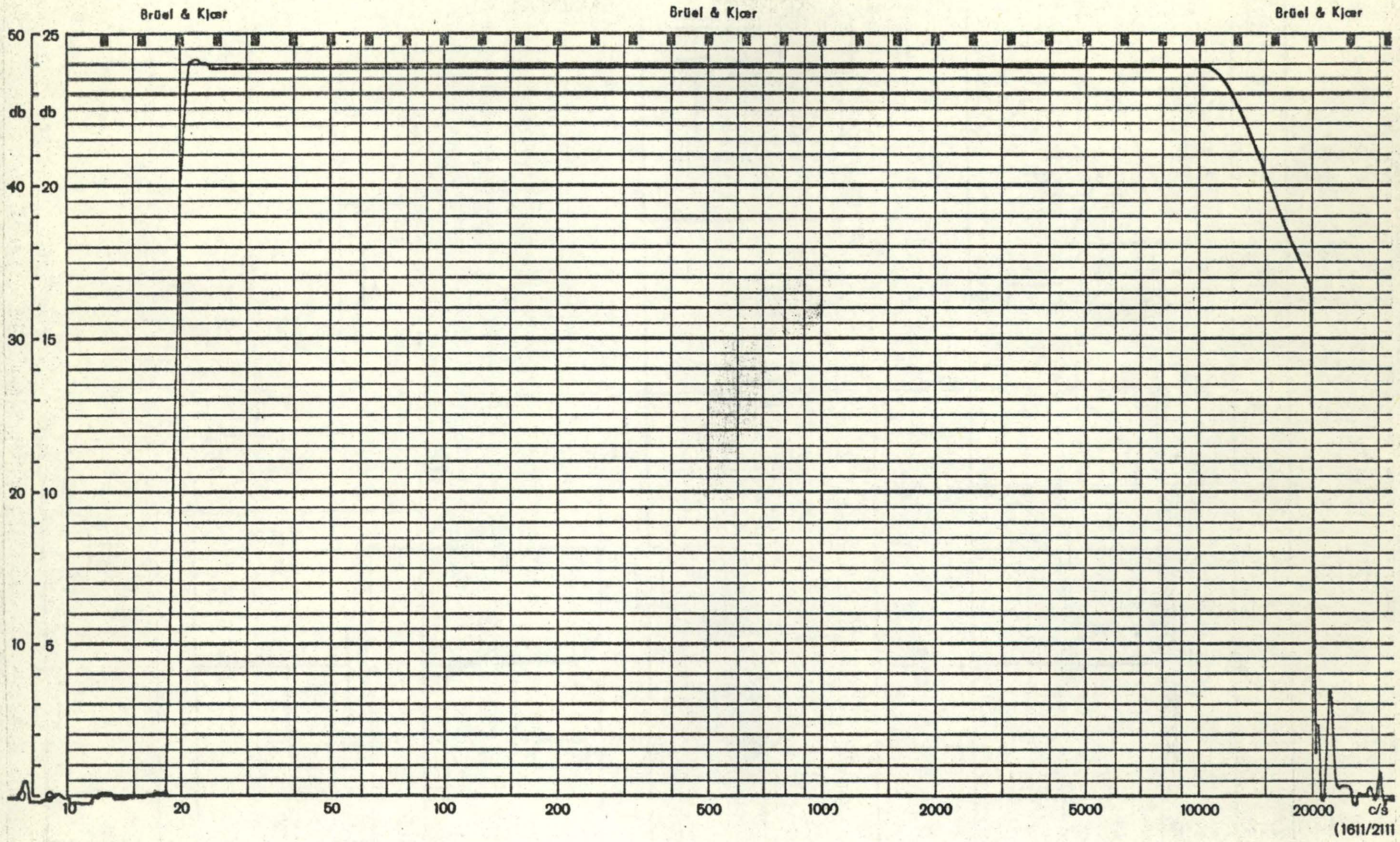


Fig. 3.

Frequency response of the glottograph without the final filters. The level variations from DC to lo.ooo cps are below o.l dB. (5o dB scale). Above lo.ooo cps the response falls at a rate of 18 dB/octave. The spectrum analyzer is not able to analyze below 2o cps.

Obtained specifications:

Oscillator frequency: 3oo.ooo cps.

Generator impedance: 5o ohms.

Generator output, loaded throat electrodes: 0.8 volts RMS.

Generator output, unloaded throat electrodes: 1.6 volts RMS.

High frequency current through larynx: 15 mA RMS.

Voltage amplification of the DC amplifier: 18o times = 45 dB.

Mains supply: llo-13o volts or 22o-24o volts/5o-6o cps.

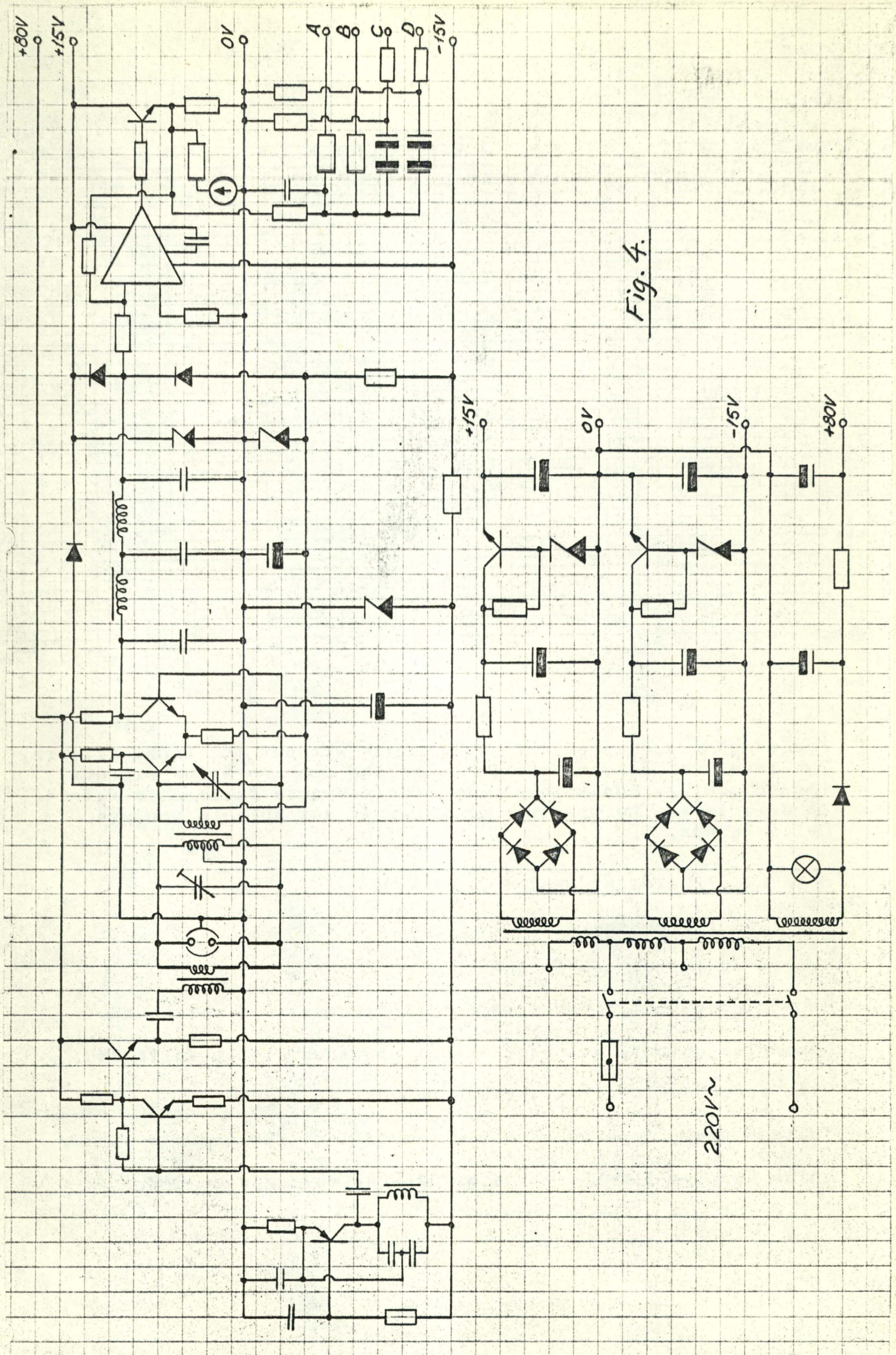


Fig. 4.

| | Output A | Output B | Output C | Output C |
|---|---|---|---|---|
| Output impedance | 60 ohms | 500 ohms | 5.6 kohms | 10 kohms |
| Min. load impedance | 0 ohms | 0 ohms | 0 ohms | 0 ohms |
| Max. output voltage $R_L = R_{out}$, f=100 cps | 3.0 V RMS | 4.2 V RMS | 4.2 V RMS | 4.2 V RMS |
| Max. output current $R_L = R_{out}$, f=100 cps | 50 mA RMS | 2.4 mA RMS | 0.75 mA RMS | 0.42 mA RMS |
| Frequency range (-0.5 dB) | DC - 10 kcps | DC - 10 kcps | 12 cps - 10 kcps T = 25 ms | 0.08 cps - 10 kcps T = 4 sec. |
| Integrated noise voltage at output $R_L = R_{out}$ | 7 mV RMS | 7 mV RMS | 7 mV RMS | 7 mV RMS |
| Dynamic range $(10 \cdot \log \frac{P_{out}}{P_{noise}})$ | 53 dB | 56 dB | 56 dB | 56 dB |

Specifications of the four outputs.

Fig. 5.

As for the results obtained with the above described Fabre Glottograph see the article in this report: "Comparison between a Fabre Glottograph and a Photo-electric Glottograph".

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The construction of the Fabre Glottograph is supported by "Statens Almindelige Videnskabsfond" (The Danish State Research Foundation).

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