[[NB06-001]]

48 - 5

7-3-51

Reconsidering additional pulses AD3 for Right shift of negative numbers it seems that much of the circuit used at present can be eliminated
At the moment on AC flip flop is used to let $L^sD_0$'s into the accumulator and it is required to stay set for as long as the sequence lasts ie between 2 & 24 minorcycles ~~If~~ $ED_1$ ~~are~~ could be gated with $C_7$ (right shift) to produce a $D_R$ without gating with $W_8$ as is done at present. The $D_R$ can then be used to produce $P_R$ which can then be fed to the

[[NB06-002]]
Acc IO as a AD3.
The effect is that AD3s are produced before and after the shifting is carried out. As these are suppressed if the number in the accumulator is not shifted no harm can come from this

---

First days work on mods over with Starter units tidied up, Output Unit 1 finished but not tested and the AD3 problem solved theoretically The collating of negative numbers has proved more difficult than expected but has been solved as follows

[[DIAGRAM]]

ie A composite number being [[it]] ASC number is inspected for sign and the resultant additional digit is fed both to $33^5$ and as an extra input to Acc IO
In feeding it as pulse to $33^5$ the job is being done twice for A but it is u

NO!!

[[NB06-003]]

8-3-51

Scheme outlined overleaf fails because the additional digit in respect of a number to be subtracted will be taken into the Acc IO unit and added to the complement produced by the complementer thus clearing one of the sign digits.
The solution appears to be to mix the additional digits with both micand and mier at the input to the Collater
In this way the additional digit for add & subtract are obtained in usual way but for collate additional digits for both micand and mier are

gated together in the collate gate to produce an additional digit in the answer as well.

9-3-51

Best part of the Modifications have been done already and today I think I can spend some time thinking about how to get back to normal again next week.
There is no doubt about it the last two days have seen a lot of things done which could cause trouble.
Many units have been taken out for valve numbering
At least six units have suffered major or minor

[[NB06-004]]
modifications.

Pulse wiring on the racks has been altered
And last but not least there is the power supply which of course should not cause any difficulties but which could.

Temporary Mods for New AD3
LC26 (a) Disconnect $W_8$+ from $D_R$ Gate
(b) Replace old $D_{35}$ by $ED_1$ on $D_R$ Gate
This makes both $D_R$ and $P_R$ Even $D_1$
LC32 Disconnect tags 1 & 7 from unit & short rack wiring across
This supplies $P_R$ to Acc IO as AD3 where it is delayed and added into acc in suppression positions

12-3-51

Pulse Techniques
Dr H A Dell.

Static V Magnetics
40μA Max 400μA

[[DIAGRAM]]

I to produce $\Phi_0$ to $O_r$

$I = k\Phi_T / N$ (no of turns)

$L \approx qN^2$

E across coil = L dI/dt
= L I/t

Subs for L $E = qN^2 I / t = qN^2\Phi_0 / N$
$E \sim N$

[[NB06-005]]
ie E is proportional to N so that I is independant of N

Methods of producing sweep
(a) Current forcing method
(b) Voltage forcing method

(a) Current forcing

[[DIAGRAM]]

Actual current

[[DIAGRAM]]

Burst of current

[[DIAGRAM]]

Also ringing - shunt Resistance

valve needs to feed current also to shunt R.

∴ $V_g$
[[DIAGRAM]]
adjustable step

[[NB06-006]]

[[DIAGRAM - CIRCUIT]]

See Williams Paper.
Howell & "" PPI

(b) Voltage forcing
used when very fast timebases required

[[DIAGRAM]]

PPI

[[DIAGRAM]]

Sin cosine
potentiometer

cos θ & sin θ voltages

<u>Direct generation</u>
two potentials produce 2 timebases which when mixed together produce single timebase

[[DIAGRAM]]

[[NB06-007]]
Switches
Double Diode Clamp ?

[[DIAGRAM - CIRCUIT]]

<u>Technical Modulation</u>
Magslip

[[DIAGRAM]]
to deflector cods
Rotating coil
Timebase

balanced waveform required to offset ~~ben~~ timebase waveform thro transformer

[[DIAGRAM]]

from modified Miller

[[DIAGRAM]]

[[Time constent]] of $RC_3$ is such that it reccurs in [[time to]] prevent any further ringing after the first half cycle

[[NB06-008]]

12-3-51

HT mods finished and I started getting machine back to normall. Apart from the usual handful of silly faults - grid cap off, pulse lead misconnected etc there was not a great deal wrong. A flip flop in the multiplication control was a little insensitive (AC ff) and a valve was replaced. The valve removed however showed no abnormality. It is probably a case of marginal working that would have been thrown out in marginal checks.

Another unusual fault was that the last G order in some of the test programmes did not produce big enough end pulse to stimulate the following O order so that the confirming letter was not printed. Why it should be the last G order when presumably many other P orders had been carried out currently is not clear. This was overcome by a slight adjustment of the EP Amplifier. Once again this may be a case of marginal working.
The V order is still producing [[fault]] which I will

[[NB06-009]]
have to pursue tomorrow but apart from this all other tests work OK.
One point that I was not aware of before is that the L test only uses the more significant half of the accumulator. It seems to me that in order to test these ~~accurately~~ satisfactorily some means must be found of testing R & L when shifting numbers occupying the whole of the accumulator. This could be achieved as a separate R & L test programme where R is used to trail a negative

number into the less signif half and then L is used to bring it back before testing.
The scheme for $AD_3$ for right shift appears to work correctly.
I have not yet tested the $AD_2$ for collate. It seems to work OK for Add & Subtract.
My scheme for producing ~~Order~~ Action Diagrams for each order which will show the relevant details of waveforms & pulses needed for each order has received official blessing from JP.

[[NB06-010]]
The idea is to have a list of the Action decoding waveforms necessary with a diagram of all the elements involved in the order (with the exception of the accumulator and coordinator)
A diagram of this sort will be very useful when fault chasing on a particular order which is not being carried out properly and even more so for marginal testing.
CCU I seems to be very nearly complete now so that by the time I have got the machine back to normal it will be available so that

I can proceed with my marginal checks.

Page Proofs for my article arrived today. The corrections I had made to the gallery proofs had not been incorporated and the photographs of CRO traces were pretty terrible but this was probably due to the poor paper on which it was printed. A letter was sent back to Mr Foster registering my feelings about this, so I hope they will either produce a considerably improved final version, or else make some provision for taking ~~a~~ new photographs.

[[NB06-011]]
Last nights lecture on Electromagnetic Time bases was extremely interesting. The production of a PPI trace was quite well demonstrated as well as described.

16x36 216
36
576 [[elements]] in 1 m/s
Say 100 per inch = 6 inches 1 m/s
500 ft sec
Drum 2' in [[$0^{ce}$]] = [[250 ps]]
= 15000 rpm.
¼" spacing - 64 sections in the inch drum

[[NB06-012]]

14-3-51

After only 1½ days LEO was back to work with only an occasional Z (in the V test) to show any signs of inefficiency. Mr Booth and Mr Simmons were both treated to demonstrations of The conversion programme (New Style) and this only caused them to question the delay in putting Leo to work.
These faults are still with me
(a) A rather elusive fault on multiplication which throws up one in a hundred
(b) Some breakthro on

the AD3 line (revised)
(c) The elusive fault on the Coordinator that occasionally prevents coincidence from being found.

---

I will deal with B first and then introduce the new CCU I preparatory to margins checks.
Miss Cox should start today on the new diagrams for marginal checks so that I should not need to do much in the way of preparation for these tests.
The new provision for Collation of negative numbers works satisfactorily.

[[NB06-013]]
I have suggested a new RL test programme which will enable the machine to be tested in shifting operations into and out of the least significant half of the accumulator

| 14-2-51 |

Programming DC Hemy

Orders changeing
C 28-16-17
C+5 Increase by

C+8 0|2|17

[[DIAGRAM]]

increases
address Transfer
by 0117

[[DIAGRAM]]
Transfer Test whether Yes
number last No
No
Add
to Address c (28 | (499 + n | 17)
c+1 5 | 399 + n | 17

at end C + 1 ≡ 5 | 479 | 17
∴ subtract 5 | 479 | 17 & use G 27
28 C + 1
12 k (k = 5 | 479 | 17)
27 | 6 | 17

[[NB06-014]]
28 | 499 + n + 1 | 17
5 | 399 + n + 1 | 17
subtract k 5 | 479 | 17
add back k + 1 5 | 480 | 17
k12 = 23 | 100 | 17

12 | k + 4 | 17 k + φ = 0 | 80 | 17

a 12 | k + 4 |
b 28 k + 1
b+1 7 c + 1
b+2 28 k + 2
b+3 5 c
c 28 499 + n
c+1 5 399 + n
c+2 28 c + 1
c+3 12 k
c+4 27 b

Factorial [[XI]]
x(x-1)(x-2)(x-3)(...)1
x in ~~as~~ (a)(b) 1 in k 2 in k+2
f 28 b x
f+1 12 k x-1
2 5 a 0
3 21 a
4 31 b x(x-1)

5 5 ~~b~~ c 0
6 28 b
7 12 k+1
8 ~~27~~ 3 f

| | | | | |
|---|---|---|---|---|
| 299 | 5 | 500 | | 400 x |
| 300 | 28 | 401 | x | 401 x |
| 301 | 12 | 402 | x-1 | 402 1 |
| 302 | 5 | 401 | - | 403 2 |
| 303 | 21 | 400 | - | |
| 304 | 31 | 401 | x(x-1) | |
| 305 | 5 | 400 | | |
| 306 | 28 | 401 | | |
| 307 | 12 | 403 | | |
| 308 | 3 | 299 | | |

[[NB06-015]]

Factorial x

Constants 100 = x & Prod.
101 = 1
102 = 2
103 = x & Factor

~~Factors~~
Programme

~~0 28 | 100 | 17~~
~~1 5 | 20 | 17~~
~~2 28 | 20 | 17~~
~~3 12 | 102 | 17~~
~~4 27 | 11 | 17~~
~~5 28 | 101 | 17~~
~~6 5 | 20 | 17~~
~~7 21 | 21 | 17~~
~~8 31 | 20 | 17~~
~~9 5 | 21 | 17~~
~~10 3 | 2 | 17~~
~~11 Answer in 21~~

100 x
101 x-1
102 2
103 1

~~..~~
~~..~~
~~20 = x, x-1, x-2 - - - - 3, 2, 1. (factor~~
~~21 = x(x-1), x(x-1)(x-2) - - - - Lx~~

| | | | |
|---|---|---|---|
| 300 | 21 | 100 | Set up Prod |
| 301 | 28 | 103 | Add factor |
| 302 | 12 | 102 | Subtract 2 |
| 303 | 27 | 309 | Test for end |
| 304 | 28 | 101 | Add 1 |
| 305 | 5 | 103 | Transfer factor |
| 306 | 31 | 103 | Prod x factor |
| 307 | 5 | 100 | Transfer Prod |
| 308 | 3 | 300 | Return to 300 |

| | 309 | Result in 100 | |
|---|---|---|---|
| 28 | 101 | | |
| 28 | 103 | 21 | 100 |
| 5 | 101 | 31 | 101 |
| 21 | | 5 | 100 |
| | | 28 | 101 |
| | | 12 | 102 |
| | | 27 | |
| | | | |
| | | 28 | 103 |
| | | 5 | 101 |

[[NB06-016]]

15-3-51.

The new version of CCU I was put into operation today and after some trouble was found to be working reasonably well. Unfortunately this circuit is very sensitive to pulse amplitude and shape and I fear that we may have difficulty at some future date with it.
Trouble with the Coordinator this afternoon which was eventually traced to the over-sensitivity of the $W_{13}$ flip flop which was being triggered off occasionally by breakthro on the $R_1R_2$ line

after temporarily desensitising this everything seemed to work again.
Shaw & I had between times devised a programme for evaluating factorial n and after getting this to work for L6 went on to limits of the machine with L13 The answer produced by the machine (after much hair tearing) was found to be correct i.e.
6,227,020,800
≡ Binary

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

[[NB06-017]]

19-3-51

Had some further specimins of demonstration programmes from Hemy on Friday. Unfortunately we had to cope with a large party from S.T.C at the same time. However faults were shown up in both the programmes and the machines. The machine fault (The only one left now) seems to be multiplication. The trouble seems to be centred around the arrangement for providing an Add end pulse in the case when the micand is zero. This end pulse is being occasionally produced

when there is a micand with the result that no multiplication takes place.
I found that there is a circuit in CCU which requires investigating for two reasons.
(a) a first glance a 1μS delay appears to be in the wrong place.
(b) [[12]] W waveform produced [[here]] has a nasty lump on the base line.

[[NB06-018]]
Cathode Follower
Probe

[[DIAGRAM]]

20-3-51

The lump on the waveform was traced to breakthro from one ~~side~~ input of a gate to the other

[[DIAGRAM]]

This was eliminated by using a separate cathode follower to feed the gate.
After fixing this and one or two other small snags which cropped up yesterday I found we were back to normal with V as the black sheep.
This time the fault ~~was~~ thrown up was the Micand tank

[[NB06-019]]
which would not hold clock. Although part of the trouble was obviously phase, the unclocked pulses being slightly late, it was also found that the pulses returning from the MSU to the A link were only of the order of 8/9 volts. That this was marginal was obvious from the way the pulses were lost if any high impedance point was touched with the "looking lead"
After consultation with JP it was more or less agreed that an amplifier was needed here. The trouble is that it is required to introduce [[illegible]]

[[than]] no delay. A possible compromise is the use of extra short coaxial lines for the micand tank. This gives an improvement of the order of 0.1 μS.

[[NB06-020]]
I feel that time is nearly [[rite]] for me to grope back into the past in order to analyse my experience in fault finding and building the machine. It will be an interesting job and will serve two purposes.
(a) it will bring some of my past troubles to light and enable me to use this experience more in [[illegible t------g]] new faults.
(b) An analysis of the faults of the past will help to avoid trouble in the future and be the basis for a troubleshooting manual when the m/c is in use.

21-3-51

Last two days have been pretty hectic with faults piling up on each other. Yesterday I continued chasing faults on multiplication and only seemed to make them worse. By 6 oclock I was in a worse muddle than ever so I decided to stay on for a bit. By 8 oclock I had managed to get the machine semi-operable e.g. able to do the conversion programe but still unable to do reliable multiplication and even falling down on Add & Subtract. Today once again has been hindered by visitors

[[NB06-021]]
a party from Ferrantis and Prof Hartree. In between times I have been trying to pin down the fault on the Add test programme. It is one of these faults that only occurs at machine speeds and I found it difficult to produce a short programme that would produce the same effect. Hemy & Caminer were also trying to get some sense out of their Wages Demonstration Programme with a little success. In the mean time the machine itself seems to be getting steadily worse

The latest effect is a fault in Store section 10 which first of all was dropping digits but appeared to work after changing a panel 1. Later it was impossble to clear it by the normal method of shorting the clock pulses and orders in this tank were visibly corrupted as extra digits crept in from nowhere.
In between Hemy's programme tests I devised a manual programme which does through up ~~the~~ a fault in simple addition

[[NB06-022]]
(a) Tank No 10.
(b) Add Programme.

Most of my new troubles seem to have arisen since the installation of the new CCU I. Now if some of the cases where the amplified ED. had been used were rather critical as to phase, it may be that a delay line needs adjusting somewhere in the computer

| | |
|---|---|
| Complementer | $17^6$ |
| CCU II | $26^7$ |
| CCU III | $27^6$ |
| CCU IV | $28^5$ |
| CCU V | $29^4$ |
| CCU VII | $31^6$ |
| CCU VIII | $32^3$ |

22-9-50

After yesterdays dismal failures it took about an hour this morning to put everything (almost) to rights again.
There was a spate of store faults to begin with (real and imaginary) one of these was due to a faulty Panel 1, another to a bad contact in a coaxial plug, ~~and~~ another to a decoder fault and yet another to C.P. frequency.
Having cleared these I tackled the spurious "1"s spoiling the Add Programme

[[NB06-023]]
Mr Pinkertons suggestion was lack of clearing the multiplicand A quick check showed that there was in fact an occasional $D_{18}$ left in the micand after clearing (only when working at machine speeds). The clearing waveform lasts for a minorcycle being set by $S_1$+$S_2$ and reset by the next $D_{18}$. Due to the rounding of the waveforms an occasional $D_{18}$ was escaping.
To cure this I am no using the End of Coincidence ~~Waveform~~ Pulse to reset $W_{11}$ and this works very well.

I received today yet another print of my article in EE this time only half of it, but the half with the photograph reproductions. They are using special Art Paper and the prints are just tolerable.

[[NB06-024]]

Physical Socy Exhib.

| Stand | |
|---|---|
| 20. | Birkbeck College Computer<br>for Fourier Series<br>Uses PO Uniselector |
| 51 | Ferranti |

| | |
|---|---|
| | Logical computer (Relay) |
| | Constant Frequency Unit 50 c/s |
| 102 | Ace. |
| | Mercury Delay line |
| 59 | Standard Tel. |
| | Attentuator |
| 122 | Attenuator Newton Victor Ltd |
| 45 | Salford Electrical |
| | Rotasol Moto operated switch |
| | (PO dial) |
| 43 | G.O.C. |
| | Germanium Crystals |
| | Barium Titanate |
| | Piezo Electric Crystals |

[[BLANK PAGE]]

[[NB06-025]]

27-3-51

Analysis of Faults

I have been thinking about the necessity for some history of the building of the machine and an analysis of the faults that have occurred. It seems now that it would be most desirable at this stage to have two things.
(a) A list of symptoms showing how possible faults will manifest themselves
(b) A list of faults which have occurred in the past which ~~have not~~ could recur due to variation in [[amplitude]], voltage etc. i.e. faults which have

not been eliminated by fundamental changes in circuitry.

---

1. Coordinator will not slip on
(a) No end pulse
(b) $W_{12}$ stuck
(c) .....
Possibly one way ot tackling the Symptom would be to construct a "tree" from the twig end down. ie starting with the causes one by one and arriving at the effect. In this way it will be seen that in some cases several different ~~ef~~ causes can produce the same effect. It would be useful to note the affect of

[[NB06-026]]
~~of~~ amplitude failure during some of the attenuator tests I propose to do today.

---

27-3-51

After a couple of false starts Computer was working well today
Multiplication still fails occasionally for reasons that are obscure. Also in the store test a long discriminant is lost from an order causing Queries.
Hemy brought down some more programmes this afternoon and quite a bit of progess was made.

The machine seems quite happy with the conversion programme. Hemy has produced a new one that does averages as well as totals. Some really large

numbers are converted and it is noticeable that no more time is taken for the large nubmers than the small.
I started attenuator tests this afternoon and although it is early to comment There are two or three lines already (control pulses) that will not tolerate the required attenuation. I have not yet decided on the right method of tackling this problem

[[NB06-027]]
whether to go thro the lot making notes and then to consider what general mods are needed to satisfy the marginal requirements or whether it would be better to do it piecemeal. The former seems best, but it also means repeating work later.

28-3-51

Continued Attenuator tests on Control pulses. These confirmed previous experience; that in many places the machine is working only by the "skin of its teeth. One of the most sensitive places seems to be the mixed computer end pulse line into the Coordinator. Here the E & G end pulse will not even tolerate the insertion of the attenuator. At present the amplifier in the EP mixer has only a 1K8 anode load so that it is possible to provide a bigger pulse but any change of this sort will call for mods to

[[NB06-028]]
delays in the coordinator
The procedure adopted for these tests on control pulses has been to remove the "1"s to SCT and insert a ~~1~~ particular order $A_0$, or $E_0$ etc in store position 0. Now when The coord is triggered it repeats the same order, ~~each end pulse~~ the action of each order producing an EP which Triggers the same order again. In the case of the E & G orders the process was done twice - one with a +ve acc and once with a -ve acc.

The next procedure I think should be to check over the control pulses in the coordinator
This was done once before some months ago but so many changes have been introduced that it would be [[dilinetly]] inadvisable to assume that all was well.
One precaution that has to be taken in these attentuator tests is to see that the termination of lines is not disturbed

[[NB06-029]]

| | |
|---|---|
| 11 - 6 - 0 | 543 - 18 - 8 |
| | 4 11 |
| | 15 - |
| 000 | 544 - 18 7 |
| 999 | |
| 999001 | 240 |
| 1 | 7 |
| 2 | 216 |
| 4 | 960 |
| 8 | 960 |
| 16 | 1200 |
| 32 | 130783 |
| 64 | |
| 128 | |

256
512
1024
2048
4096
8192
16834
32768
65536
131072
130783
289
240
49

11 - 6 - 0
1 4 1
12 - 10 - 1

1 - 4 - 1
11 6
12 - 10 - 1

131072
10922 - 8

546 - 2 - 8
543 18 8
2 - 4 - 0

30 65
120 4
360 3
720

---

30-3-51

Attenuator tests continued with test on Control Pulses in the Coordinator. I finished these yesterday morning, and on analysis shows that ~~One~~ two of the biggest offenders are (a) insufficient amplitude of EP from Computer
(b) insensitivity of $W_{12}$
I put in some mods ~~to~~ as a preliminary effort towards improving these conditions

[[NB06-030]]
and then was about to recommence attenuator checks when TRT announced that he had a visitor from America (working on "Wirlwind") Just about at that moment I had blown two fuses and burned out a resistor in an amplifier so that I was not a little annoyed. The effort was made however and after a very rough setting up of a new amplifier managed to do an "A" test. An SOS to the programmers bought Miss Hyams down with two rather indefinite tapes which were put on. The first was the conversion [[down]] programme which seemed to work

correctly. The second I hadn't a clue about but after spending about 5 minutes taking in the programme I saw that the data was for the Departmental toatls for the Wages job a programme that had failed several times before.
To my amazement it not only took in the data (for 33 [[mins]]) printed the wage tables with calculations of tax etc but finished it off with a [[complete]] (if incorrect) summary of Totals stamps [[&]] cash dissection.
The American visitor was very impressed and gave his opinion that this was a better

[[NB06-031]]
demonstration than he had seen in any American project.
Mr TRT got JRMS to come and see the machine doing this programme. He noted the mistakes (that were fairly obvious) but was visibly impressed.

One line of results which caused some amusement was Key No 11 which started off with £11 6 gross pay & had £543-18-8 tax deductions resulting in a net pay of £12-10-1.
I see from a little manipulation of figures that the tax figure is actually

minus £2-4-0 - the machine finished that particular line with complements

---

30-3-51

A rather useless day Today with lots of small faults causing long delays.
First fault on reader for some time. Least significant digit occasionally being left out.
Fault due to dirty contact corrected with needle file.
Insensitivity in TCT circulation improved by inserting amplifier.
More wages programmes

[[NB06-032]]
put on with similar sorts of ~~faults~~ errors in printed results. One curious error which must be due to the machine because it does not do the same thing every time is that the key numbers jump about curiously ie instead of
1 2 3 4 5 6 7 8 9 10 11
the machine prints
1 3 3 5 5 6 7 8 9 11 11
Hemy tells us that "for simplicity" the program puts in the key numbers and then multiplies them by 240 & converts to £s suppressing the shiftings & pence

The conversion to £s is done by subtracting 240 repeatedly and counting the number of times before it turns the total negative "Simplicity" because he already has the Lsd conversion in the programme and the ~~Dec~~ B/D conversion would call for more programme space.
The machine printed out two lots of Departmental Totals fairly satisfactorily & then failed in the middle of the Third.
Towards the end of the afternoon the frequency control unit gave out.
I have left this to be dealt with on Monday.

[[NB06-033]]
It is becoming more evident that I shall require an assistant working with me all the time. For some purpose I am better alone ~~If~~ but when there is trouble I need a helper that is familiar with the geography of the machine.
Another requirement is a permanent frequency indication so that I can be assured at a glance that troubles are not due to frequency drift.

<u>Points for Discussion</u>

(a) Assistance
(b) Frequency Monitor
(c) Atten Tests  Control Pulse
(d) How long are Atten tests going to take. We should have at least a week ~~between~~ for full programme tests i.e. Investigation of faults on a particular programme This would be distinct from attenuator tests.

---

[[Faiting]] on V end Pulse?

Y " "

Corruption of order in Store tests.

[[NB06-034]]
In view of the proposed demonstrations I feel that the time has come to pay more detailed attention to peculiar faults that have arisen causing programmes to fail. In view of the fact that Attenuation Tests have held the field for some days now these unexplained faults have been sidestepped in the hope that correcting for failures in attenuation tests would cure other faults also.
So far this has not happened although it is true attenuator checks have not proceeded very far. As the date of the demonstration approaches

I would feel happier if ~~some~~ more attention were paid to some of these faults.
What I would propose is
(a) Complete Att T for those modifications that I have so far installed. (ie increased amplif of EPs. Sensitising W12, Ampligying TCT digits.)
(b) Investigate Test programme faults that are showing up. (ie R & V)
(c) Get Hemy to produce extracts of his programmes where queer things happen (eg Key No)
(d) Then proceed with attenuator checks when either all programe faults

[[NB06-035]]
are eliminated or it is felt that ATs are the best method of dealing with what is left

[[DIAGRAMS - PULSES]]

High Fidelity Pulse Amplifiers

[[K]] R Sturley

[[DIAGRAMS - WAVEFORMS]]

phase discrim different at differ
phase α frequency for correct amp

$f_1 = 1 / 2f$

[[NB06-036]]
eg. Rise of .1μS

$f_1 = 10^6 / 2.1$ s

Group Delay

---

$E_0/E_1 = F(\omega) + j\, G(\omega)$

Freq Respon = 1 $0\log_{10} (F\omega)^{[[2]]} + G(\omega)^2)$

Phase $\phi = \tan^{-1} G(\omega)/F(\omega)$

Group $d\phi/d\omega$

$\tan \phi = G\omega/F\omega$

$d\tan \phi/d\phi \cdot d\phi/d\omega = d/d\omega\ G\omega/F(\omega)$

$\sec^2 \phi\ d\phi/d\omega = F(\omega)G'(\omega) - F'(\omega)G(\omega) / F(\omega)^2$

$(G'(\omega) = d(G\omega/d\omega$

$d\phi/d(\omega) = \cos^2\phi A$

$d\phi/d\omega = \frac{(F\omega)^2}{} / (F(\omega)^2)^2 + (G\omega)^2 \times F(\omega)G'\omega - F'(\omega)G(\omega) / \frac{F(\omega)^2}{}$

$E_0^2/E_1 = a_0 + a_1\omega^2 + a_2\omega^4 \ldots a_n\omega^{2n} / b_0 + b_1\omega^2 + b_2\omega^4 \ldots b_n\omega^{2n}$
form of any amplifier calculation

Condition for
Maximal [[flatness]]
ie least dependancy on ω

$a_0/b_0 = a_1/b_1 = a_2/b_2$

[[NB06-037]]
[[DIAGRAM - CIRCUIT]]

$E_0 = g_mEiR / 1 + j\omega CR$

Freq Response $10\log_{10} = E_0^{1\,2} / g_mE_1R$

$= 10\log_{10} 1 / 1 + \omega^2C^2R^2$

let $\omega_0 = 1/CR$

$FResp = 10\log_{10} 1 / 1 + (\omega/\omega_0)^2$
$= 10\log_{10} 1 / 1 + x^2$

[[DIAGRAM - GRAPH]]

$\omega / \omega_0 = .5 = 3Mc/s$

$\omega_0 = 6Mc/s$

(Television receiver)

$\omega_0 = 6 \times 10^6 \times 6.28 = 10^{12} / \cancel{6}\ 30R$

$R = 885\Omega$

$Gain = 8 \times 10^{-3} \times 885 = 7$

Phase

$E_0/E_1 = R/1+jx$ $\phi = \tan^{-1} - x$

Group Delay $d\phi/d\omega = 1 / (1+x^2)\omega_0$

$| Z_\omega |$

[[DIAGRAM - GRAPHS]]

[[NB06-038]]
Valve figure of Merit
[[DIAGRAM - WAVE]]

$E_0 = g_m E_i R (1 - \xi^{-t/CR})$

[[DIAGRAM - WAVE]]

Rate of rise
$dE_0/dt = g_m E_i R (-\xi^{-t/CR})(-1/CR)$

$= g_m E_i \cancel{R} / C\cancel{R}$ when t = 0

$-g_m / C$ is known as figure of merit of valve

let $g_m$ = 8 mA/v

c = 30 pf

$dE_0/dt = 8x10^{-3} \times 10^2 / 30$
$= 2.66 \times 10^8$
$= 2.66 \times 10^2$ μS.

Compensated [[Cels]]

[[CIRCUIT DIAGRAM]]

$E_0/g_mE_1 = R + j\omega L / 1 - \omega LC + j\omega CR$

$= R( 1 + j\omega L) / 1 - \omega^2 LC + j\omega CR$

let $\omega_0 = 1/CR$

let $L = aCR^2$

$E_0/g_mE_1 = R[1 + jax]/(1-ax^2)+jx$

$\omega L/R = \omega aCR^2/R = \omega aCR = \omega a/\omega_0$

Freq Resp.

$10\log_{10} 1 + a^2x^2/(1+ax^2)^2+x^2$

[[NB06-039]]

$\frac{1 + ax^2}{1 - 2ax^2 + a^2x^4 + x^2}$

$\frac{1 + a^2x^2}{1 + x^2(1 - 2a) + a^2x^4}$

let $a^2 = 1 - 2a$

$a^2 - 2a - 1 = 0$

$a = -2 \pm \sqrt{4+4} / 2$

$= -+ \sqrt{2}$

$= 0.414$

$1 + a^2x^2 / 1 + a^2x^2 + a^2x^4$

$) 1 + a^2x^2 ( 1 - a^2x^4 / 1 + a^2x^2 + a^2x^4$

[[CIRCUIT DIAGRAM]]

$L = aCR^2$

$\omega_0 = 1/CR$

$C_1 = bc$

$C_1$ is [[self]] cap of choke

Freq response

$10\log_{10} (1 + abx^2)^2 + a^2x^2 / [1 + ax^2(1+b)]^2 + x^2(1 - abx^2)^2$

Max flat

$a = 0.414$

$b = 0.354$

[[NB06-040]]

Cathode Compensation

[[CIRCUIT DIAGRAM]]

$E_0/E_1\ g_m/1+g_m\ .\ Z_0\ /Z_K$

$= g_m R / 1 + j\omega CR / R_K / 1 + g_m j + j\omega C_K R_K$

make time const of Anode & Cathode equal

$= g_m R / 1 + j\omega CR / 1 + g_m R_K / 1 + j\omega CR$

$= g_m R / 1 + j\omega CR + g_m R_K$

$= g_m R / 1 + g_m R_K + j\omega CR = g_m R / 1 + g_m R_K / 1 + j\omega R C / 1 + g_m R_K$

let $g_m R_K = 1$

$C_a = C / 2$ but gain is halved.

C = 30pf R = 1770Ω 3db [[at 3Mc/]]

$R_K 1/g_m = 1/8\ 10^3 = 125$

$C_K$ = 425 pf
1 db at 3 Mc/.
Gain dropped to half

[[NB06-041]]
Last Friday the frequency control unit seemed to go completely "haywire" & it was left until today to put it right. On starting up this morning I set up the FC unit which responded quite happily and everything seemed normal again
I have suggested that I should be ~~let~~ permitted to continue tests on control pulses unhindered and when these have been completed to turn to particular faults on programmes. Also I have ask for the assistance of Dutton for the next week. This has been agreed to

I have proceeded with AHC on control pulses and have found that my amplified end pulses have not achieved the desired effect I am trying to reach some nice compromise between a large end pulse and a break-thro-free pulse. This seems a little more difficult to achieve that I had hoped.
On reconsidering the problem of apparent insensitivity to EPs it seems that a good place to put a limiting amplifier is after the mixer in the Coordinator

[[NB06-042]]

5-4-50.

The machine went completely out of action ~~j~~ on Tuesday and Dutton & I spent a dreadful day chasing a fault which eventually turned out to be due to a new cable which had been put in by Gibbs in the general tidy up effort. The effect was to cause the clearing waveform applied to the Order tank to droop sadly leaving an occassional D19 in it. This ~~caused~~ converted subsequent /F orders into /D orders
Unfortunately I had taken the line that it must be due to some change that I had made. This coupled with the fact

that the fault did not occur when the machine was stepped on slowly wasted nearly the whole day.
Eventually I managed to get a short sequence which reproduced the effect and yesterday morning I pinned it down definitely to the mechanical clearing of the OT. This is done by a relay in the starter unit and my connection had previously been via a loose pulse wire. The added capacity of a multicore cable put in by Gibbs had caused the change.
Another hold up has

[[NB06-043]]
been caused by one of the synchronous motors supplying the controlled AC has had bearing trouble and the machine has been shut down since yesterday noon. This may last the whole of today.
In the meantime a mod on the coince unit to overcome this difficulty in the Order Tank clearing is being put in by Dutton

I have made another attempt to clear the trouble in the other Coince unit which very occassionally prevents correct coincidence

taking place. I have now replaced most of the components in the suspected area and I did find one cunningly concealed dry joing which may have been the cause.
Before shutting the machine down yesterday an attempt was made on ~~the~~ a revised conversion programme but ~~A~~ all was not well and the machine made three different answers to the one programme

---

Collected 100 yards of 10 core cable from [[Elpreque]] Ruislip
7 cores of 9/012
3 " " 16/012

[[NB06-044]]

9-4-51

Last Friday afternoon I left P & Dutton investigating the shortcomings of multiplication I went to the ~~N~~ Phys Soc Exhib. Earlier I had located the trouble in multiplication to the Micand Tank & Shifting Unit. There appeared to be trouble in the Tank itself as the pulses were emerging rather on the wide side. P was for patching up & making do ~~S~~ rather than taking the tanks down so that we shortened the delay of the system by using much shorter ~~leads~~ coaxial leads. It was then found that after multiplying

by 1 occassionally an entire 1 was dragged into the micand tank during the ~~fi~~ shifting. It was suggested that this might be due to the W2 waveform not completely shutting the gates in the M.S.U. Inspection of this waveform during repeated multiplication showed that this might well be the cause of the trouble as there was quite a lot of hum on the waveform and this was varying in amplitude there by setting up conditions
The hum was definitely coming from the W2 flip flop and various methods of

[[NB06-045]]
eliminating it were tried without success. P's latest suggestion as I left was to reduce the coupling timeconstant to something just big enough for the minorcycle waveform but not big enough to pass 50 c/s.

[[DIAGRAM - SQUARE WAVE]]
All that is required for a 1 ~~μS~~ minorcycle waveform is a RC of about 700μs at present we have .1 & 1MΩ = .1 sec ie .001 would do.
It remains to be seen whether this does in fact cure the fault

If it does, then there are many other places in the machine that can be treated similarly
W1±
W3
W4
W6
W8
With the demonstration so near this week will probably be a near-panic week but I feel that we are due for a good spell so that all may yet be well.

[[NB06-046]]

7-4-51

The "good spell" anticipated ~~yesterday~~ this morning has not materialised. Nothing worked this morning and after a few hours the following trouble had been suffered.
(a) Tape Reader - bearing gone causing tearing of tapes
(b) Teleprinter - jammed with piece of paper caught in pneumatic carriage return cushion.
(c) Frequency controls out of action
(d) Clock pulse generator out of action.
(e) Interference from Test Rack

(clock pulse frequency)
(f) Interference from Control Desk. (wrong plugging shorted out - 200v)
(g) 2 panel '1's with faulty clear gates used in Micand position.

This was sufficient to last out a very unsatisfactory day but even when these things were eliminated late this afternoon there were still troubles from starting orders.
On two occasions only today was I able to put a tape in and get results.
On other occasions either

[[NB06-047]]
start position 20 became cleared or else frequency went off causing all information to be cleared, or the tape jammed or some other trouble cropped up.
One of the most persistent at the last minute was that after feeding in a few rows of tape position 7 (containing a left shift order) because cleared for no apparent reason.
On two occasions both 6 and 7 became cleared.

[[10-4-51]]

The only legitimate way that a single store position can become cleared is by transferring the content of the cleared accumulator to it this means that somewhere in the store the order 5/7/17 or 5/6/19 has been built up. On each occasion that this clearing has take place I have looked for such an order but have not found it. This may mean one of ~~several~~ two things.
(a) Coincidence unit is failing to find correct compartment.
(b) Order is becoming corrupted in order tank.
(b) is more likely than (a) in view of the fact that both

[[NB06-048]]
6 and 7 were cleared on one occasion. This would mean that in addition to coincidence unit going wrong $F_1$ waveform wsa being set up as well.

5/7/17 00101|.....|00111|0
5 6 19 00101| |00110|1

If a previous order contains 7/17 or 6/19 as ~~the~~ part of the address was in the order tank and the clearing waveform had failed to clear all of the contents then a subsequent 5/0/17 might be added to it thus producing the corrupted

order.

This is not beyond the bounds of possibility as a mod has been done to the clearing waveform only recently.

One ray of brightness emerges from the present gloom. The fault on the coincidence unit which ~~caused~~ prevented coincidence with any position other than zero has not recurrect since I rewired that part of the circuit. ~~T~~ I think that it was a dry joint on a .01 condenser but there is still time for [[it]] to recur.

[[NB06-049]]

10-4-51

Worked till 9pm tonight in an effort to get somewhere but progress is still slow. Best part of the morning was spent setting up tape reader which last night was tearing my tapes due to [[lack]] of pecker withdrawal. Since reassembling have had no trouble although there are many obvious shortcomings to present article.
The next thing to go wrong was the teleprinter which made a thorough mess of the output test tapes - at least I thought it was the teleprinter until I analysed

the faults & found that they were all due to printing mixtures of ~~several dif~~ two or more different numbers eg. 5 & 6 printed as 7  3 & 4 as 5  This was found to be due to a stray computer end pulse EP3. This in turn was due to ~~loos~~ oversensitivity of the flip flop to $S_1$ + $S_2$ (This had been shown up in attenuator tests but had not been followed up)
Having corrected this I turned to multiplication again only to find trouble in the shape of Add EP's [[turning]] up in spite of $W_8$-

[[NB06-050]]
This was traced to the fact that $ED_1$ which resets the $W_8$ flip flop had a spike in front of it which reset the flip flop early and let thro the test of the $R_2$ pulse which in turn set up conditions for $AD_2$
During a spare moment I also checked up on a relay which had been clicking away for weeks for no reason at all. This was due to an out of date circuit used to ~~luc~~ make a pulse set a ~~flip flop~~ relay.
$D_p$ (warning of counter out of step) had some

breakthro of the counter tank on it and this was being amplified to the extent of triggering the relay. I have disconnected $D_p$.
Another trouble that has reared its ugly head is that the address part of some orders is being corrupted and appearing as x/2 where x is the address
This is the next trouble to be investigated

[[NB06-051]]

| | | | |
|---|---|---|---|
| E.g. | | ~~12/17/19~~ | |
| | | 12/16/19 | |
| 0 | | | |
| 1 | 1 | 43 | |
| 2 | 2 | 6 | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | [[Budged]] | IT + 6 |

7
8 10
9 Petrol +4½
10
11 Children +£10
12
13 Married +£10
14
15 Taxable 248 = 248
16
17 Extra [[Allce]] 30 = 43
18 218
19
20
21
22 $T_{43}$ $T_{44}$

39 11
40 1

40 L 12
1
-10
+ 1
1
16
2
6
-5
6
6
16

40 S S
| Mier
| 17 16 15 14 13 |
| 0 0 1 0 1 | 0 0 0 - - - - - 0
0 | - - - - - - - - - - - - - - - - - - - - 10

2

20

19
8
16
5
A 40D
2D
A 43

| 110 | ||| | ||| |
|---|---|---|---|---|
| 1010 | 0110 | ||| | ||| |
| 000 | 1010 | ||| | ||| |
| | 1 0000 | | | |
| | 1000\|0 | | | |

[[NB06-052]]
12/16/19 2
[[eanp]] 0 1 40
1 12/0/17

---

12-4-51

It seems that the "Good Spell" anticipated last monday may have arrived
Yesterday morning the corruptions of addresses of orders taken in from tape were tickled.
Theory suggested insufficient left shift and a short left shift programme proved this to be correct. It was found that the W2 waveform was most

irregular. This was found to be due to the setting of the external amplifier in the TCT set up which was nearly full up.
Now the correct number of shifts were made each time but the left shift test programme showed faults for shift of more than 3 places. This was also shown in the V test programme which was tried again at this stage.
A short manual programme showed that [[in]] fact if a large batch of "1's were shifted many places some gaps some times appeared.

[[NB06-053]]
With this sequence running inspection was made round the accumulator loop and the most likely cause of trouble was found to be the two cascade amplifiers in ASU II advancing the gain of $P_1$ cured this fault and subsequently all the shifting programmes worked correctly.
A new attempt on the V programme ws now made and unmasked by the shifting faults it was now apparent that the faults left on this programme were due simply to not carrying out

multiplication.
Now this was the familiar ~~D~~ $EP_2$ instead of $EP_4$ so that a little more de-sensitizing of the ~~first~~ W8 flip flop in CCU II was called for (being ~~set off~~ reset by spike in front of ED1)
With this mod made the A1 long test was carried out without faults right thro to the bitter end - a real tonic after the last week's work!!
This is the first time that LEO has got thro it to the bitter end

[[NB06-054]]
At 5.15 Caminer & Fantl[[e]] brought their test programmes down and many of them were found to be correct.
The final Wages Dem program was not however correctly printed an it is still not clear whether this is due to LEO or LEO ([[Fantls]])
There are still two things to be chased on the machine.
(a) Clearing the store by shorting CP does not work
(b) Occasional frequency slip causing clearing of store

13-4-51

After a good start yesterday morning much time was lost in ~~setting~~ setting up a new Clock Pulse Generator. After having lost the contents of the store twice as a result of frequency slip a new CPG was tried, but this had the effect of ruining all yesterdays good work so that when yet another slip occurred I put the old CPG back. The fault ~~on the~~ causing this appears to be in the Frequency Control Unit where the discrim valve is extremely sensitive to vibration. A valve was specially selected for this position eventually

[[NB06-055]]
with the old CPG in position things looked a little better but I still could not produce the clean

G E A S C H L R Y

that I got ~~last~~ the previous night. Right shift and multiplication were failing occasionally The odd fault in right shift which causes failing on the Y order has been solved. It was found that a manual sequence could be made to go wrong if the accumulator was negative prior to doing the Y order. This suggested that there might be suppression of the Y End Pulse $EP_3$ if

the sign digit were breaking thro the gate in LC29 producing a $P_G$ pulse which suppresses $EP_3$ in LC30.
Sure enough the sequence was OK provided the $P_g$ pulse was disconnected.
The fixed gain amplifier in the $P_g$ line has been reduced in gain to allow for this.
LEO did some good work on Tax tables yesterday producing several yards of Tally Roll with tax for week 17.
A fault shown up in this programme was ~~the~~ quite incidental to the calculation of tax

[[NB06-056]]
The programme calls for a [[form]]

| [[£]] | s | [[?]] | s |
|---|---|---|---|
| | 5 | | . |
| | 10 | | 1 |
| | 15 | | 1 |
| 1 | 0 | | 2 |
| | 8 | | 2 |
| | 10 | | |
| | 15 | | 3 |
| 2 | 0 | | 2 |

actually LEO ~~printed~~ got the tax correct but the [[?]] & [[shillings]] of the rate wrong often printing 0 instead of 5
This program works by counting in [[5/-]] so that the two least significant digits are collated out to indicate what shillings are required:

collate out 11
negative print £
subtract <
positive

positive print 1~~0~~/-
subtract 1 <
negative

subtract 1 - positive print [[5/-]]

[[NB06-057]]

13-4-51

Late Thursday Evening someone in a rather dispairing way put on the Input tape which stopped half way thro.
This was the point I followed up yesterday morning. The trouble was not due to

incorrect readin (the fault that the tape is designed to test for) but to incorrect subtraction.
By stepping the programme it was ~~seemed~~ seen to fail to produce the extra sign digit when 1 was subtracted from zero
Then I tried a short programme ~~T I~~ for subtraction which worked correctly

even when I put appropriate input orders in it would not go wrong. Then I repeated this short programme using the same part of the store as used in the actual Test programme. This gave the same error so putting an extra E order after my sequence I was able to get a repetition of the fault.
On examining the number from the Complementer I could see that the extra sign digit was fluctuating in amplitude (beat with mains)
The programme being used was subtracting $D_{19}$ from

[[NB06-058]]
a clear accumulator and in the complementer the $D_{19}$ is gated and reversed to produce the complement of 1 which is a batch of clock pulses finishing with a even $D_1$ ~~the~~ The break thro of subsequent $D_{19}$ (or $D_1$) was sufficient when amplified to operate the suppressor gate slightly so that as the amplitude of this breakthro pulse varied so the second sign digit of the complement became partly suppressed.
An adjustment of the amplifier was sufficient to remove this effect

and the short programme thereafter went correctly.
The input programme now functions correctly and the tax tables also produced the correct results.
A new tax table producing a quicker change in limits was tried and produced an almost faultless sheet.
The wages problem was tried at this stage and produced rubbish again.
In between programme efforts I replaced a CG6C by a CG1C in CCU I in

[[NB06-059]]
an attempt to get rid of the spike in front of Even $D_1$.
This was successful reducing a 6 volt spike to 2 volts. After this change the wages programme was tried and did everything correctly with the exception of the Key number which still does

1
2
3
5
5 etc.

Caminer is producing a shortened version of the key number sequence.

Worked today (Saturday) until 4 oclock.
First of all working on Wages programme. By inspecting store during the printing of the key number it was found that occassionally after a subtraction which should have cleared the accumulator, a "1" was left which caused an error of +1 in the subsequent number to be printed. This has been explained in theory but as yet no programme avoiding the point has bee ~~found~~ tried.
It is proposed if possible to avoid the issue rather than to cure it at this late

[[NB06-060]]
stage. I did produce a short sequence which showed up a rather meagre AD2 and I propose to follow this up at the earliest opportunity.
~~Another~~
After dinner today Kaye and I worked on to get the controls on the Control desk working in parallel with those on my small table These work OK now but I feel that I should beware of the effect of a long line which is now hanging on the Accumulator clear gate.

Incidentally this W9 waveform which was originally 3 minorcycles long is now only 2 minorcycles - however as it is being applied to both Accumulators there is plenty of overlap.
Complete control of the situation from the Control Desk is not quite with us as the W12 waveform still more often than not sticks in the set condition after the starter comes to rest. At present this calls for a "wet finger" but it may be possible to use the starter $D_9$ to

[[NB06-061]]
reset this by mixing with the input to the [[next]] W12 gate in panel 10.

15-4-51

In view of proposed demonstration this week it would be interesting to go thro some of the faults which have occurred recently putting the machine out of action for one reason or another.
I should start with one which cropped up on Saturday morning - W13 flip flop sticking - cured by moving one of the ff valves.

Fault during 2 weeks ending 12-4-51

| | |
|---|---|
| Subtraction | partial suppression of second sign digit |
| Wages ? | Spike infront of $ED_1$ |
| Y Orders | Suppression of EP3 |
| Frequency Slip | Microphonics valve |
| Multiplication | $EP_2$ instead of $EP_4$ |
| Shifting | Over amplification in TCT |
| Reader | EP relay |
| Teleprinter Corruption | Spurious EP3 |
| Tearing Tape | Broken ground on [[reader]] |
| Coincidence | Dry joint |
| Clearing of OT | Capacity on gate. |
| Teleprinter | Jammed with paper |
| CPG | Interference from Test Rack |
| Micand | Faulty Clear Gates |
| " | Too much delay |

[[NB06-062]]

16-4-51

## The ~~anthal~~ Analysis of Transient Behaviour

Damped tuned circuit

[[DIAGRAM - CIRCUIT]]

(Kelvin)

$Ldi/dt + Ri + 1/C \int i\,dt = t^0$ $(t \geq 0)$

impedance times current voltage

$[\ Z\ ]\ i\ =$

[[I]] satisfy this $i = Ie^{mt}$

i in any circuit $= I_1e^{m_1t} + I_2e^{m_2t} + I_3e^{m_3t} \ldots$

$[\ mL + R + 1/mC\ ]\ i = 0$

$m = -R/2L \pm \sqrt{R^2/4L^2} \sim 1/LC$

$\therefore i = I_1e^{-R/2L+j\sqrt{1/LC-R2/4L2}}$
$I_1$

[[DIAGRAM - CIRCUIT]]

$\Delta / B_{rs} \,.\, i_s = e_r$

$[\ a_nm^n + a_{n-1}m^{n-1} \quad a_0 / b_qm^q + b_{q-1}m^{q-1} \ldots b_0\ ]\ i_s = e_r$

factoring zeros
$(m - m_1)(m - m_2) \ldots / (m - m_2)(\quad)\ i_3 = e_r$
poles

[[NB06-063]]
conjugate vectors

Sine wave must be represented by two vectors rotating in opposite directions

[[DIAGRAM - GRAPH]]

$\xi^{jwt} = \cos \omega t - j \sin \omega t$

$\cos \omega t = \xi^{i\omega t} + \xi^{-jwt} / 2$

$\sin \omega t = \xi^{i\omega t} - \xi^{jwt} / 2$

Complex ~~Waveform~~ Frequency

$\cos - \omega t = \cos \omega t$
$\sin - \omega t = - \sin \omega t$

m may be real imaginary or complex

$Ie^{\alpha \pm j\omega t} = Ie^{\alpha t}(e^{j\omega t} + e^{-j\omega t} / 2)$

damped waveform can be regarded as a complex waveform of two frequencies
α j ω
α being decrement
j ω being frequency of complex frequency phase

[[DIAGRAM - GRAPH]]

$\xi^{-\alpha t}\cos \omega t$

$e^{\pm j\omega t}$ or cos ωt

$\xi^{-\alpha t}$

[[NB06-064]]
Fourier Series (periodic waves)

[[DIAGRAM - WAVEFORMS]]

K $T_0/T_1$

T -> ∞ envelope fills up with harmonics.

$f(t = \sum a_n \cos b_n \cos) 2\pi nt/T_0$

$\int a(\omega)\cos b\ \omega \cos) \omega t\ d\omega$

$\int a\ \omega \cos \omega t\ d\omega$

$\int b\ \omega \sin$

[[DIAGRAM - PLOT]]
Found axis
Fourier Mellin

[[NB06-065]]

17-4-51

It seems that the Dem is definitely on provided ~~the~~ LEO doesnt blow up in the mean time. Most of the programmes are worked correctly now although the wages programme has been re punched to avoid the trouble on the key numbers. Apparently occasional digits are left in the accumulators after subtracting to clear so that an extra ~~clea~~ transfer order has been put in.
One fault that still crops up occasionally is once again in the wages programme when having taken in the

Factory headings it takes in the first [[rows]] data and prints
3000 - 00 00 00
3000 00 00 00
etc.

It would be a most laborious task to wade thro to find out how this goes wrong. What an advantage it would be to have the complete contents of the store printed out on an occasion of this sort.
Hemy has already produced a "post mortem tape" which will print out the Action letters of the store from any position but so often it is the address

[[NB06-066]]
which is important.
One way of doing this would be a special output order that prints 1 or 0 for a pulse or a space in the ~~mo~~ sign digit of ~~the accumulator~~ a long number
Then with a program

```
T O' A L T A A E
   L1
T CR LF A T O' A L T A A E
   0   T  drain                14 - 1
   1  [[D]]  CR
   2    0   LF
   3    A   6
   4     a  1+
   5    T   0
   6    O'
   7    A
   8    L1
   9    T
  10    A    A
  11    A
  12    E    5
  13    E1   0

   T - Drain
   O    CR
   O    LF
   A     7
   A    14
   T     7
   A
   O'
```

[[NB06-067]]

17-4-51

Three practise full dress rehearsals today  two went off without a hitch but the third failed on the last (wages programme)  The failure was attributed to frequency drift and true enough the frequency was off the beat
Fortunately we were left alone after this because trouble began to blow up in large lumps and I am returning home now at 10:30pm still not completely sure that all is well.
Soon after [[4]] oclock it was obvious that the wages program

was failing again. A run thro the test A1 suggested that L might be the cause but the A 3 L programme worked correctly. This put us on to the store sections 5 & 6  Tank 5

looked likeliest and the panel 1 was changed  After renewed attempts & failures the trouble seemed to have settled now on tank 6 and a new panel 1 was tried here. This too was [[US]] and yet another panel 1 was put in. After much more trouble it was shown that a insensitive panel 1 coupled

[[NB06-068]]
with a bit of [[microphoning]] in the FC unit had been the cause of the trouble and finally parts of the Wages programme was successfully carried out at 10 oclock.

Frequency Monitor.

[[DIAGRAMS - WAVEFORMS]]

[[NB06-069]]

19-4-51

Contrary to many expectations during the day yesterday was a success.
At 930 LEO was going at half cock failing on orders in tanks 5 & 6 which eventualy found to have either lost digits or gained them.
Eventually suspicion settled around the frequency control unit and on my suggestion it was disconnected
At 11.15 The demonstration for the Directors was cancelled at 11.20 it was on again as we found that LEO unrestricted by the FCU lapped up

the wages programme quite happily
For the directors there was not a foot set wrong and LEO behaved perfectly. During the afternoon some faults did arrive but not directly due to Leo - Wrong tapes were put on Wrong buttons pressed even the Teleprinter failed (due to lack of oil!) but LEO kept on till the bitter end without a [[blot]]. During the day I adjusted the frequency three times only.
JRMS & TRT are very pleased with the whole days work and the audiences

[[NB06-070]]
found the impact of LEO pretty shattering
Our thoughts now turn to the future - what shall be our immediate program
Several things need to be done but the order in which we should attempt them depends rather upon how operational we are expected to keep LEO during the next few weeks.

- Frequency Control Unit
- Frequency Monitor
- Control desk wiring
- Installing of new racks
- Continuing Attenuator check
- Modifications arising
- Z order

[[Found]] more efficient way of inserting attenuator at different points is required
Possibly a telephone jack with a two way switch on it. with a socket at each test point.

[[NB06-071]]

20-4-50

Yesterday morning I spent writing solidly. Fault sheets had fallen a long way behind during the panic of the past week or two and had it not been for these notes I would have had a hard job to remember many of the obstacles overcome During the afternoon I turned to the fault which had dogged us during the preliminary stage of the ~~subtraction~~ wages program and which had been available during the demonstration namely subtraction of negative numbers.
Apparently this fault had

got worse so that even the Store test programme failed.
Boiling it down to simple terms LEO just did not like subtracting negative numbers and even a continued subtraction of an order $A_0$ went wrong. Under these circumstances it did not take long to trace the cause of the fault. Oversensitive flip flop in the complementer which was receiving a small breakthro pulse on the set terminal at the same time as the reset pulse was applied. The effect was an extra ~~2~~ 2 minorcycles worth of clock pulses which filled the less significant half

[[NB06-072]]
of the accumulator.
By reducing the amplitude of the pulses ~~of~~ setting the flip flop this could be overcome but it would be more reasonable to reduce the sensitivity of the flip flop to the set pulse as these need to be fairly large for the complementing circuit.
With this critical adjustment of amplitude LEO ~~took~~ accomplished in the original wages programme without fault.
I have not had any opportunity for pursuing my idea on attenuators.
I like the idea of a plug & socket method as it would

be possible I think to insert such a device without [[destroying]] the circuit

[[DIAGRAMS - CIRCUITS]]

Unfortunately this would mean extra contacts in circuit all tending to increase possibility of failure

[[NB06-073]]
W1± Even 35 0 1 Odd 35 0

Clock

[[DIAGRAMS - CIRCUITS]]

What are the most suitable points to do attenuator tests on pulse patterns in the machine

1. Accumulator Loop. Circulation
(a) with full accumulator
(b) - 1111000011110000
Half Adder I a
" " II a
Acc II $A_2$

Acc I $A_2$
ASU I
ASU II

[[NB06-074]]
Accumulator Circulating
" Shifting
" Adding (~~Shift~~ Subtract & Collate)
" Multiplying
" Output
Micand circulation
No in to Computer for ASCV (micand)
" " " " " H (Mier)
Paths to Accumulator
~~(a) Adding Collater~~
Collater ~~to~~ via Acc IO
" " Complementer
Micand Shifting (multiplication)

0 $A_3$
1 R 8 places
2 $E_0$
3 (31 32 31 34)

[[NB06-075]]

26-4-51

Attenuator checks have been continued during the past few days interspersed with demonstrations and new programmes being tried
Mr Geoffrey Salmon & Mr Douglas Gluckstien with others had a demonstration on Tuesday. LEO behaved perfectly and everbody was suitably impressed.
Until yesterday I had been working without the frequency control unit. This has now been tidied up and put back. The first effect was a shower of faults

These were most definitely attributable to the introduction of the FCU as on taking it out the faults vanished.
On replacing the units an effort was made to find the reason for the faults which seemed to be worse on Left shift.
One thing that was found was that the waveform that was closing the normal path during shifting operation had breakthro of the pulse pattern on it which occasionally caused the pattern to follow both paths.
This is due to the fact that the reversing valve is a pentode which supplied

[[NB06-076]]
the shifting gate by means of a load in its cathode.

[[DIAGRAM - CIRCUITS]]

The fact that a certain amount of pulse breakthro from the positive gate gets onto the cathode of the pentode produce similar amplified pulses on the waveform which is being used to close the other gates. This trouble has been met before in

another place and the cure is to provide a ~~spare~~ separate cathode follower to deal with the positive waveform
It is not at all clear why the Frequency Control unit should exaggerate such a fault. The control was removed and the same breakthro noted but the faults did not occur. I think that it may all be tied up with this beat effect which is noticed in so many places on the machine. It could be that without a frequency control the frequency itself shifts slightly in time with the mains and this permits

[[NB06-077]]
other variations at the same frequency to be tolerated. Alternatively the FCU may introduce a slight shift opposing the natural beat so that the effect is exaggerated
Inspection of the control voltage showed that this was shifting slowly but by a very small amount hardly likely to procude the effects noted

27-4-51

A modification to the gates in ~~CC~~ LC 23 providing a separate cathode follower for the positive waveform almost eliminates the trouble mentioned yesterday. Left shift troubles seem to be removed now and even with the frequency control unit in use no faults occur on A1 L. Further faults did however crop up on Right shift and by means of a short programme using 15 shifts it was seen that occasionally the W5 waveform was resetting to early so that one too few shifts were done
This was found to be due to

[[NB06-078]]
the W5 flip flop being too sensitive to reset and actually getting reset on a breakthro of ED1. (Incidentally there seems to be no reason why ~~it~~ this should not have been happening in the case of Left shift.
Increasing the series resistance from 690 Ω to 1 K eliminates this fault.
The A1 test now works OK with the Frequency Control Unit in position with the exception of V which still goes wrong

1-5-51

50 Bauds  333 Bauds  1000 Bauds
100 per inch
10 inches/sec
Query possibility of sheets of paper coated with magnetic material as a skin of a single drum.
Information recorded on helical trace.
Article in WW. May 51 re new ~~Dutch~~ Belgian recorder using this principle
Possible snag is trailing edge of paper causing spurious signals

[[DIAGRAM - DRUM]]

[[NB06-079]]
Attenuator Tests
A4 test with Attenuator in "Acc IO to First Half Adder"
Step 0.
Faults on A S C H & V

---

A4 test with Attentuator in Complementer to First Half Adder
No faults on steps 1 2 3 & 4

Faults on V on step 5.
On step 6 programme fails.

---

A4 test with Attr
In from Collator to Acc in IO
Faults on A C 4 L R V

Investigation of Trips on Power Racks.

HT main breaker very sensitive. Current being drawn at present 12 amps DC.
Distribution of AC load measured by taking current readings on all three phases with and without Main HT Breaker on.

| | Heaters & ~~Controlled~~ [[Stabilised]] Supplies only | Full Load. | +250 HT Unst Load |
|---|---|---|---|
| Phase | | | |
| Blue | 12.6 | 17.65 | 5.05 |
| Yellow | 14.6 | 19.6 | 5.0 |
| Red | 13.4 | 18.8 | 5.4 |

[[NB06-080]]

7-5-51

Much of the past few days work has been useless as Attenuator test records made one day have not been repeatable the next. Rightly or wrongly I have blamed the FCU and future tests will be made with this out of circuit. Have also had trouble with storage units the [[width]] of pulses being [[recessive]] in some cases.
This afternoon I spent setting up relays in operating control unit as the tape reader was not producing end pulses. Eventually

I found that the trouble is due to the circuit. The pulses setting & resetting the flip flop for the end pulse ~~are~~ is elongated in the usual way with 470 pf condensers. [[If is]] applied to altenator inputs by relay switching. If the relay goes over after the pulse has started the test of the pulse may get thro & set the flip flop after the $D_0$ so that the effect is lost. The answer is to put in 470 pf after the relay contacts instead of before.
Looking back to my notes of 19 Jan I see I have been thro this phase before but

[[NB06-081]]
thought I had cured it by disconnecting the 470 pf.

9-5-51

With the modification as outlined above this works OK.
Past two days spent attempting to repeat attenuator tests. On Tuesday I had had some trouble with multiplication and I spent most of yesterday tracing it. As it transpired the trouble was not with multiplication as such but the path to the accumulator which was the cause of the trouble.

The two sources of Trouble were the Collater and the Acc IO. In the collater the trouble was insufficient amplitude of W4- (to 15 volts only) which was robbing me of

2 volts of pulse
With this improved input to the Acc IO I found that the output from the unit was on the thin side. I found that the unclocked delayed pulses were the cause of this. A condenser across the cathode improved the situation but reduced amplitude. With an increased anode loads in the amplifier (4K7 replacing 3K3) there were sufficient strays to make the

[[NB06-082]]
cathode condenser uncessary
This finally gave an increased pulse size into the first half adder of 15 volts
Some repeated Attenuator tests now gave satisfactory readings from points which would not accept the attentuation at all previously.
Shaw has been working on a widening circuit from the Panel 1 which we hope will increase frequency tolerance. I have been working with two tanks (0 & 2) which show a difference in delay of about .2μS. This calls for a very critical setting of frequency

and it is felt that this situation would be improved by a pulse shaping circuits which gave a sharper rising & falling edge to the unclocked pulse. An improvement to the circuit has been made and it remains to try it out
Incidentally the difference in delay of the two tanks has definitely been traced to the tanks themselves & is thought to be due to some interference causing a slow build up of [[oscill]] under some circumstances.
The reason for W12 sticking up at the end of the starter sequence has been

[[NB06-083]]
traced to a stray kick on the mechanical end pulse line. This appears to be coming from relays in operative control II and it is thought that it may be possible to eliminate it by decoupling the 50 volt supply to this unit.
A celebration dinner has bee arranged for next Wednesday and then demonstrations once again. First of all to the Board of STC and then to supervisors.

9-5-51

Best part of the day was spent on the stray kick on the Mech end pulse line. Eventually it was traced to Sparking in the Starter unit. A little suppression cured this and after restoring things to order again I went on to the phasing of pulses in the store with Shaw. A mod to panel 1s is being tried out and there is a considerable improvement in time of rise and fall of unclocked pulses. One snag is now that the pulses tend to run into each other when in batches of five or six

[[NB06-084]]
In order to get a better picture of the effect I moved the CRO over to the store rack where I was horrified to find that the clock pulses had tails on them running in to each other.
For the first time I found that JP has economised in the storage junction unit by using no zero restoring diode on the CF feeding clock pulses. A quick mod to the unit using a crystal and the negative line improved these enormously.
With this mod it may be that a lot of my trouble

in the store with pulses running in to each other may be eliminated.

---

Tomorrow being Friday before the next big dem. it is worth while considering whether it is desirable to do any serious mods this week end. Pinkerton wants some decoupling put in the Ht line to the oscillator valve in order to remove some 50c/s Frequency modulation. He thinks that this may be part of the cause of the Frequency Control Unit failing.

[[NB06-085]]

10-5-51

Work for Today

1. Mod to 2 storage junction units
   22K to negative line
   Grid to earth Clock Pulse KT61
   Crystal restorer
2. Machine tests. (Daily)
3. Decoupling in FCU
4. Consider Mod to reset W12 at start of starter sequence.
5. Check attr tests on Multiplication control Pulses.

---

Recently it has been difficult to prevent the overload trips from ~~preve~~ operating when first switching on the HT in the morning. On consideration

it is obvious that if these merely make connection ~~for~~ directly to unit the supply has to produce infinite current to charge up all the smoothing condensers. There appear to be several ways of avoiding this
(a) Connect HT before running up voltage
(b) Insert a current limiting resistance is series with each supply which can be shorted out
(c) Insert series resistor in each condenser
(d) Delay operation of trips in some way

[[NB06-086]]

15-5-51

I need not have bothered about the desirability of making any mods before the demonstration. The query now is whether there will be a demonstration at all.
For a week I had had a strange failing of the multiplication test which although only occuring occasionally was eventually shown to be due to addition of long batches of ones into the accumulator. The effect was that occasionally a digit in the more significant half of the accumulator would drop out when ~~add~~ -1 was being

added in the less significant half. This fault got steadily worse until on Friday afternoon The machine would not read tape. Unfortunately the fault would only happen at machine speeds but eventually it was narrowed down to the Acc IO unit. I worked until 9 pm on Friday in an attempt to clear it and again on Saturday until 1 pm
TRT called in on me at 1130 on Saturday so I expect I spoiled his weekend for him. In investigating this fault I have come upon another

[[NB06-087]]
which may have been causing failure without causing any additional signs of faults

other than the ones I have.
This is a spike strongly resembling a D19 on the line carrying C16 to the ~~output~~ Pulse selector Unit  If the D19 pecker happens to be up at the time it occurs it means that a D19 ~~is~~ may be added into the ~~accumulator~~ accumulator or transferred to a store position along with any other number or order. The fact that the affect of this has not previously been noticed

is probably due to the fact that ~~most~~ many of the test numbers are negative and would not change for having an extra digit mixed in with it.
The spike referred to is probably only present during some other particular sequence but so far I only know that it does occur
This spike ~~was fo~~ or the results of it were first noticed when examining the number going into the micand tank during a short test program
Comparing with a Cr I could not only see the number going in but also

[[NB06-088]]
a single digit much earlier but still within the gating period. This single digit was traced via the transfer Unit to the PSU.

15-5-1
Continued investigation Much of PSU trouble was increased this working due to lack of emission in one Double diode causing excessive breakthro. This was not the entire solution hoever as there was still a spike on the C16 line letting thro one of the digits. Fortunately

it was not doing so at a time when any ill effects were caused.
A similar effect on C18 (mier input waveform) caused spurious "1"s in the mier tank. This incidentally is the cause of the multiplication test going wrong. If the mier gain is set high enough of an extra digit gets into this tank to give circulations and instead of +1 x -1 its +3 x -1
The cause of the dropped digits in the more significant end of the multiplication total was eventually found in the transfer tanks.
I had argued that

[[NB06-089]]
because subtracting 1 from the accumulator repeatedly worked OK where as adding -1 did not, then the fault must lay in the path from the micand via the collater & Acc IO. This isa false argument. I had omitted to take into account the fact that in adding -1 a long string of 1s was being taken from the store whereas with subtracting 1 only a single digit was being dealt with. The fault lay partly in the panel 1 of the store where a modification had included an insufficiently

decoupled voltage reference point, and partly in the transfer unit where the amplifier does not produce a sufficiently wide pulse
It seems now that there is more hope for tomorrows demonstration. All tests are accomplished without faults

[[NB06-090]]
16.5.51
Demonstration of LEO to Dr Wilkes & Mr Sadifer went off very well until we tried to

curtail the Payroll programme by cutting out the last dozen men whereupon the machine just stopped. This seems to prove to Dr Wilkes that it was even a better machine than he had thought
Celebration dinner at the Trocadero this evening was a great success

17.5.51
Demonstration to Directors of STC. No hitches.

Programme of demonstration

Friday 18-5-51
2.15 Rehearsal
4.00 Standard Telephones Party A

Monday 21-5-51
10.30
11.30 Supervisors
12.30
4.00 Standard Telephones B

Tuesday 22-5-51
10 30
11 30
2 30 Supervisors
3 30
4 30

[[NB06-091]]

23-5-51

Demonstrations not completely successful. A bundle of faults centred around the reader and printer marred the Tuesdays shows and the last one had to be postponed until this morning. However as this went off very well everybody feels reasonably happy
The faults on the reader were to some extent man-made ~~on the tape guard~~ It started with the tape guard which broke off. A replacement was slightly oversize and ~~cause~~ reduced clearance on the tape which in turn caused the reader

to slow down and to cause excessive wear on the sprocket holes. This caused occasional corruption of orders read in with the accompanying chaos. Attention was drawn to this mercifully when ~~the~~ one of the tapes tore at the sprocket holes.

[[NB06-092]]

[[DIAGRAM - CIRCUIT]]

[[BLANK PAGE]]

[[NB06-093]]

[[BLANK PAGE]]

[[BLANK PAGE]]

[[NB06-094]]

| CPG $P_1$5 | $P_2$99 | $P_3$48 | $P_4$35 | $P_5$80 | $P_6$47 | $C_3$35 |
|---|---|---|---|---|---|---|
| FCU | $P_1$ 50 | | $P_2$ 61 | $P_f$21 | | |
| Collator | 25 | | | | | |
| CCU VII | 73 | | 60 | 60 | | |
| TCTSU | 17 | | 28 | | | |
| CCU VIII | ~~37~~ 40 | | | | | |
| MSU | 37 | | 38 | 40 | | |
| Compl | 63 | | 53 | 80 | | |
| CCU IX | 92 | | | | | |
| CCU VI | 50 | | 50 | 80 | 100 | |
| CCU X | 17 | | 22 | | | |
| CCU V | 60 90 | | | | | |
| ACC IO | 37 | | 100 | 40 | | |
| CCU III | 50 | | | | | |
| CCU XI | 50 | | | | | |
| ACC SU I | 54 | | 32 | 36 | | |
| ACC SU II | 47 | | 58 | | | |
| HA 16-4 | 40 | | 48 | | | |
| HA 16-6 | 32 | | 37 | | | |
| PSU I | 30 | | | | | |
| PSU III | 39 | | | | | |
| OPCU II | 35 | | | | | |
| Maj Cy PG | 65 | | | | | |
| Coord III | 49 | | 30 | | | |
| IV | 50 | | 40 | | | |
| Coince I | 65 | 40 | | | | |
| HA 16 2 | 40 | | 70 | | | |
| HA 16 3 | 34 | | 46 | | | |
| PAD | 54 | | | | | |
| TRANS. | 60 | | 97 | | | |

[[NB06-095]]

[[BLANK PAGE]]

23
2 + 5 + 5 12 = 23/-
2 + 7 + 7 + 7 23/91 of 110

@36mpg
16th 8-11 $\frac{12 \times 24^8}{36}$ = 8 gal

3

28/-
2
30/-

[[NB06-096]]

[[INSERT SHEET?]]
[[BINARY CALCULATION?]]