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Interviewee: John V. Atanasoff (1903-1995)
Interviewer: Bonnie Kaplan
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KAPLAN:

This is an interview with Dr. John V. Atanasoff at the Smithsonian Institution, August 10, 1972. I am Bonnie Kaplan. I suppose we should start with what we were doing last week when you were trying to emphasize the difference between your method of adding and the counting by ones method of adding, just so we'll get that all down. Do you want to tell me about that again, please.

ATANASOFF:

Last week I was going over with you the different approach to adding which began with me essentially on my trip to the honky-tonk - do you know what honky-tonk means?

KAPLAN:

It's some sort of a bar.

ATANASOFF:

Yes, in Illinois in the fall of 1937 - in the winter of 1937, according to this concept addition was to be performed by logic and not by successive inching of a dial around by successive addition of ones. This was the essential difference which I felt was original with me at that time. For instance, the Harvard-Aiken MARK I used essentially the same method of computation that computers of the type of Monroe did, in which if one wanted to add five you added five ones into a dial, by having five teeth appear on a wheel when you pressed the five key, so that in one revolution the dial would be inched forward five spaces. Then the Eccles-Jordan circuit essentially turned towards the successive addition of ones in the same way, usually however base two number system rather than base ten number system. I began my interest in electronic computation by thinking in the Eccles-Jordan lines. The circuit was then in use, in fairly wide use for counting cosmic ray impulses, impulses from ionization chambers, Geiger-Muller counters and the like, and had proven satisfactory. According to the logic system there was to be a logic circuit which looked at the state of the - of each of the two numbers being added, each state corresponding to the digit in question and also carried in a memory from a previous digit in the computation and then combined these by internal logic and imposed a consequent state upon some memory devices and carried into a transitory memory a carry-over for use in the next position of calculation. The high speed of the electronic circuitry permitted the same logic circuit to be applied successively to all of the digits of a large number so that high speed was maintained with considerable simplicity of circuit and all that was required was a memory, complete memory.

KAPLAN:

What was the state of logical circuitry at the time? Do you know anything about logic circuits? Did people make logic circuits before that or was this a completely new concept for you?

ATANASOFF:

I'm trying to think how to answer you. I cannot remember anything that was secret to the logic circuitry that was necessary for computation. I think that the idea must have come from somewhere but where it came from is hard for me to say. Yes, well, all ideas come from somewhere, from some happy coincidence, from some combination of circumstances which give vent to the ideas. One can't expect that ideas spring full-bloom within the human anatomy. Be that as it may, I have no referrant to link you to. I think that I was looking for another approach to computation. I believe that at this stage I was impelled a little bit by a peculiar circumstance. I intended to use Eccles-Jordan circuitry to give the two numbers being added and/or subtracted and to give vent to carry-over so that the ultimate state of a small Eccles-Jordan combination would then be recorded on a memory, so that I wouldn't have to use Eccles-Jordan circuit for logic circuit. That was a curious combination of circumstances. When it came to build Eccles-Jordan circuit we weren't very expert and it didn't work very well and perhaps this is a little bit the cause of my sticking at the other possibility in which the firm element, the state of the logic circuit, was stationary. It had imposed upon it the state coming from each of the numbers being added and/or subtracted and the state was correspondent to the absence or presence of carry-over. Then it was in a stationary state. The logic circuit was in a stationary state for a moment, for a short space of time here and during that time it steadied into the state which indicated the output which was acquired - that is, the number that went into the end of the sum and the number that went into the carry-over.

KAPLAN:

What made you think of using vacuum tubes?

ATANASOFF:

Well of course I had decided that it wasn't possible. You see, I was going to build a very complicated computing machine so I was looking for economy and I realized that if I could do this with vacuum tubes and the vacuum tube circuits were fast enough so that I could successively solve the sums of all the digits in a large number and thus economize on time and material, the only additional material that would be required as you made the numbers larger and larger would be additional elements of memory.

KAPLAN:

First you decided you were going to use base two for your arithmetic?

ATANASOFF:

Yes, because it was simpler.

KAPLAN:

You also decided at some stage that you were going to do addition the way people do addition, by adding two numbers and a carry instead of doing it by adding successive ones. Did you decide that first and then try to find a way to do it?

ATANASOFF:

Well, I'd have to do a lot of thinking to give you a final answer to this. These things were all in my head rattling around more or less simultaneously. This sequential addition - I call it sequential addition where the logic circuit is applied successively to the successive digits of the sum being obtained. I call that sequential calculation and that, where one uses repetitively an element for the successive stages, I think was one of the original concepts which were devised about the year 1937.

KAPLAN:

And all these went into your notion of a black box which you didn't know exactly what went into the black box. I just figured that there should be a black box which would do all these things. I felt that it could be materialized in terms of vacuum tubes and having this in my mind, then in 1938 I went to work on the black box.

ATANASOFF:

Well, switch is a funny word. Of course I knew that vacuum tubes would change state and I suppose that's the same as being used as switches. I don't want to get myself involved with the word "switch". We didn't use the word switch at that time. I am determined to make the vacuum tube work essentially in two states and these states were off and on if you wish and in many people's mind this would correspond exactly with switch, but a switch was not exactly what was on our mind at that time.

KAPLAN:

How did you actually go about designing the circuit and eventually getting out the one that you used? Was it a trial-and-error method? Or did you really have some sort of a notion of how to make some kind of a logic circuit and sat down and drew it out and then modified it as occasions arose?

ATANASOFF:

It was a hit and miss proposition and it took me, I suppose, a week of more of careful concentration to figure our how to do it. I worked hard to keep track of time because this is all complicated by a lot of extraneous detail which flooded my thinking at the time, such as I was thinking all the time about how to build a practical vacuum tube circuit, one that wouldn't require too much power, one that could be duplicated in large numbers with economy. I hit upon the idea of using dual triodes rather freely in the circuit strictly on the basis of economy, economy in original cost and economy of space and economy of filament current and economy of plate current. The dual triode which first entered my picture was 6F8G and I felt as if the 6F8G had too high a plate impedance and that in order to get a condenser that would stay charged long enough I would have to use fairly large condensers and I was afraid this 6F8G would have too great a plate impedance to charge the condenser sufficiently in the times which I had at hand. In the end this proved not to be so.

KAPLAN:

In the end didn't you use 6C8G?

ATANASOFF:

In the end I even went further in this direction and I switched from 6F8G to 6C8G. This occurred some time later. This occurred probably in the fall of 1939.

KAPLAN:

What's the difference between the two kinds of tubes?

ATANASOFF:

The 6F8G and the 6C8G, in comparing them you can say that the 6C8G used only half the filament current and half of emission, and plate impedance of the 6C8G was higher than that of the 6F8G, so that there was an economy in filament current of 2 - by a factor of 2 and plate current effectively of a factor of 2 by employing 3 6C8G's and by this time I had tested condensers and found out that much smaller condensers would suffice to do my memory work, so that in charging condensers I had passed through three stages, one in which I was going to use pentodes. A pentide circuit was use in the first model.

KAPLAN:

In the prototype?

ATANASOFF:

The facts were, you see, that we were reaching for economy. The pentodes only had one element in a tube and so that meant more end loops around and much more plate current and much more filament current. We were trying to streamline in these directions and rapidly after this we switched first to a set which employed 6F8G. I remember now, as I'm thinking about it, that the transition from 6F8G to 6C8G occurred when Clifford Berry was with me and that meant probably either in conversation during the summer but probably in the fall of 1939, wasn't it, that Clifford Berry was with me? Yes, it did, it occurred in the fall of 1939 and Clifford Barry was very loath to have me switch from 6F8G to 6C8G. I remember back.

KAPLAN:

Why was that?

ATANASOFF:

Because he felt as if we had no margin in the 6F8G and I was very intent with the economy which could be attained with the 6C8G and I realized we had a bigger job ahead of us than perhaps Clifford Berry did, to output all these various units that I wanted to in a single box.

KAPLAN:

Was your concern with economy because of the lack of funding that you received, or because of looking for commercial...?

ATANASOFF:

Oh no, for a practical structure. No, the funding could have been a little higher but only a little bit. That really isn't it. I already realized that computing machines manufacture in terms of vacuum tubes were going to be extremely expensive things from the viewpoint of power. This already was very clear to me that if I multiplied these units sufficiently to accomplish great works, that one would have an awful lot of power around the house and I was reaching as far as I could in the direction of economizing on this power.

KAPLAN:

You foresaw then that people would want to produce your machine commercially and that therefore you would need to go to work as cheaply as possible?

ATANASOFF:

I knew people would want - yes, I guess the answer to that is yes. I guess I was aware of the commercial import of all of this.

KAPLAN:

How did you finally arrive at the seven dual triode circuit, the diagram of which is in your manuscript? Was that after trying other kinds of circuits and experimentally determining that this one was better for reasons of parameter latitude and cheapness of production? Or were there other ways that you managed to get at this?

ATANASOFF:

...For a long time I wondered if a vacuum tube circuit would really work. I had some kind of a mystical concept that maybe I was getting myself in trouble by moving into the vacuum tube field. Held back by these ideas I knew that what I had to do in order to make the thing work under the greatest variety of circumstances was to limit fan-in and fan-out, what is now called fan-in and fan-out. I had limited that in a specific way and then the seven-tube circuit became fairly evident when one had limited this. I limited the number of grids that would be connected to a given plate - grids in successive stages that would be connected to a given plate and the reverse so as to make the thing.

Now, this was all in line with my concept which I otherwise described, described in other places. The concept was this. After a while you see, in thinking about whether vacuum tubes would work in a computing machine and if they would work as well as mechanical elements, I realized that connected with any digital computing machine as a series of parameters and when these parameters are within certain range, the machine would work and work perfectly. When the range of parameters exceeded the machine would cease to work at all.

Now, when I got this idea in my head why then I realized that in order to make vacuum tubes work as well as possible I didn't want to have excessive fan-in and fan-out. When I specified a limited fan-in and fan-out then this seven-tube circuit became evident. Later Clifford Berry did invent a five-envelope computing circuit which I believe is in the files somewhere, but Clifford Berry and I came to the opinion that it would not be as reliable as the seven-tube circuit so we proceeded with the seven. Now, it's not seven-tube. Maybe you can say seven-tube but it's seven-envelope, strictly speaking, and each one of them was a dual triode, 6C8G in the case of the final –

KAPLAN:

You mentioned someplace that there originally was a nine-triode logic circuit.

ATANASOFF:

I think it's a nine-envelope, wasn't it?

KAPLAN:

A nine-envelope circuit?

ATANASOFF:

Yes..

KAPLAN:

That one was never used...?

ATANASOFF:

I'm not sure, I'm not quite sure about that. I think that if I research the files I will conclude - my memory is - and you know I've got an awful lot of memory about this matter still around - but my memory is that the nine, or I believe and eight-envelope unit - I believe it was eight instead of nine. I believe eight is the correct number and I believe that that was the unit that was used in the prototype.

KAPLAN:

Was that your original conception when you tried to work out the black box?

ATANASOFF:

Not original in any real sense. It was one stage of the conception and it had, I believe, pentodes in the output circuits.

KAPLAN:

Yes, the eight-tube circuit did; you described that in the last tape.

ATANASOFF:

Yes, I think that had pentodes in the output circuit.

KAPLAN:

O.K., Go back to some other questions. What sort of work did Ernest Anderson do on the machine? I've come across names of lots of people who seem to have helped in little bits like that.

ATANASOFF:

Ernest Anderson is a mathematician at Iowa State College who afterwards became a Professor of Aeronautical Engineering. He had nothing to do with the machine.

KAPLAN:

Nothing at all?

ATANASOFF:

Nothing at all. He just knew me at the time.

KAPLAN:

O.K. Your machine in a sense does subtraction using (Comptu's?) complements. Your notation of negative numbers is in a complement type notation. Was that an original idea or were other machines doing that sort of thing? Was that done because it's easier to store negative numbers that way?

ATANASOFF:

You know, I didn't want to carry the sign into the memory so I decided that I would just use complements in the memory in order to subtract, for negative numbers, to represent negative numbers. However, you know in the logic elements I did carry a subtraction indication into the logic system to indicate when subtraction should take place. You realize that?

KAPLAN:

Yes.

ATANASOFF:

Now this use of complements in this way was not original with me. It is inherently contained in previous work. For instance, the adder and subtracter had the complements written on the keys, you know. Three would also be - what would it be? Three you subtract from nine, don't you? In getting a complement do you - I ought not to be recording this. I believe when you're subtracting 3 it's the same as addition of 10 except for a carry-over... The subtraction of 3 is equivalent to the addition of 7 except for a certain carry-over situation.

KAPLAN:

O.K. Why is it easier to store things in complements than to have some sort of a sign indication? Why did you decide to do it that way?

ATANASOFF:

I was looking for new additional complications and I already had the counting system set up. I decided to do it that way just because I would have had to have gone and altered my logic system slightly in order to encompass the other concept.

KAPLAN:

OK., another question. In determining which number base to use you had said that at first you tried bases larger than 10. Why did you think in terms of larger number bases first?

ATANASOFF:

Well, in time I had some sort of an idea that immense - I remembered the following fact. When a man can pretty easily remember the multiplication table up to 25, I realized that if one were attempting to perfect a number system for mini calculation, one would use a larger base because the human brain is perfectly capable of operating and remembering the multiplication table up to 25. This prejudiced my thinking about computing machines, I think, and caused me to turn in that direction first in order to simplify things. I soon found out this was the wrong approach.

KAPLAN:

Did it have anything to do with, that you can store a number with fever digits?

ATANASOFF:

Of course, of course. That is one of the concomitant facts, but it wasn't the principal motivating point.

ATANASOFF:

Yes.

KAPLAN:

It didn't have anything to do with mechanical or electrical considerations?

ATANASOFF:

Oh, yes, of course I was well acquainted with the fact that storing the number - you see, you'd have less digits if you used base 25 but we had the practical necessity of storing the numbers in the machine. Of course there are many good reasons for switching to lower bases as far as storing numbers. If you want to store numbers to base 25, for instance, you would have the problem of converting these numbers according to a certain code and putting them in an one would have a lot of individual elements retaining these numbers, unless you used a mechanical system which is capable of 25 separate states or an electrical system which is capable of 25 different states. The mechanical system which is capable of 25 different states was well known. It consisted of a disk which could be turned into 25 individual positions. But the electrical system with 25 different states is kind of awesome to contemplate. It can be accomplished but it would be accomplished only with the addition of lots of different agencies which would complicate the picture. The simplest way of storing numbers up to 25 of course is by including them into numbers probably with a base 2. After one unravels this little scheme one comes back to the practicality of the base 2 and this is all enhanced by the fact that numbers with a base 2 were associated with a simpler logical system.

KAPLAN:

You mentioned several times that first you decided that you might possibly want to use bases other than 10. You than considered large number based and found –

ATANASOFF:

Very briefly, very briefly.

KAPLAN:

- and found it unsatisfactory, I assume because it was just too difficult to implement.

ATANASOFF:

Yes, of course.

KAPLAN:

Then (maybe we should turn this off). I assume the reason you stopped considering larger bases was because it was just too difficult to implement in the machine.

ATANASOFF:

You see, I soon knew that the best way if you wanted a number with the base 25, the best thing was to change it to base 2 numbers and code it.

KAPLAN:

Well, did that come first? It seems to me that you had said that you then decided to do calculations to see which number base would be easiest to work with.

ATANASOFF:

Then I made certain hypotheses about calculation and what bases would require the least successive additions in a multiplication and that calculation is contained in my manual - in my manuscript which –

KAPLAN:

Is that calculation based on any considerations of electronics at all or just on how people do arithmetic?

ATANASOFF:

It is based on how a machine will do arithmetic.

KAPLAN:

A mechanical machine, or an electrical machine?

ATANASOFF:

Either one, either one. It isn't too good a calculation. It's based upon certain hypotheses and these hypotheses are that if I'm going to do a total multiplication, what base should I use in order that the total additions would be a minimum. Now if I had a Monroe calculator calculating 25 times 25 I would first have to add in 5 times and then I'd have to change the relation of the two parts of the machine and then I would have to add in 2 times. We call that shifting the register. We'd have to shift the register and then we'd have to add in 2 times, so we'd have 7 additions which took place there. On the other hand, if the two numbers were to be multiplied by base 2 one would have larger numbers but the number of additions in each stage would be less. I think this calculation minimizes the total number of additions. It just represents a kind of an approach, kind of a theoretical approach to minimizing effort of computation. I felt happy about that calculation at the time. I made a calculation - we could take a look at that manuscript and I could reconstruct this, and reconstruct it entirely from memory. I don't believe I have reconstructed this since the time I originally - I don't believe I've gone into this. With all this thinking I've done about computing machines I don't believe I've really gone into this calculation again to refresh my memory. I can refresh my memory and be sure of this but I think that all that calculation did was to recount the number of additions that a machine of more or less the manual type would have to do in order to - the number of additions that the multiple type would have to do in order to multiply given numbers and I think this demonstrates that the most efficient base is B. Of course it wouldn't do so I then calculated the speed of base 2 and base 3 and those were found out to be equal and then of course I changed to base 2 because it was simpler.

KAPLAN:

Why did you use the Monroe as your model?

ATANASOFF:

Well, because the Monroe - I'm not really using it as a model. I'm using it for counting, that if you're going to multiply numbers, if you're going to build a multiplier where multiplication is done by successive addition, and this really represented a fundamental concept rather that Monroe. I just used the Monroe to take your mind off and other people's mind off as to how the multiplication would proceed, but I believe no other method is known for doing multiplications in the general sense.

KAPLAN:

You had mentioned numerous times also that you wanted to make your machine all electrical. You didn't want any mechanical parts but that at times, for instance, for your mechanical drive shaft you had to use mechanical parts because of lack of funds. You just couldn't make it...

ATANASOFF:

It isn't only lack of funds; it's lack of effort. Funds and effort - the limitations of funds and limitation of my personal effort were there too. Of course after all you might call that lack of money too, if you want to, because if I could hire enough people to do enough thinking I could have figured out some way to have done it without - but since I had reached a stage in which I would do the successive calculation, the serial calculations as I call it - is that right?

KAPLAN:

I don't know.

ATANASOFF:

The word serial...

KAPLAN:

Sequential

ATANASOFF:

All right, sequential. I'm using the word serial and sequential as synonymous here. All right, sequential calculations. Now I decided to economize by using electronics and doing sequential calculations. Then it seemed to me as if I had taken a large step forward and I could afford to leave the rest in a mechanical state.

KAPLAN:

Is that the same reason why you had a mechanical bade 2-base 10 conversion table instead of an electrical one?

ATANASOFF:

This seemed to me from where I stood there in terms of the logic of the times to be much the simpler approach.

KAPLAN:

Using it mechanically?

ATANASOFF:

Yes. And it certainly was very simple and practical.

KAPLAN:

What other people besides Clifford Berry worked with you on you machine and what kinds of jobs did they do? Haryy Frizzel was one such person and (Merceris?) was another one.

ATANASOFF:

I had graduate students around there and I tried to talk to other people in the Physics Department and other places who were present at the time... I thought nothing of discussing the machine with them and did on many occasions. Frankly I did not receive much interest. People just didn't think much would come of it. People didn't think that the consequence were large. I have in other places recounted that one of my friends said - he listened patiently. He was always a patient man. He's still a patient man. He listened carefully and he said, "I don't think a computing machine will ever run a streetcar," meaning that computing machines have limitations. They certainly do but probably computing machines have already run streetcars and from now on the trend is ever upward. But I quote the man just to indicate a sample of the interest. On the part of my graduate students, interest was greater. Graduate students always have other duties. They were taking course work and they were doing theses and they had other things that they had to do, but Gross - there is in my files a letter from Mr. Gross in which he recounts the various things that I discussed with him.

KAPLAN:

He said for instance that you had numerous discussions about base 2, using base 2. What kinds of discussions were those?

ATANASOFF:

Well, I told him - and he was amazed that I was attempting to build a computing machine with a base 2 number system. He was amazed at this. I told him that I had come to this and - Mr. Gross - I don't really remember too much else about it, but I know that Mr. Gross and the other man by the name of William Mercer did the calculations which were needed for the base 10-base 2 conversion table.

KAPLAN:

Was that just calculations of a number in base 10 as represented in base 2, or did it involve anything more?

ATANASOFF:

Not much more. The table was an abbreviated table; it didn't have all numbers to base 2 and numbers to base 10 and convert between them, but it proceeded along the following lines. It would have the base 2 number for 1 in the base 10 system. It would have the base 2 number for 10 in the base 10 system. It would have the base 2 number for 100 in the base 10 system. We converted all of the powers of 10 to the base 2 number system and the table stored these... For example, if I wanted the base 2 number for 23 I added the base 2 numbers for 10 repeated twice and then for 1 repeated 3 times.

KAPLAN:

Then you were doing conversions in the machine. Was this addition made on your addition logic circuits?

ATANASOFF:

Yes, it was, yes. This addition was automatically carried out in the computing machine so that we really didn't use a complete base 2-base 10 table but an abbreviated one and the computations were done in the computing machine automatically –

KAPLAN:

The conversion wasn't strictly mechanical? It was mechanical and electronic, going through the logic circuit to add these numbers?

ATANASOFF:

That's right. That's exactly right. This is just a practical way of getting at that problem.

KAPLAN:

O.K. Berry invented something to do with the floating grid. That was mentioned someplace. What was the floating grid...?

ATANASOFF:

Oh my. I suppose sometime I crossed a T and that would be the subject at the present time.

KAPLAN:

I don't know, it may have...

ATANASOFF:

(LAUGHTER) I'm a bit perplexed by all this up to this very moment, but I can give you a few facts. It turned out that in this particular logic circuit we were using we needed 13 triodes, so there was an extra triode left out. When the circuits got embedded and constructed all 13 were in use but the fourteenth triode was used in a very strange way. It had a floating grid.

KAPLAN:

What's a floating grid?

ATANASOFF:

A floating grid means a grid which does not have a bias resistor to the ground. Most grids in vacuum tubes have a bias resistor connected to the ground. The grid's resistor may be high or may be low but this grid was... left free. A free grid in a vacuum tube circuit performed in a rather weird way but we were commencing to understand how it would perform. Clifford Berry employed this grid there in some way to slightly alter the performance of the rest of the circuit. Without doing a lengthy investigation I think I'd better stop at this point.

KAPLAN:

Could you possibly remember if that's tube No. 9 on you circuit diagram, because that one looked like it was extraneous somehow?

ATANASOFF:

Well, I can look at the circuit diagram and I can tell you which tube it is. There's no problem there and...

KAPLAN:

Well, we can look at the circuit diagram...

ATANASOFF:

There is in those diagrams, you know... the last time we discussed a correction in the circuit diagram. I drew a correction in. Now that's not the floating grid... but the floating grid is very evident in the circuit too. The corrections which I made in Figure 1 and Figure 2 - contains the floating grid which is very evident. It's also evident in the photographs taken at the time of the logic circuit, because one of the grid caps is missing. I've got to back up. I don't know whether this is right or not. I'm getting into the edges of my memory and I'm not quite certain. We can review these matters with manuscript and figures before us and we can perhaps reach better conclusions.

KAPLAN:

After Clifford Berry left you in 1942 he wrote to you that he had some ideas about a base 10 machine. Did he do any work at all on a base 10 machine?

ATANASOFF:

I did no work on a base 10 machine except just thinking it over casually. I might tell you that I had Ideas on the base 10 machine too and the base 10 machine would be obtained by concatenating a logic system for the base 2 and a logic system for the base 5. I made some progress toward working out a logic system for the base 5 but it contained a much larger number of vacuum tubes.

KAPLAN:

Was this before or after you started working on your other machine? Was this one of the ideas you were toying around with before you actually started to try to build a machine?

ATANASOFF:

It was during that period when I was thinking about the - how to build the final machine and also during the period when I was working on the final machine. I continued to think about base 10 and these ideas came into being at that time.

KAPLAN: Did Berry follow through his interest in computing machinery? Did he ever do anything further or any more with the base 10 concept?

ATANASOFF:

Clifford Berry was working for a firm and became interested in computation. They thought they were going to build computing machines and they were working on it and he was thinking about it a little bit during that period. Pretty soon the company gave up this idea of going into computing –

KAPLAN:

This is Consolidated Engineering in Pasadena?

ATANASOFF:

Yes. It was what was then Consolidated Engineering and now it has a different name. I'll have to get that name in record. I don't have it in my mind to put it in record. I believe that some of their concepts were transferred to the Burroughs outfit.

KAPLAN:

OK. Who was Len Bishop? He also did some sort of work on your project.

ATANASOFF:

I believe Len Bishop was one of those numerous students who did various jobs that Clifford Berry outlined for various students to do. Students were paid on an hourly basis for doing these jobs and it extended Cliff's handiwork.

KAPLAN:

You said that A. Brant had an influence on the development and work of computer machines. I wonder if that was in general or whether that was specifically your machine.

ATANASOFF:

In the first place Brant was at Iowa State College in the Statistics Department . He was a friendly man and still is. He lives in Gainesville, Florida, today at an age of 80 or so, approximately 80. He is still interested in statistics and still doing some work in statistics. Now, A. D. Brant was ready to stop and talk to me about computation and he introduced me to the IBM tabulator and said a few words to me about how it worked. Then you remember that he and I did a job together on the use of the IBM tabulator for the resolution of complex spectra. In order to get this machine into fruition he did some procurement for me with International Business Machines Company and got together some of the parts which went into construction of this machine. When we had the machine working we wrote a paper together and that paper is duly recorded somewhere.

KAPLAN:

This is in the Journal of the Optical Society; I forgot the date.

ATANASOFF:

Right, it's in the Journal. I have prints of that paper still.

KAPLAN:

Did he have any further influence on the development of computing, not necessarily only through you?

ATANASOFF:

No, he didn't do any work on this computing machine. I believe he had left by the time I was working on this computing machine seriously...

KAPLAN:

...Did he have contact with other people in the computing field?

ATANASOFF:

No, he did not. I mean I did not have much contact with Brant after he left Iowa State College. I wish I knew the exact date at which he left Iowa State College. We can get it by writing to Mr. Brant, or otherwise perhaps.

KAPLAN:

Who was Mr. Cannon? Was he another one of your graduate students? He also somehow or other played a role in the development of your machine.

ATANASOFF:

I don't think so.

KAPLAN:

He had nothing to do with it?

ATANASOFF:

Well, I think...

KAPLAN:

Can you just tell me a little bit more who he is?

ATANASOFF:

I can't remember him.

KAPLAN:

It could possibly be a misprint.

ATANASOFF:

Yes. It couldn't be Hannon, could it?

KAPLAN:

I suppose so. The Court Reporter of May 3rd.

ATANASOFF:

Yes, it could be Hannon.

KAPLAN:

O.K. You knew about the complex calculator that was being built at Bell Labs? Was that a relay machine.

ATANASOFF:

Yes, that's a relay machine. I didn't know about the machine until rather late in these efforts here, but when they made a public announcement to the Mathematical Society I knew about it at that time and I don't remember when that was.

KAPLAN:

Who was William Dale?

ATANASOFF:

William Dale? William Dale was another of the numerous men that worked on the computing machine. He is a man who now lives on the West Coast. I have had his telephone number and perhaps still have it. He was an engineering student and I know Dale's father even. I knew where he lived but as far as his relation to that machine goes he just did some minor part and he was on the payroll.

KAPLAN:

That's where I got most of the names.

ATANASOFF:

Yes, that's where the names came from.

KAPLAN:

In your dielectric sheet that you used to record the base 2 numbers you said that a hole was punched by an electric spark. Is that a hole that you could poke your finger through?

ATANASOFF:

No... if the dielectric sheet were made of paper it would be a charred channel through the paper. You could see it under some circumstances and at other times it was charged and hence somewhat conductive and one then attempted to have a machine that would read these punchings.

KAPLAN:

And it wasn't a hole like you could look through?

ATANASOFF:

No. It could be a hole large enough to see through though. It wasn't either one of those things precisely.

KAPLAN:

What material did you use for your dielectric?

ATANASOFF:

Various kinds of paper. But you remember that paper of course has cellulose fibers in it and these cellulose fibers are derived from various sources and then it used various sizing materials. I had plans for starting with the raw paper and then attempting to size it in different ways to make the paper more reliable. This is a part of the research which was never accomplished.

KAPLAN:

What do you mean by size?

ATANASOFF:

Size means you add to the paper - you treat it in some liquid and dry it again so that the constituents of the liquid fill the pores of the paper. That's called sizing and that's the standard procedure for treating paper. All paper has some kind of sizing in it. Most paper, let's newspaper, has some kind of sizing. I imagine blotting paper doesn't but most - and filter papers don't, I know, but most other kinds of paper do have some kind of sizing on them. I was planning to fill the pores of the paper in various ways until I got a paper that would work satisfactorily for this...

KAPLAN:

Did you ever find a paper that would work satisfactorily?

ATANASOFF:

I found a piece of paper that worked with a high ratio. This is a ratio of the current which is necessary to break down the dielectric to a voltage necessary to read back the signal there. When this ratio is 1 of course the paper is absolutely useless. When the ratio gets to be high the paper gets to be no more useful. I found a sheet of paper - just one sheet of paper and the source was unknown and it was very successful paper but I didn't know what the sizing material in it was. I didn't know how the paper was constructed and for a long time I saved the remnants of this piece of paper intending to analyze them microscopically and otherwise to see how to redeem this piece of paper. I found a piece of paper that was good but I never found a supply of paper that was good, that was very good. They worked but they didn't work with a high enough ratio so I felt they would be reliable in practice.

KAPLAN:

Is that the problem you were having with the dielectric? Is that that main reason why it didn't work?

ATANASOFF:

That's the only reason it wouldn't work, getting this ratio sufficiently high. All I had to do was find the right paper and it would obviously work. I don't know whether it would be a useful method of recording today but you remember in that time we had a problem that we had no associated apparatus and I had to build everything from scratch. This was a matter of intermediate memory, what we would call today I believe in computing machines, slow memory. Don't you call a tape a slow memory in a computing machine today? It would more or less take the role of a tape, play the role of a tape. We could have used magnetic memory, magnetic recording at that time. Magnetic recording was known to me at that time and known to me in detail.

KAPLAN:

For what were they using magnetic recording? For what purposes was magnetic recording being used?

ATANASOFF:

It wasn't being used. I just invented it and I knew I could use it. Of course I hadn't thought of tape. I was going to use magnetic disks or something of the king. The only reason I didn't is because it required - levels of read-back were low and...

KAPLAN:

You mean... the information on it?

ATANASOFF:

The levels of the read-back would be low and I knew they would.

KAPLAN:

What do you mean by the level of read-back?

ATANASOFF:

I mean to say the signal which could be generated by the reading head would be low and also I had to use a lot of magnification, a lot of amplification, and I didn't want to build the banks of amplifiers which were necessary to bring those back to usable levels.

KAPLAN:

This paper that you used for the dielectric that was good? Was that one that you had produced experimentally somehow and then didn't know how you produced it?

ATANASOFF:

No, it's a sample that I picked up somewhere.

KAPLAN:

You wrote in one of your letters that you had a desire to build a differential analyzer?

ATANASOFF:

Well, I remember the letter in question and I remember my desire. You know, a differential analyzer wasn't only a computing machine; it was an integrator and a differentiator and other things and I was attempting to turn my computing elements to the field of differentiation and integration by using small increments and the increments would be - this is really a new method in numerical analysis. I was planning to use my computing elements in a special way, using the kinds of numerical analysis which permitted me to do the same processes that were done by the differential analyzer.

KAPLAN:

When you were referring to this dime-store basis differential analyzer, then you were talking about your ideas to convert your machine?

ATANASOFF:

Yes... I believe that a differential analyzer built according to these principles would actually be much cheaper...

KAPLAN:

Is this what you meant by a dime-store basis?

ATANASOFF:

That's what I meant. The dime-store basis means cheap.

KAPLAN:

Why did you not do that?

ATANASOFF:

Time, I would say, a lack of time and other interests.

KAPLAN:

What is the meaning of a mechanical clock drive shaft?

ATANASOFF:

Well, you understood that most computing machines use an electrical clock, don't they, today? They use machine, pulling them into synchronism, where I however had a rotating drive shaft which played that role and held the operations into interrelation.

KAPLAN:

You mean it was just the speed at which it rotated worked as a clock?

ATANASOFF:

Yes. As a matter of fact later the drive shaft was the first that was driven by an induction motor, an old washing machine motor in fact, and then later it was driven by a synchronous motor, a synchronous motor and since the electrical circuits were synchronized to 60 cycles per second it became accurately a clock circuit. It was driven by a synchronous motor and...

KAPLAN:

Within the accuracy of let's say the wall current?

ATANASOFF:

Within the accuracy of the electric current and plenty accurate enough for the purpose at hand. As a matter of fact for many purposes with asynchronous induction a washing machine motor was sufficiently accurate.

KAPLAN:

And this was used only in your large machine? You didn't need this sort of rotation... in your prototype II?

ATANASOFF:

We did use this - we did it on the large machine also.

KAPLAN:

I have another who question. Who was James Elder?

ATANASOFF:

Oh, James Elder was another one of the numerous group that did a specific job on the machine. I've seen James Elder within the past five years; he's in California.

KAPLAN:

What specific job did he do? Do you remember?

ATANASOFF:

I can't remember, no.

KAPLAN:

He was one of the other people who Clifford Berry farmed out the work to?

ATANASOFF:

Right.

KAPLAN:

What about Robert Fulmer?

ATANASOFF:

He was another man; and Robert Fulmer afterwards became a patent attorney for General Electric and when General Electric was working on computing machines he remembered my efforts on computing machines, so he was either way one of the first really several people who independently recalled our computing efforts at Iowa State College and played some role in bringing it into public notice.

KAPLAN:

What about Norman Fulmer? He also worked on –

ATANASOFF:

That was the name we were just discussing.

KAPLAN:

Robert Fulmer.

ATANASOFF:

Robert Fulmer I don't know unless there was one in Fulmer's pocket. This speech I just made was about Norman Fulmer. Robert Fulmer was perhaps his father. He was the only other Fulmer I ever knew.

KAPLAN:

I don't know. Norman Fulmer became a GE patent counselor.

ATANASOFF:

Right.

KAPLAN:

Robert Fulmer, the only information I have is that he worked on the machine somehow.

ATANASOFF:

That's wrong. It's Norman Fulmer that worked on the machine. There's an error there, I believe.

KAPLAN:

We can check.

ATANASOFF:

I believe. To the best of my knowledge and belief.

KAPLAN:

Why did you have such a strong desire to go to work for IBM? You wrote to them over a period of several years and kept asking them and they kept saying, no, we don't need you.

ATANASOFF:

Yes, that's true... I foresaw the future of IBM in spite of a succession of rebuffs. At one time I was told by an officer of IBM in a letter that they would never use an electronic computing machine, but I myself knew very well that they would and I felt that it would be a good place for me to be active in the future in computing machine work. KAPLAN:

Were you at all dissatisfied at Iowa State?

ATANASOFF:

No, I was very happy at Iowa State. I just was very ambitious.

KAPLAN:

They were more or less things like: you wanted to be more in the maintenance of development of computers; you wanted a place where there was more interest in funding and possibilities for research –

ATANASOFF:

I would say those were accurate statements, as you remind me of what I wrote at that time those are accurate statements. They were perhaps to a certain degree synthetic because I had that purpose. I felt as if, if I were to work on computing machines the ideal thing would be to become associated with International Business Machines because at that time they seemed to have the biggest future of any company.

KAPLAN:

Were you so interested in computing machines as to be willing to give up your teaching and your physics and your mathematics?

ATANASOFF:

At that time I was willing to do that, yes.

KAPLAN:

O.K. In your complex spectra work, it that the same attachment that you used as you call auxiliary equipment for equation solving, with the IBM typewriter?

ATANASOFF:

No, the machine for analyzing complex spectra made the IBM machines practical.

KAPLAN:

Was that an attachment to the IBM tabulator?

ATANASOFF:

It was an attachment and they'd have hung me if they'd known I had the thing hung on their machine, but it worked.

KAPLAN:

Did you tell them?

ATANASOFF:

Oh, no.

KAPLAN:

I wrote to them that you had some sort of auxiliary equipment-

ATANASOFF:

Yes. I may have told them at some stage of the game but I was very careful to keep it away from them at other stages of the game, so I don't know exactly what stage you're talking about. But they were very careless of anyone who modified their machine or attached anything to their machine. I was afraid to do it because I was afraid I might make an error and it might damage their machine and they might find out as a consequence and they might cancel the contract with Iowa State College to supply IBM machinery for tabulators and other devices for statistical purposes. I was afraid I'd get involved and Brant was considerably exercised by this possibility although he and I were courageous people and went on and did it anyway.

KAPLAN:

To what are you referring when you talk about auxiliary equipment for equation solving in connection with the IBM attachment?

ATANASOFF:

This was a matter of ideas only. I commenced to see if I wanted to use an IBM machine for equation solving. I had it modified for solving complex spectra with considerable success, I felt. I then commenced to explore the possibility of making it solve systems of equations. But these mental gyrations reached the idea stage only and I never built this machine and as a matter of fact it failed because I saw that the capacity of the IBM tabulator was not sufficient –

KAPLAN:

Was this your idea to gang them, to put them all together?

ATANASOFF:

No, I was only going to use one IBM tabulator and the largest IBM tabulator which was available I had a computation in 80 - 80 best 10 places. The one we had at Iowa State College would only compute in 40 IBM places, but the largest one available computed only in 80 because that was the number of places on the IBM card at that stage of the game. Those were the years in which IBM had only recently changed from a 40- or 45-column card to an 80-column card in order to get more capacity and so their machines were only capable of computing in 80 places. As a matter of fact an 80-place computational capacity was not nearly sufficient to permit me to get anywhere with practical equation solving.

KAPLAN:

When you discuss punch cards methods, are you also referring to the IBM tab equipment?

ATANASOFF:

I suspect so. That was the common –

KAPLAN:

O.K. In your complex spectra work what sort of mathematics were you dealing with, if it was not equations solving?

ATANASOFF:

I can recount to you, the mathematics was very simple. It was just a succession of exploratory additions and subtractions. I can recount to you how spectra are generated. They are generated by knowing the nature of an animal molecule. Let's speak of atoms if we're talking about atomic spectra. An atom has a succession of states. These are energy levels within the atom. When the atom changes from one state to another, from state one to state two, the difference in the energy level of the two states is converted into-

KAPLAN:

Into light.

ATANASOFF:

Into radiation according to the principle the E = HU where H is Plack's constant.

KAPLAN:

And U is the frequency.

ATANASOFF:

U is the frequency, right. Hence making use of this principle if you had atomic spectra you could - you were attempting to see what energy levels these were derived from and this is a cut and tried process, manipulating them so as to see from which energy levels they derived. I was using an IBM tabulator to accelerate this process of this investigation.

KAPLAN:

You were more or less comparing energy levels.

ATANASOFF:

I was manipulating the energy - the frequency levels in such a way that the energy levels from which they were derived would come into evidence. You can read my paper if you want to see the details. They don't give it very carefully there.

KAPLAN:

What is the difference between a differential analyzer and an integraph, because you had said that you had thought of converting it to an integraph, when earlier we were discussing conversion of it to a differential analyzer?

ATANASOFF:

A differential analyzer consists of a succession of devices which do differentiations and integrations and an integraph does only integrations and so there is really no difference except that if you said differential analyzer you probably were talking about Bush's machine.

KAPLAN:

Bush also made an integraph.

ATANASOFF:

But he also made integraphs, yes. That's true and with this we're coming down to the levels of the short-comings of language, aren't we? This is the way language gets developed in shorthand methods of this kind.

KAPLAN:

In our discussions of your conversions to a differential analyzer, that would also subsume conversions to an integraph?

ATANASOFF:

It would, yes.

KAPLAN:

O.K. Why did you have so much trouble with your input-output in your machine?

ATANASOFF:

Because this represents an immense body of technology which had never been done and I had to do it all at the same time –

KAPLAN:

What sorts of trouble? Was this the base 10 input-output that you were worried about, or your base 2 I/O?

ATANASOFF:

Suppose I wanted a machine that would hitch on to my machine and print numbers. There was no such machine in existence. It would require modification and it would require me to become an expert on typewriters. Everything I wanted to do, the whole field - I had no magnetic tape recorders. They did not exist at the day. I myself conceived of a magnetic recorder but it wasn't a magnetic tape recorder. I however knew of a magnetic wire recorder at that time. I don't believe magnetic tape recorders had been invented at that time. I knew of a magnetic wire for an input/output device.

KAPLAN:

Are you talking about base 2 I/O or base 10 I/O right now?

ATANASOFF:

Either one, for input/output devices in either category. I knew of magnetic wire because that had been invented I believe before the turn of the century, before 1900.

KAPLAN:

I have absolutely no idea.

ATANASOFF:

I do. KAPLAN:

Then your problems were just in setting up some sort of auxiliary equipment?

ATANASOFF:

Yes. It meant that beside inventing the basic computational element, you had to invent the material to get numbers into the machine and to get them out and these represent a great bulk of technology and this is a great deal of work and this is what was bothering me.

KAPLAN:

We already discussed some of your problems with your dielectric sheet. Did you have many problems with your card reader and –

ATANASOFF:

The base 10 card reader never gave us a moment's trouble because we used base 10 cards and we used exactly the same brushes to read through the cards that IBM had used previously and here I was using previous technology. Of course my base 10 card reader was far different than any card reader, that I had to build a new card reader to make it behave just exactly the way I wanted it for my purposes, but I ... relied on IBM technology to certain extent, to wit, I read through the cards, with a brush and this was exactly the same brush that IBM read through the card, and it was a hole of the same size... As a punch for these cards I could use an IBM, standard IBM punch.

KAPLAN:

What had to be different about your base 10 card reader?

ATANASOFF:

Well, that base 10 card reader - I'll recount some of the numbers associated with the machine for your edification and information. I was using it in this way. I was using 5 fields of 16 digits each and 5 times 16 is 80 and there were 80 columns on the base 10 card, which was the standard card used in IBM tabulators.

KAPLAN:

(NOT CLEAR)

ATANASOFF:

I worked simultaneously in these 5 fields. The IBM tabulator would not have read simultaneously. It would have read simultaneously all the fields but it would not have read them in the way that was interrelated to my machine. I couldn't subject the IBM reader, any IBM reader that I could procure I couldn't subject it to interrelating it to my machine, because at that time all IBM equipment I couldn't even buy. If I'd have had enough money I couldn't even buy an IBM reader because the IBM readers in that day were not sold, only leased. So I had to invent a new card reader which would in the first place be procurable. The only thing I didn't procure was the brushes; I got those from IBM. I got them by surreptitious processes from IBM.

KAPLAN:

They also sent you some complimentary ones.

ATANASOFF:

Yes. The first ones were procured surreptitiously but after a while they sent me some. Then I sent back for some more and they sent them, but they told me they would sent me no more. So I did use their brushes. However, I built a new card reader. I can describe it more in detail if you wish –

KAPLAN:

The main reasons for building a new one –

ATANASOFF:

But it was the card reader... (NOT CLEAR) ... correlate with the clocking mechanism in my machine, you see. I could clock it into my machine. That's saying something in that language.

KAPLAN:

I understand also, then, it had five fields on the card and you read simultaneously each low order digit first in each of the five fields and then the next lower digit and so on.

ATANASOFF:

Well, you're not doing so badly. You're been doing pretty darn well, I think you're just doing fine. I think your question - well, they're not necessarily repetitious, but I think on the whole you're doing pretty darn well in getting at the gist of the matter.

KAPLAN:

Somebody named Hazeltine at Stevens Institute had some correspondence with you about your machine and served to advise the Research Corporation of New York on whether or not to finance –

ATANASOFF:

Well, you see I had something to procure money by - was Hazeltine connected with the Research Corporation - those two names are related in your mind?

KAPLAN:

Yes.

ATANASOFF:

I presume that is correct. I suppose that the Research Corporation sent my manuscript to him to be in the Hazeltine review.

KAPLAN:

When he reviewed it? Then that's how he knew how your machine solved equations. He wrote some sort of a manuscript on how to do –

ATANASOFF:

I'm going to discuss all of that. Now you know who Hazeltine was? He was a great inventor in the field of electronics.

KAPLAN:

No, I don't know anything at all about him.

ATANASOFF:

You can find all you want to find out about him. He founded an independent fortune on radio circuits and his corporation is currently going bankrupt, I understand. The Hazeltine Corporation exists to this very day. Hazeltine is dead. I had one telephone conversation with his wife at one time. When Hazeltine got this –

KAPLAN:

Hazeltine was some sort of electronics radio circuit expert, which was why they asked him about your machine.

ATANASOFF:

Yes, he was, that's right. Because this was electronics - there weren't a lot of electronics people around and they just naturally turned to him for advice on electronic gadgets. Hazeltine did not comment on the electronics of the machine at all. He only commented on the method I used for solving some of these equations. He reminded me that there is a method for solving simultaneous equations using determinants. This is a very strange idea to come from Hazeltine, because Hazeltine was supposedly a practical man. As a matter of fact, he recommended that I use this method (called Cramer's rule I believe) –

KAPLAN:

Yes, it is.

ATANASOFF:

- for solving simultaneous equations in terms of determinants, or matrices and determinants. But as a matter of fact it was already known to practical computers, this was a very bad way of getting at the method of solving simultaneous equations.

KAPLAN:

Did he recommend this after he found out what your method was, or before?

ATANASOFF:

After he found out, after he had read it

KAPLAN:

So he thought that perhaps using determinants would be superior?

ATANASOFF:

Yes, but he hadn't thought much about it and of course I knew all about Cramer's rule. I knew a lot of the things he told me. I knew that because this is a matter of advanced mathematics which I had studies. It's given in algebra courses. You probably studied it in algebra, didn't you? I knew all of that but as can be shown, if you really attempt to expand in accordance with the standard method of expanding the determinants, there is actually more work in that method than there is in the method of solving simultaneous equations which I used.

KAPLAN:

Hazeltine essentially made no contributions in any way to your work.

ATANASOFF:

Ineffectually, none. He made an effort and he's a very great man.

KAPLAN:

Now, you mentioned that in terms of your large machine, that when you finally had to leave working on it it could store-eliminate variables, but it could not solve equations. Now if you could store-eliminate variable –

ATANASOFF:

I never solved that system of equations. I did eliminate variables on it. That is the truth.

KAPLAN:

It would seem to me that if you could eliminate the variables on it, you could solve equations.

ATANASOFF:

I could, yes; no doubt about that. I just didn't do it, because I wanted to have - it was pressing, you see, to get this data in and date out. You see, in order to solve a system of equations - wait a minute, let's back up. What you said was not quite correct. According to the practical method that I had outlined for solving system of equations I had to have a base 2 card reader and punch working. You remember that?

KAPLAN:

Yes.

ATANASOFF:

But they were not working right, so that this was an impediment towards solving a system. However, I could eliminate a variable in the following way. I could put the two equations in directly from base 10 cards and then I could eliminate a variable between them and then by making tests on the machine I could find out what coefficients were left in the machine and then I could verify that this elimination was correct.

KAPLAN:

You could have done something like punch up another IBM card.

ATANASOFF:

Well, I couldn't punch an IBM card - yes I could. You're absolutely right. I believe that what we did have, though, was to test - was to take the numbers off the IBM, very laboriously take the numbers of the big computer by using an oscilloscope.

KAPLAN:

But what I meant is that when you took those off you could have then used those numbers and fed them back into the machine through your base 10 card reader.

ATANASOFF:

I could have made the - that isn't quite right. There was a method of taking base 2 numbers off as base 10 numbers, which had been devised and which is in the literature, and that had been devised and constructed.

KAPLAN:

That was your oscilloscope method?

ATANASOFF:

No, it was not.

KAPLAN: No? What method was that?

ATANASOFF:

This is still a different method. This used the base 2 to base 10 conversion.

KAPLAN:

Then how do you finally get out of the machine?

ATANASOFF:

You get out of the machine as base 10 numbers on a dial.

KAPLAN:

On a dial? And the dial is controlled somehow by the conversion mechanism?

ATANASOFF:

That's right, and that's in the literature somewhere too. I don't believe we used that either. I believe what we did, and just because it seemed to be at the moment and be simplest, my memory tells me that we took the numbers off by using an oscilloscope, in this case where we eliminated an unknown between two equations. That was where the use of the machine stopped.

KAPLAN:

Then the reason why it couldn't solve the equation really was just because of your I/O problems, because you couldn't punch out your dielectric properly enough so that you could get it to feed back in to keep eliminating equations.

ATANASOFF:

That apparatus was not reliable at that stage.

KAPLAN:

What is meant by overdraft in addition and what sort of controls were lacking - in division (I'm sorry) and what sort of controls were lacking?

ATANASOFF:

Overdraft?

KAPLAN:

Yes, to control you division process.

ATANASOFF:

You know, if you subtract numbers until subtraction requires a negative number, the computing machine does something at that stage and what it is, it represents the negative number as a complement automatically. When it changes from numbers to complements we used a signal derived from the last place at the left of the machine to indicate that an overdraft had occurred.

KAPLAN:

Does an overdraft just mean that you changed –

ATANASOFF:

By an overdraft I mean the same thing as I sometimes mean by carry through.

KAPLAN:

Carries, but it changes signs?

ATANASOFF:

Yes –

KAPLAN:

You pass through a zero one way or the other?

ATANASOFF:

Automatically. Now, when the last digit at the left in the field changed from zero to one, that was the signal which was used to indicate overdraft or carry through, but when it changed from one to zero, it was another carry through in the opposite direction, wasn't it?

KAPLAN:

Yes.

ATANASOFF:

Those were indicated by a signal device which was attached to the last - which was related to the last digit, the highest order digit in the computer...

KAPLAN:

You meant it got signals to tell it to shift and start adding if you had been subtracting, or shift and start subtracting if you had been adding?

ATANASOFF:

Exactly.

KAPLAN:

You said that in your final machine there was control lacking in your division process. You didn't have proper control for your overdraft.

ATANASOFF:

That's not right. We had that built in.

KAPLAN:

That was all working perfectly?

ATANASOFF:

Yes.

KAPLAN:

You also said someplace that you were so optimistic about working on your machine and the work was going so well that you upped your original plan so that it would now hold 30-15 place numbers simultaneous for computing. What were the original plans that you had had for the machine?

ATANASOFF:

Ten or fifteen.

KAPLAN:

Ten or fifteen 15-place base 2 numbers? Base 10 numbers?

ATANASOFF:

No, no, no. I was planning about 10 or 15 base 10 places and the corresponding number of base 2 places. Fifteen base 10 places is equivalent to about 42 or 43 base 2 place.

KAPLAN:

Thirty-two base 2 places would give you 2 to the 32nd at best, yes.

ATANASOFF:

Yes, well, we can figure it out but it's roughly what I say. I'm not sure I'm giving it correct to the last decimal place but –

KAPLAN:

You never can when you're converting that many.

ATANASOFF:

No, you never can; that's quite true. In my original plans of the large machine I had planned to build a smaller but I considerably upped it at this stage because everything was working out so well.

KAPLAN:

So you originally had thought that you would only work with abut 10-digit numbers and because things went so well then you –

ATANASOFF:

Both stages - I'm not quite sure –

KAPLAN:

Ten 15-digit numbers, I'm sorry.

ATANASOFF:

Yes. I was planning to use as my length of word 10 to 15 base 10 digits.

KAPLAN:

Why did you decide on that?

ATANASOFF:

Because that was more or less what was necessary in order to give me some range for the numbers to drift during computation and yet give me some substantial accuracy. You know how numbers drift during a calculation?

KAPLAN:

They sometimes will shift from zeros to ones.

ATANASOFF:

Well, say, if you get into a weak triangle... the numbers tend to drift and if you want to get a root accurate to six places, this may mean that the root turns out to be a number which is disadvantageously portrayed to a computing machine which does not have a floating zero, a floating decimal point. I don't mean a floating zero, a floating decimal point. You know what a floating decimal point is?

KAPLAN:

I know what it is.

ATANASOFF:

We have floating decimal point in this machine so the numbers will tend to float off the scale so you have to have scales of a considerable size to give you some room for computation and to give you some accuracy.

KAPLAN:

How did you adjust where you would put the decimal - the binary point actually, in your calculations?

ATANASOFF:

Well, there would be arbitrary assumptions in regard to that.

KAPLAN:

And you as the operator had to monitor that...?

ATANASOFF:

... (BOTH VOICES AT ONCE) ... planning of the machine and of course it really didn't matter because it's a simple thing to transform a given system of equations into a new system where the roots will be large or small, isn't it? And this is true of simultaneous systems just as it is of algebraic equations, isn't it? I mean, it's true of both places. Now, we knew about floating decimal point and the problems which were consequent to that. We had no floating decimal point, let me put it that way. We knew that the roots might tend to drift off the scales that were employed. Suppose I said, "Here's where and I've got so many places." Then the root might appear off the scale. Then you couldn't get it with a machine set up that way. Right?

KAPLAN:

Right.

ATANASOFF:

So what is the practice to approach this? We had no technology to furnish floating decimals. The concepts was in our mind but the technology to do it was not available. So we had to make the numbers relatively large to give them room to float and still get an answer, right?

KAPLAN:

Right.

ATANASOFF:

Now, we also had defined the following procedure. If we got into trouble and the numbers shifting threw off scales, we intended to go back and transform the roots, writing a new equation and then to solve that one, and then transform it back to get the roots of the original equation. This is a classic piece, see, of horsing around that we didn't ever do but it seemed to be the possible first step.

KAPLAN:

Before when we were talking about drift, did you mean that same thing as floating points? Before when we were talking about the numbers drifting, you meant the same thing as the floating point?

ATANASOFF:

The two things are related.

KAPLAN:

Or did you mean electrical drift?

ATANASOFF:

Floating decimal point is a characteristic of machine so it keeps track of the numbers and shifts the decimal point to (reconcess?) the summation.

KAPLAN:

Yes.

ATANASOFF:

But I didn't have that in my machine. I serve again. Now, what was the language Don used - the root might drift off the scales?

KAPLAN:

You said drift.

ATANASOFF:

Drift is the word. It's related to floating decimal point but floating decimal points are used to prevent numbers drifting off scale, aren't they?

KAPLAN:

Yes. ATANASOFF:

Even in machines which don't have a floating decimal point the numbers will draft, won't they?

KAPLAN:

Even in machines which do have floating decimal points you sometimes get what's called underflow or overflow, like the numbers will go up either at the high order and/or the low order, because there's always ...

ATANASOFF:

Right, there's always so much float allowed, isn't there? Well, after all the problems are related, aren't they? Those two problems are related, Bonnie, and we're communicating all right. I think you understand what was on my mind and how I went about it, don't you, pretty well?

KAPLAN:

Did you at all try to build in a floating point in your machine?

ATANASOFF:

I never tried, no. I thought that I couldn't encompass that; I never tried. I realized that technically that would be possible but that's all I realized. I never attempted to do that.

KAPLAN:

Who is Mather?

ATANASOFF:

Mather is another of the boys that worked on the computing machine and he was perhaps the best one after Clifford Berry, the most able and had the most comprehension of the machine and its operation. He's also in California.

KAPLAN:

He was after Clifford Berry, because I have also that he worked during 1941 which was before Clifford Berry left, so they both worked together and then he worked later.

ATANASOFF:

He was after Clifford Berry –

KAPLAN:

Oh, you mean he was the best if you eliminated Clifford Berry?

ATANASOFF:

Yes, except for Clifford Berry. Among the boys who just worked on the machine down there, except for Clifford Berry he was the best, the most able.

KAPLAN:

What sort of work did he do on the machine?

ATANASOFF:

I remember some of the elaborate wiring on the machine, of which I have a photograph, that he did.

KAPLAN:

He just did putting the wires in? He didn't decide –

ATANASOFF:

Oh, he had no - he hadn't reached the stage that Clifford Berry had of deciding how the machine should work. He was a hand but he was the best.

KAPLAN:

What did he have to do with the vacuum tubes? Also just putting them into the circuits?

ATANASOFF:

Yes. He constructed the electronic circuits for us –

KAPLAN:

By constructed you mean that he had put them together, not that he designed them?

ATANASOFF:

No, he did not design them.

KAPLAN:

O.K. When you were working at the Naval Ordnance Laboratory, again you were trying to get some sort of a machine that had non-mechanical parts involved. Did you intend to just modify your machine to make it so that it wouldn't have mechanical parts, or were you going to try something completely new? ATANASOFF:

There isn't any answer to a question like that. I intended to use all the knowledge that I had and I intended to use my logic circuits. I discussed with my boys, the staff who worked on computing machines, the difference - these two approached to computing machines which I discussed the last time you were with me, with you; namely, the difference in computing machines that just tick around and the ones that use logic circuits. We went over that picture again very precisely at that stage and we decided to use the logic circuit approach. It seemed to us to be the most logical, but we were working on input-output devices and memory devices and we did an awful lot of work during that period on electronic memory employing cathode ray tubes.

KAPLAN:

A cathode ray tube memory? The memory in your machine - you made the memory regenerative, the reason being that you most emphasized was because the condensers would leak and you had to recharge them in order to prevent the leakage.

ATANASOFF:

Not only because of the leakage of the condensers but also because if you wanted to preserve the memory after you'd read out –

KAPLAN:

I was going to ask you about that.

ATANASOFF:

So as to regenerate and prevent this occurring. I mean to prevent the signal deteriorating on readout. There were two reasons for using regeneration. One, the signal would leak because they were on condensers; and two, when you read them you tend to diminish or destroy the signal and it was to recover the signal after readout.

KAPLAN:

O.K. When you decided to do the regeneration - as I said, most of the things I've read you keep emphasizing this leak and very rarely do you talk about losing the charge from reading.

ATANASOFF:

That's true, but we –

KAPLAN:

Was that the original reason that you chose regeneration?

ATANASOFF:

Oh, yes, it was the original reason, -

KAPLAN:

The leak.

ATANASOFF:

...was the leakage. And then we realized that every time we read it we took some charge off too, and that this would cure that as well. Do you follow me?

KAPLAN:

Yes, right.

ATANASOFF:

The two were present all the time, or very soon after the first one the second one was present. Who would be lecturing on nuclear structure in here?

KAPLAN:

Today? Somebody - - You built when you were doing work with your quartz crystals an oscillator that used the Miller effect, the Miller oscillator. It would span different frequencies that you could test your frequencies. I don't know exactly what a Miller effect oscillator is. I'm curious as to whether you employed some sort of a new design in that. You said something about how you constructed a new circuit, or did you just modify whatever Miller did, or what?

ATANASOFF:

Of course the Miller effect was already known at that time.

KAPLAN:

Does the Miller effect just refer to this variable range of frequencies?

ATANASOFF:

This what?

KAPLAN:

On getting out of variables.

ATANASOFF:

What is the Miller effect? That's what you're after me. The Miller effect is the effect that the input capacity of a vacuum tube depends upon the amplification factor of the vacuum tube and hence it can be used for changing the frequency of an oscillating circuit. Now I can go into more detail but –

KAPLAN:

I don't know if that's necessary.

ATANASOFF:

I don't know, but at any rate the Miller effect is a well-known effect and the Miller effect is the recognition of the fact that the input impedance in the vacuum tube depends upon the conditions of bias in the tube, the amplification factor of the tube.

KAPLAN:

In you circuit did you put anything new in that circuit?

ATANASOFF:

Sure I did. Now what happened here was, not the Miller effect. That was well known, but I was searching out a way of depicting the individual frequencies of a crystal oscillating circuit in a graphic way and I invented this method which employed the Miller effect, an oscillator which swings through the various frequencies and an oscilloscope which indicates whenever any of these frequencies was encountered.

KAPLAN:

But what is it that you invented exactly? What was it supposed to do?

ATANASOFF:

It was supposed to depict the characteristic frequencies of a piece of quartz.

KAPLAN:

So you had to modify the Miller effect somehow. You used a Miller effect circuit –

ATANASOFF:

I used the Miller effect oscillator so that the frequency oscillator would swing through a range of frequencies and then I employed a cathode oscilloscope to indicate when it struck a frequency of the crystal.

KAPLAN:

Would it swing through those frequencies normally? Does the Miller effect give you that swing of frequencies?

ATANASOFF:

The Miller effect was only for giving me the swing of frequencies.

KAPLAN:

So then what you did was to put in something that would allow it to read on the –

ATANASOFF:

Yes, I built a special oscillator that could be shifted throughout the range of frequencies where we wanted, but in any given frequency there would be a band of frequencies, there would be a little by looking into the back of the oscilloscope. I believe this was the first time this was ever done. I can't be sure. I haven't researched the subject so well and carefully.

KAPLAN:

At least as far as you're concerned you didn't know of any previous work until you did it.

ATANASOFF:

As far as we were concerned, yes.

KAPLAN: It seems that many of the people with whom you worked at Iowa State College eventually went into the Navy research work, as you did. I was curious as to why so many of them did Navy work. Was it because you were working with the Navy at Iowa State and they were all working with you, and then they all left to go to NOL? Or was it that your research interest was –

ATANASOFF:

At Iowa State I wasn't working with the Navy. I was working with OSRD.

KAPLAN:

What does OSRD stand for?

ATANASOFF:

Office of Scientific Research and Development.

KAPLAN:

While we're at it, what does NDRC stand for?

ATANASOFF:

National Defense Research Committee and I worked for both of those organizations. One transformed into the other due to a Government reorganization.

KAPLAN:

OSRD changed in NDRC?

ATANASOFF:

I think NDRC was first but I may be wrong.

KAPLAN:

O.K. Was the work you were doing for that more closely related to the sort of work the Navy wanted and that's why people went to the Navy? Why did so many people there just go Navy –

ATANASOFF:

Well, let's see how many did. Clifford Anderson did. Clifford Anderson was working –

KAPLAN:

, McVey, you did –

ATANASOFF:

No. Let's see, McVey did but he had no association with me whatever. He was just accidental. The Navy laboratories were being built up very fast and they were just looking for every man they could lay their hands on. I don't know how McVey got over there. Cammer did; he worked for me and went to the Naval Research Laboratory. Harold Anderson did. He was in the Engineering Department At Iowa State College and he came to the Naval Ordnance Laboratory afterwards.

KAPLAN:

Why did you eventually go into the Navy instead of say the Army?

ATANASOFF:

Because they always had people around urging you to go. They needed help so badly. To tell you the truth, the scientific development in the Army was much lower. You know we had to go into the Armed Services on account of the war. The development of the Army was much lower than the Navy. The Navy was much more scientific. In this earlier period the development of the Navy was expanding much more rapidly than the development of the Army. The Navy laboratories were expanding much more rapidly than the Army laboratories were at this stage.

KAPLAN:

Why do you think that the Army had more interest though in computing than the Navy did?

ATANASOFF:

Oh, you're talking about what actually happened. They had these ballistics tables that they wanted to compute.

KAPLAN:

Didn't the Navy need ballistics computations also?

ATANASOFF:

They did, but they just didn't happen to get started on it. This was a matter of accident and fate. Where are we going to eat - downstairs? .....

KAPLAN:

O.K. You were aware of the original idea of using sequential calculations in your machine. Did you have any other ideas that were related to that at all that you consider really new or significant?

ATANASOFF:

I don't know what you're talking about.

KAPLAN:

All right.

ATANASOFF:

It's a patented question that I don't even know what it's about.

KAPLAN:

What's a potentiometer?

ATANASOFF:

A potentiometer is a device for measuring electrical potential or voltage, but a potentiometer also is a device for adjusting electrical voltage.

KAPLAN:

So it does both? It'll do both?

ATANASOFF:

Well, they're different. You know, words are like this; they get used in various senses, so I'm like a dictionary. If you ask me what a word means I have to give you all the definitions.

KAPLAN:

Let me look up and see which potentiometer I've been talking about... Who was Harold Sexton and what sort of assistance, if any, did he give you on the machine? He was working under the NYA, whatever that is, and he gave you some kind of assistance for the machine.

ATANASOFF:

Harold Sexton. I have only vague memories of Harold Sexton. I better not quote anything at all for the moment.

END OF INTERVIEW