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R.F. Note #90

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7/19/83

Subjects:
1. Loop Coupling Test
2. Consequences of same
3. Alternate coupling schemes
4. More thoughts on neutralizing
5. K800 driver tests
6. Present status of thoughts on K800 resonator

1. Loop Coupling Test

On 7/13/83 we tested out the loop coupling scheme described in RF Note #85. The loop was installed in the lower "C" stem and connected by a 6 ft. length of RG59U (75Ω) to the output of the 4 inch directional coupler of the drive line from the "C" transmitter. At the transmitter the line was disconnected from the anode circuit and connected via a 150Ω resistor to the 58 Ω cable leading from the 50 watt amplifier.

We excited the "C" dee and noted that unlike last week when we could break through the 200 volt multifactoring level, we now had to operate below that level. We first tried 20 MHz with no success (success meant that we would get no reflected power). We moved to 27 MHz and were able to get a 1 to 2 ratio of reflected to incident power, meaning that although we were close, the loop was still too small.

We next put a variable condenser (30 to 1000pf) in series with the loop and found that we could drive at 27 MHz satisfactorily with about 400 pf and maximum loop coupling. We could also drive at 20 MHz, with about 800pf. We were unsuccessful in demonstrating that satisfactory drive conditions could be achieved at 14 and 10 MHz, but this was probably due to the press of time and low signal levels due to the multipactoring problem. That was the end of the test.

2. Causes For And Consequences Of This Failure

I had calculated that loops of the same size as the neutralizing loops would be satisfactory, but in this calculation I failed to include the fact that the neutralizing loops picked up voltage 120^{o} apart in phase and therefore had $\sqrt{3}$ times as much differential voltage. This accounts for a factor of 1.7 in my error. A factor of two comes from the fact that I neglected to take into consideration the fact that we have neutralizing loops on both upper and lower stem. Altogether then, the loop should have been 3.5 times bigger than it was.

The consequences I believe, are that this type of loop coupling is not worth considering further.

3. Alternate Coupling Schemes

The only practical alternate coupling scheme I can think of is to use capacity coupling on the air side of the insulator. My calculations show that at 28MHz the voltage on the corona ring should be about 1/5th the dee voltage and the coupling capacitor should therefore be about 10pf (vs the present 2pf).

Keeping a two inch spacing to the corona ring and central conductor we would need an area of 90 sq. in. or a piece of an anulus 3" wide by 30" long and there is just enough room to do this. However, this is asking for a lot of area. Instead, we could use half this area, and vary the spacing to the corona ring from one inch at 27.5MHz (where the voltage is low) to 2 inches at 9MHz, where the voltage is high, but only 5pf's are necessary.

The big unknown here is the actual rather than the calculated voltage. If we knew this, we could proceed or cancel the idea. There are two ways to determine this. One way is to excite the dee at 27.5 MHz at 100 volts and measure the corona ring voltage with the H.P. voltmeter. The other way is to again exciting the dee to 100 volts, place a variable capacitor between the end of the TR line and the corona ring and find out what capacity is needed to get zero reflection in the line. I propose that we try both!

Alternative schemes involving a fixed capacitor with a variable capacitor or inductor to ground, or various modifications of the loop coupling scheme involving reducing the line impedance to 10 ohms or so don't look very appealing, but will be studied.

4. More Thoughts On Neutralizing

For inphase operation with the present neutralizing method, the three dees will be independent of each other providing the ion source and puller arrangement shields dees B & C as well as they do now. So consideration in the design of the central region for other harmonics should be given to trying to achieve at least as good shielding between C & B dees as we presently have.

Since we only achieve perfect neutralizing with our present loops down to only about 11MHz, and in doing so compromise both the voltage holdhing ability at low frequencies and the high frequency limit, we should reconsider other neutralizing schemes, especially for the K800 design.

An appealing design is the fixed capacitor plus $\lambda/2$ line between the corona rings, as proposed in RF note #78 . Texas A & M is proposing to use this scheme on their otherwise copy of the K500 cyclotron. I think this should be considered further, and perhaps a test of it made on the K500! It has many desirable features over our present loop coupling method.

5. K800 Low Level Driver Tests

We have measured the various modes in the K800 driver. There was considerable difficulty in getting the driver grid tunable over the required range because of various modifications made to the geometry from the K500 circuit. But by moving various components about we achieved tunability. The driver anode plus final grid circuit proved to have many problems. Figures 1 & 2 show these modes as a function of the turn number of the variable capacitor.

There are at least three tunings of the fundamental where harmonics can excite 2nd, 3rd, 4th and 5th harmonic modes. There is no question but that this will cause trouble at about at least 6 or 7 fundamental frequencies. One of the modes, a fixed frequency at about 50 MHz can be moved a little bit by varying the series capacitor. The other two are immutable to this variation, and their circuit has not as yet been identified, but a good candidate is the mode associated with the 1000pf capacitor. We make no judgments yet, but very likely we will have to return to the design described and calculated in RF note # 82. I don't know why it was changed.

Meanwhile, the water circuits are being constructed in the K800 basement and by the end of the week we should be able to high power test the driver. Complete transmitter tests should commence in two weeks.

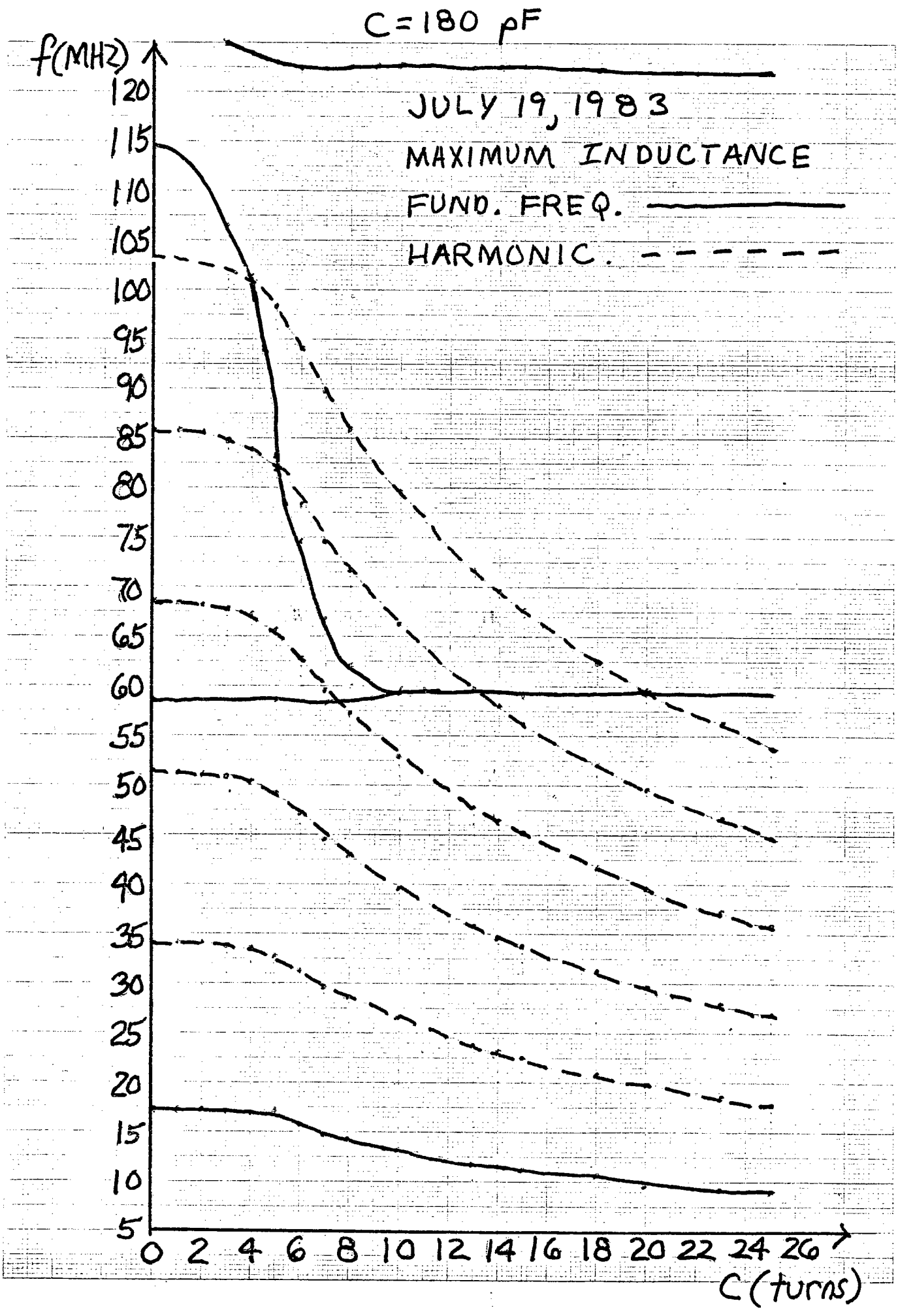
6. Present thoughts on the K800 resonator. H. Blosser, after much cogitation, has finally decided that we will use a 12 sided panel design, similar to the K500, for the K800 outer air stem conductors. We will use outer conductor fingers with graphite silver 1/16 in contact tips and the K500 design for the inner contacts.

The dee is designed, in that a 1/4 scale clay model exists. The insulator geometry design will be as elucidated in RF note # 72, and the vacuum part of the inner stem will be a smooth transition from 5 inches to 10 inches just prior to entering the insulator.

Ottarson, when he isn't doing other also useful things, is designing a wood and copper full scale model with two 6 ft. dee stems plus dee, so that we can decide that the upper frequency can be reached without pushing the insulator further towards the median plane and thus making our present neutralizing scheme more difficult. It is estimated that this model may exist by 1/1/84.

Meanwhile, we are experimenting with soldering copper tubes to panels, and with riveting brass bars to copper sheet as an alternate to braking the panels.

Fishing on Beaver Lake in Arkansas will be just great after this horrible Michigan weather.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JULY 19, 1983
MAXIMUM INDUCTANCE
FUND. FREQ.
HARMONIC.
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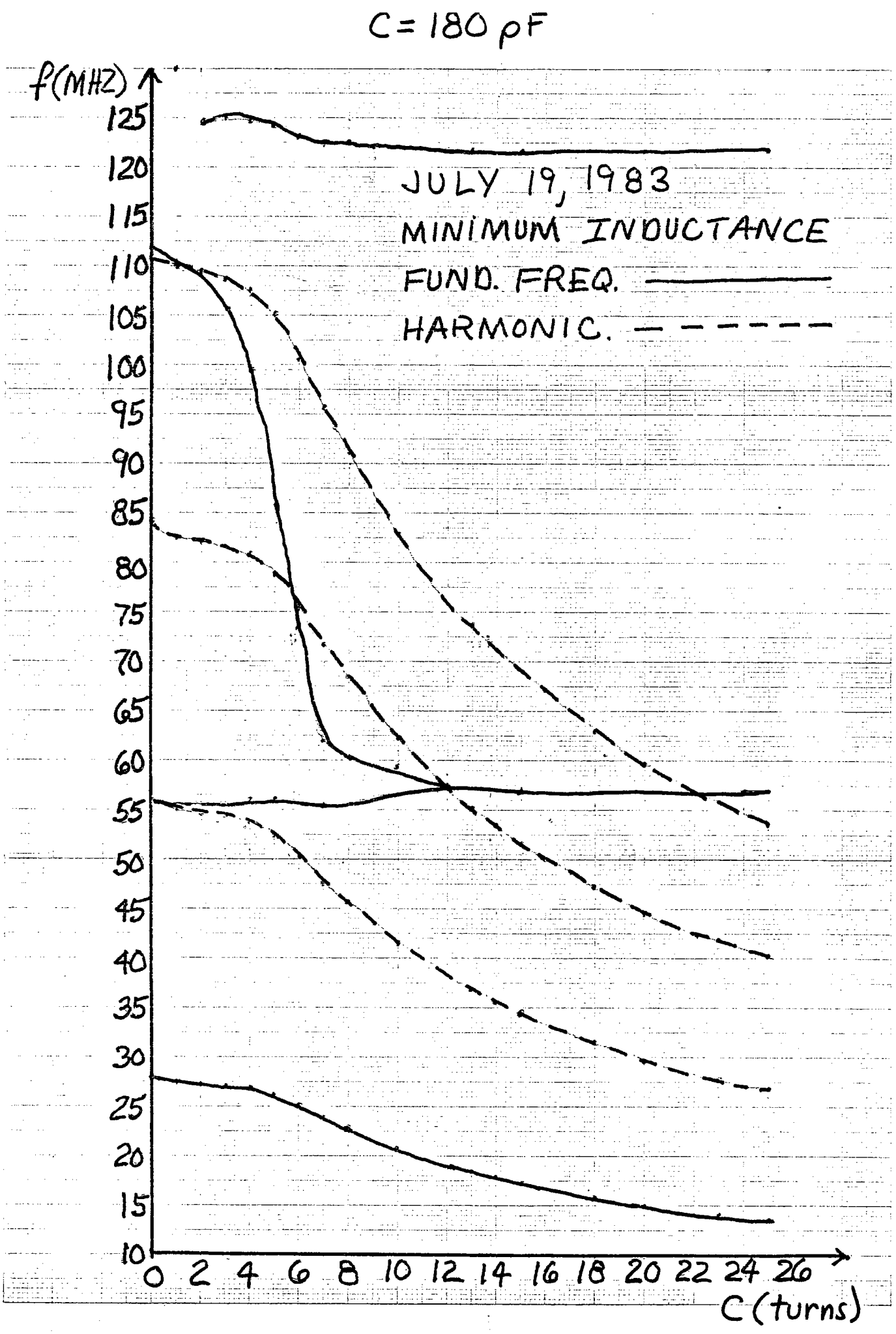
C (turns)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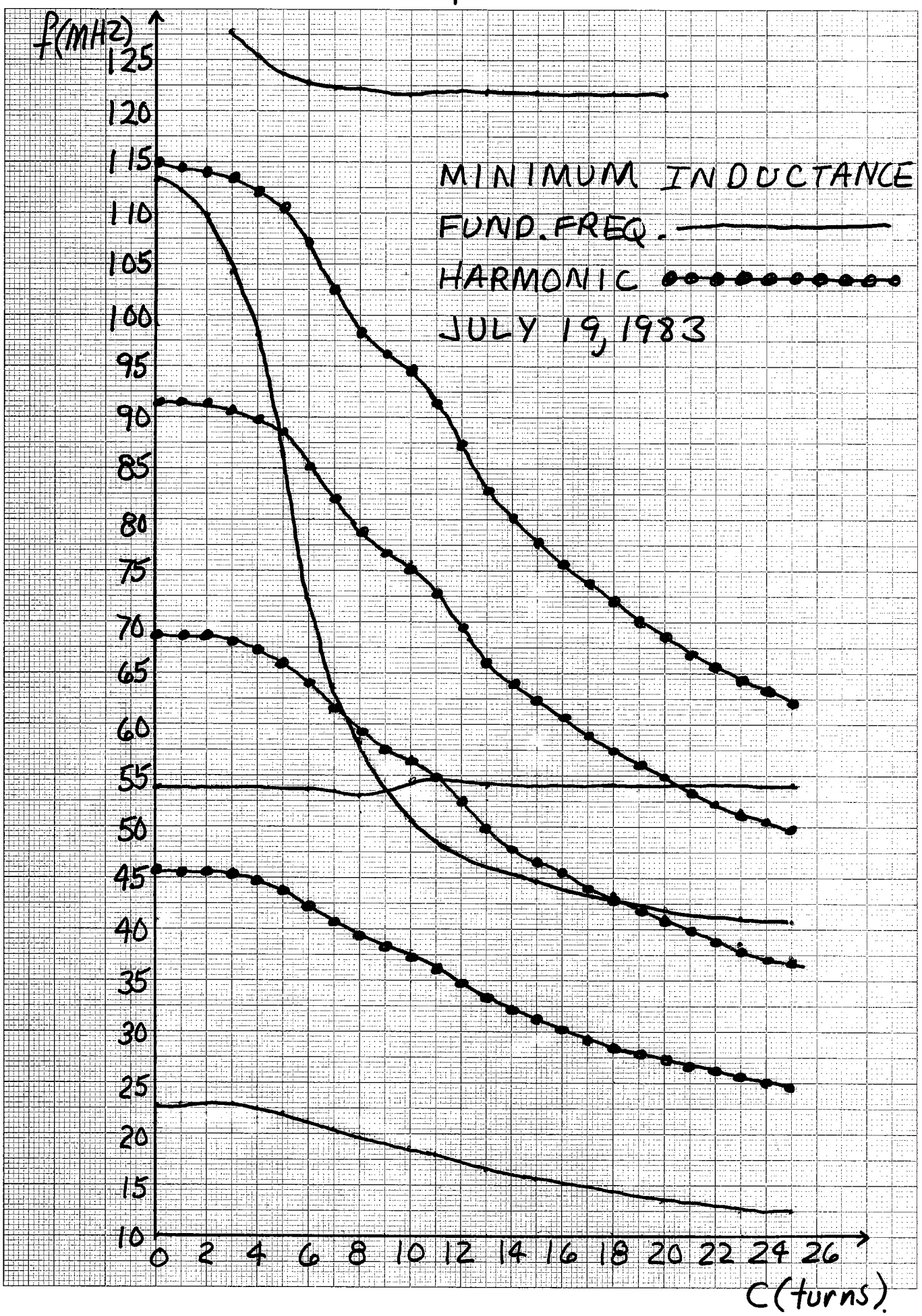

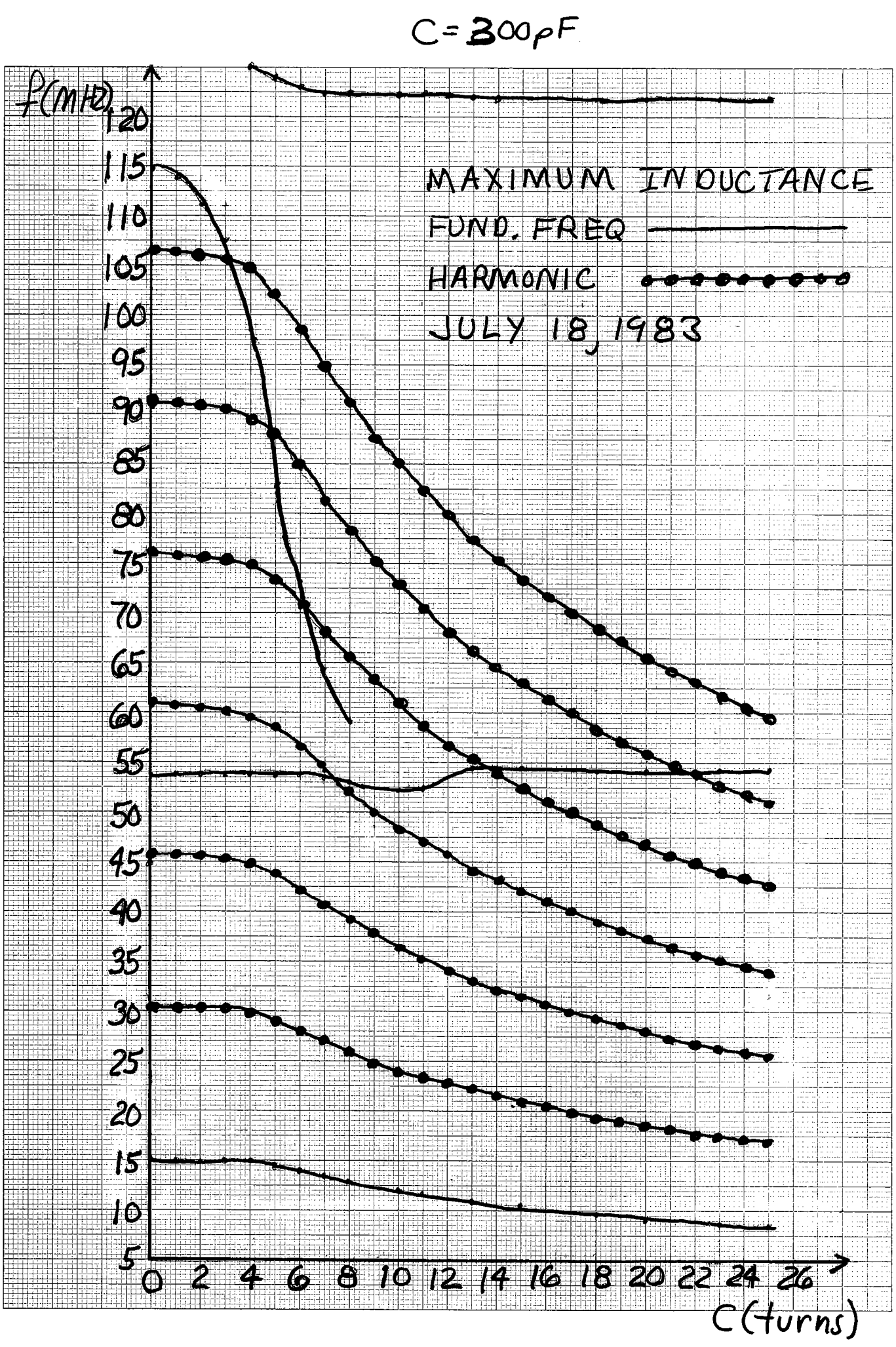

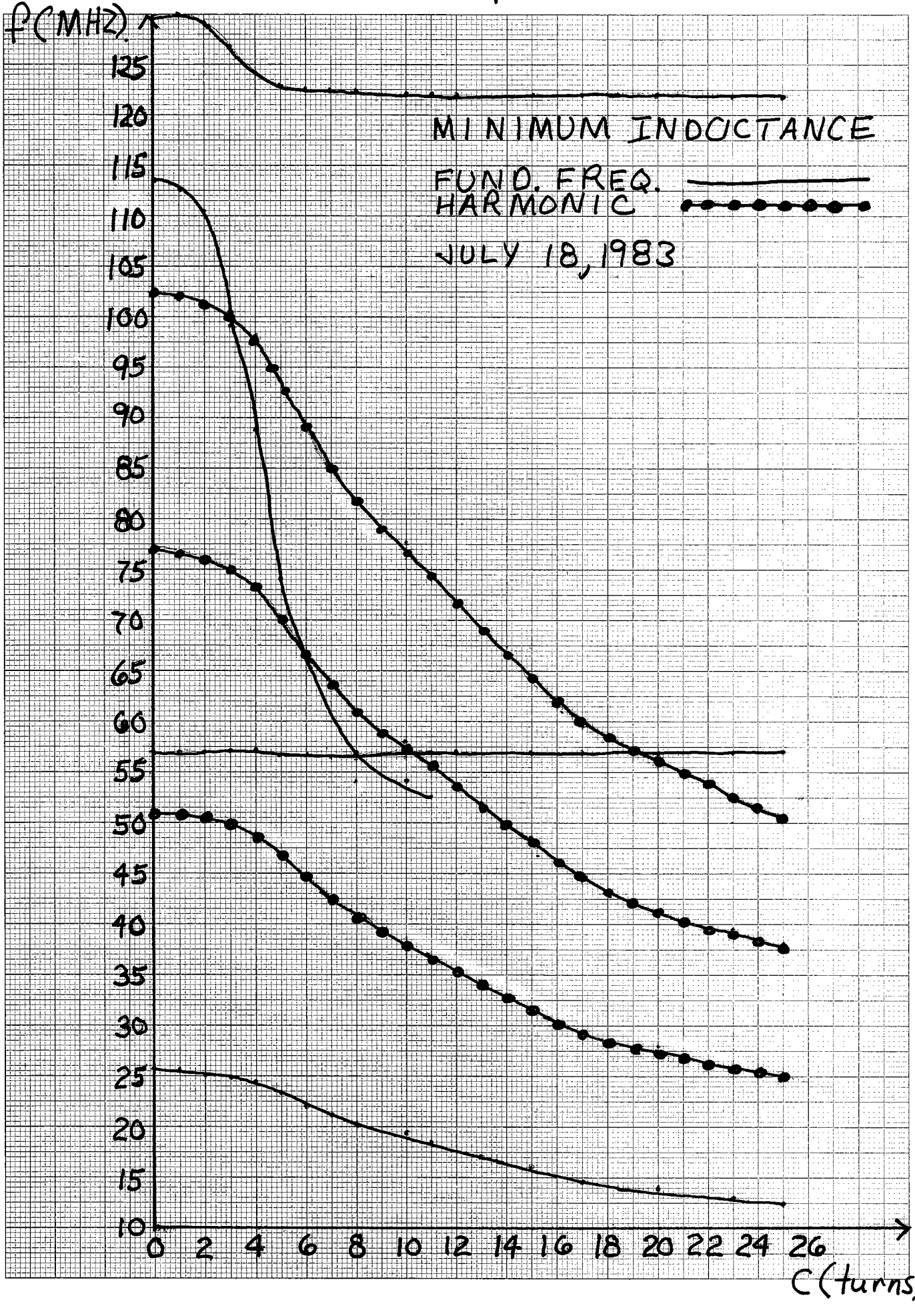

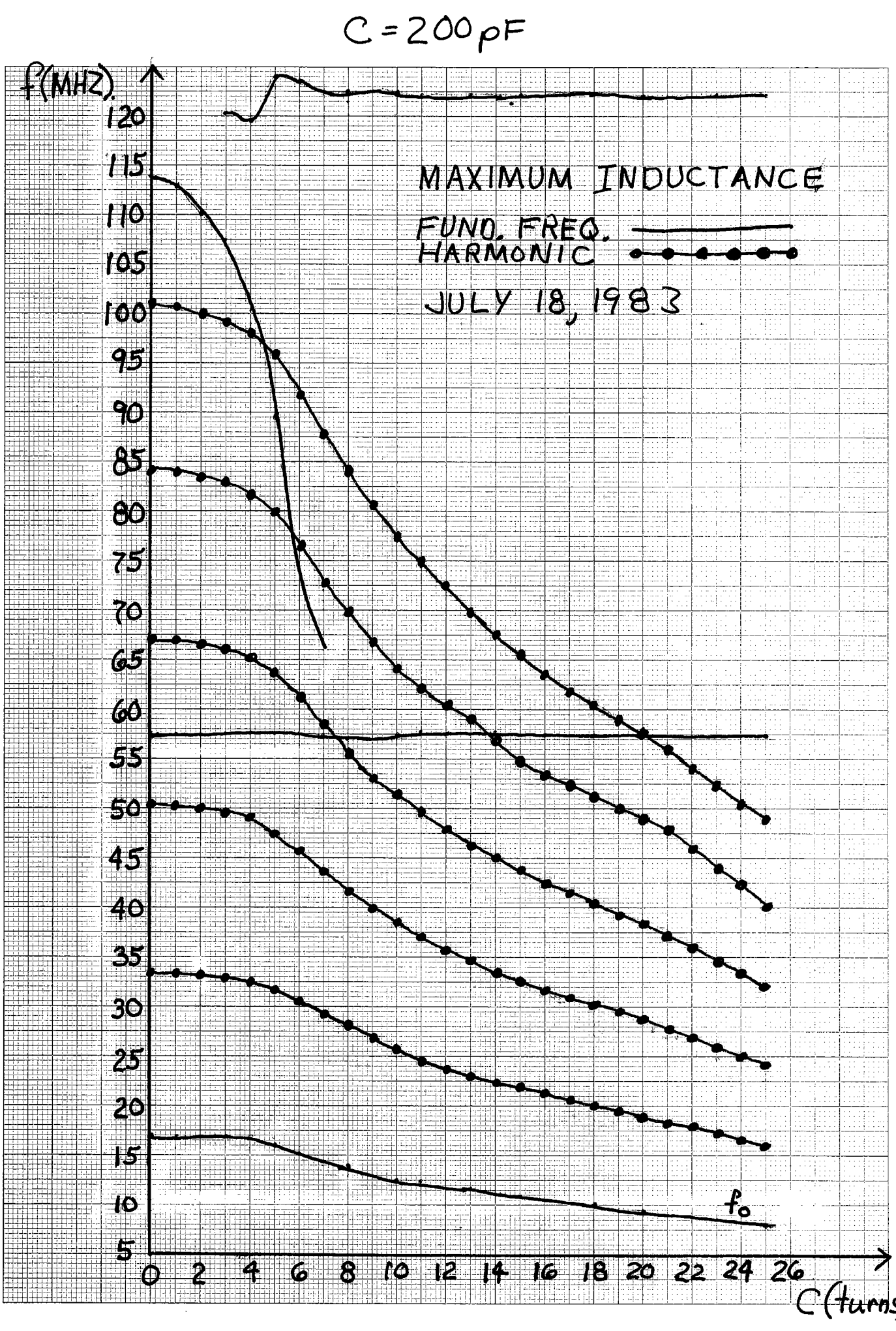

C = 180 pF