BILL POLITS

Modifications of the 310:

About a month ago we became aware of excessive hum on the trace of the 310 in the pre-amplifier position. This was pin-pointed to electromagnetic coupling from the high voltage transformer to the pre-amplifier. The following modifications were made to correct this condition:

1. The air gap of the transformer was reduced.
2. The turns per volt on the transformer were doubled.
3. A copper shield was placed around the transformer core, which further reduced the stray field put out by the transformer.

We also increased the ratio of primary to secondary turns, which enabled the plate to swing further, and the oscillator to draw less plate current.

The resulting increase in efficiency made additional changes necessary in the regulator circuitry. R702 was increased from 47K to 150K. Since the screen current now is smaller, this in turn required changing V701 12AT7 to 12AU7 to reduce regulator loop gain.

We have changed C731 from .0068 to .015 to decrease intensity modulation and increase transient stability of regulator loop. The frequency is about 25 kc instead of 60 or 70 kc. We also re-worked the board to reduce some of the close spacings.

In addition to high voltage oscillator pickup, the pre-amplifier had 60 cycle hum trouble. A compromise solution to this problem was made on the serial #'s 215 to 315, by increasing R410 from 27 ohms to 2.2K. This corrected the hum but introduced a problem of tube selection; the reduced screen voltage resulting from this change caused grid current difficulty on some 6AU6's. We were forced to tolerate this compromise because it would have been necessary to change the printed circuit boards already in the instrument.

After serial #315 new printed circuit boards were used which enabled us to raise screen voltage from 94 to 109 volts. R410 was increased to 3.3K and another resistor R415 33K was added between the screen and +300. This gives V320 adequate bias so no trouble is expected from grid current in subsequent instruments.

Another capacitor was added to bypass the 100 volt bus because by these changes C402 has become solely a screen bypass.

Spiking in the attenuator in the pre-amplifier position: Shortly after our difficulty with hum, it was discovered that it was impossible to critically compensate all three pre-amplifier attenuator positions when using a probe. This was traced to capacity existing between output and input of the pre-amplifier which varied due to Miller effect. Beginning with serial #215 the following changes were made to clear up this condition:

1. A new shield was placed between C340 and the attenuator switch.
2. C320, R320, and R401 were re-located.

We are about to install a new design of attenuator switch for the D unit, which enables individual differential balance adjust of each decade attenuator step.

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JOHN KOBBE

We have been finishing the always last-minute modifications in getting the 570 into production. One problem revolved around a barely perceptible lack of flatness of the first grid step. This produced an "opening out" of the topmost trace in the plate characteristics, the magnitude of which increased as the number of steps was increased. We had not realized until recently that this resulted from circuit difficulties, since many tubes under test show hysteresis and DC shift effects, which produce almost the same aberration in the display. We discovered two causes for this lack of flatness in the first step: (1) the contact current biasing effect of the diode in the DC level setting feedback loop; (2) "soak" in the Mylar miller feedback capacitor. The first trouble was cured by insertion of a RC compensating network, while the "soak" effect required getting our capacitor department to wind Polystyrene capacitors instead of Mylar. It should be noted that Mylar capacitors do not have excessive "soak" for ordinary sweep circuits (being much better than oil impregnated paper), but purely by chance the 570 display is a particularly sensitive method for measuring "soak" effects.

With a few more changes such as resistor wattage mods, we are now shipping 570's and it looks like we may start getting caught up on them pretty soon now.

We have been working on a square wave generator with which to tune the 540 series, and we have one that looks pretty good. This one doesn't use any unconventional means of getting the fast rise except to run the tubes about as hard as they can stand. It uses a 6BQ7 multivibrator and three 12BY7' shapers with a 6AU6 output.

The rise time seems to be in the order of two or three μsec. The frequency is now variable from about 200 kc up to 1 megacycle. We are hoping to get this or a more elaborate square wave generator to the field people in the next few months. One suggestion which has some support is to combine the high frequency square wave generator with the following.

1. A 1000 cycle calibrator with fast enough rise time to tune RC attenuators in the 53/54K. This requires 5 to 10 times faster rise time than the calibrator in the scope. For all other attenuators this calibrator should be superior to that in the scope.
2. A 50-cycle square wave for low frequency compensation.
3. A .1-cycle square wave for DC shift compensation.

With these additions this one unit should provide needed waveforms to adjust the vertical amplifier in all of our scopes, including the 517. We would appreciate your comments on the desirability of this combination. We are presently worried about gain changing with line voltage in the 545. Most of this trouble seems to be in the 6CB6's. Even with a very good

set of tubes the gain change appears to be 5 or 6% and with some tubes as much as 20% has been experienced. Sylvania tubes appear to be the most free from this gain change, but have the disadvantage that present DC shift compensation doesn't have the correct time constant. Current instruments are still using RCA tubes.

In order for you to help our customers make a decision between the purchase of a 530 series and a 540 series oscilloscope, we would like to pass along a few observations on the comparison of these models. Some of us feel that in advertising the 545 there has been undue emphasis on the bandwidth by omitting some other factors which may be equally or more significant to some customers.

Except for the decreased bandwidth the 530 series has a number of advantages over the 540 series. Some of them are:

1. Better reliability since fewer tubes are used.
2. 6 cm instead of 4 cm of deflection, which is quite significant in dual trace applications.
3. CRT focus and linearity are somewhat better because of wider deflection plate spacing in the 51 tube compared to the 54.
4. The better focus also results in slightly better writing rate.
5. The 545 does not have as long a delay in the vertical amplifier as the 535. The extra delay is very useful when you are looking at slower rising signals, in the order of .5 μs or so. With these signals the sweep will take from .15 to .2 μs to get started and when you are using up this much of the delay line this extra .05 μs becomes very important.

This may not be as bad as it would sound from the above paragraphs, but we feel the customers should be made aware of these limitations and problems.

515: We are working on the 515, and one problem is to get the delay line to tune without wrinkles, and at the same time to give us 15 mc bandwidth. Another problem is to find an input amplifier tube with which we can get the gain bandwidth and at the same time for the variable gain control to work. The 6AW8 at first appeared to have the qualifications, but due to the suppressor being connected to the cathode internally, it seems that the variable gain control will not work satisfactorily. It looks like the tube we are going to have to use is the 12BY7. We see a few more problems in the 515, such as high frequency synchronization of the sweep and getting the sweep underway fast enough, to make full use of the delay line. However, these should be solved without too much difficulty.

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RODGERS JENKINS

With reference to the 53/54S plug-in sweep unit for the 542 (536) we have decided it will be necessary to make two S units. One will be a simple sweep with trigger circuitry, and the other one will have sweep gating capability as mentioned in the first newsletter. We have a working model of the simple sweep unit, but not of the more complex one.

We originally intended to call the equal vertical and horizontal amplifier scope the 542 since it required a 54K plug-in unit. However, they now call these plug-in units 53/54K, and as this scope is a 10 mc amplifier, this will probably be known as the 536 hereafter.

We are in the process of checking out a tentative production model of the 536. A little too early for predictions or apologies.

532: This instrument has undergone some rather extensive modifications, mostly behind the panel. A DC coupled vertical output signal has been added to make it possible to use the 360 indicator as a slave unit. The vertical amplifier has an adjustment added to it to facilitate balancing of the 12AU6's. Also, a DC internal trigger level adjust has been added. The sweep amplifier has been completely modified to a feedback amplifier system. This results in a considerably more linear and less critical sweep circuit.

An additional 12B4 has been added in the +350 regulator. This should be in production fairly soon now. It has been turned over to assembly.

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CHUCK NOLAN

360: The horizontal circuit of the 360 has been re-worked. We have put in an amplifier with feedback, and extended the positioning range from 1/4" to about 2-1/2 inches. The amplifier linearity is sufficiently good so that the chief source of non-linearity will be in the sweep waveform used. In this respect the sawtooth out of the early 532's exhibited starting non-linearity because the sweep output cathode follower was returned to ground instead of -150. This has been corrected from serial #125 on.

Work has been continued on the 515. We still are hoping for delivery of this instrument in March or April. Recently a change was made in the vertical amplifier to enable meeting the specified bandwidth without having grid current troubles in the input cathode followers. (See J. Kobbe's report). The new tube line-up is expected to be 6AU6 CF, 12BY7's - input amplifier, and 6CL6 - output amplifier.

A few other changes have been made to improve performance:

1. The horizontal amplifier has been changed to a full 6BQ7 on a side, resulting in less critical tube selection.

2. An additional cathode follower has been added to speed up the unblanking.

3. A trigger input tube has been changed from 6BQ7 to 6U8.

4. Since Bill and John are working on this instrument now, anything can happen.

We are experimenting with a small pee-wee type power supply for the 360. One has been built, and while it has a few problems, they look like they can be solved fairly easily. As we get the time to spend on this, it will be pushed into production. This small power supply would come complete with a case which would accept the 360 or any unit of the 160 series.

We have completed a modification of the 545 for NEL to be used as a monitor for pulse RF. It's main features are:

1. Automatic selection of three sweep speeds by remote switch.
2. Single shot sweep facilities when using the delaying sweep.
3. These features are provided by special positions on some of the switches without interferring with normal operation of the scope.

Progress is being made on the 530-540 series "A" models to the extent that extrusions have been ordered for bottom rails and center bars.

We have also worked out the details for modifying a 545 or 535 to provide delay time per cm. from 1 sec/cm to 3 μsec/cm. On a single twelve position switch using a 1-3-10 series. This is about equal in difficulty to the S1 and S2 Mods, and will be available for $25 additional as an S6 Mod.

In the 530-540 series, unblanking has been coupled into the sweep giving an aberrationto the start of the sweep. This condition was corrected by re-routing the unblanking lead so as to shield it from the cathodes and feedback network of the sweep output amplifier.

Unblanking was also coupling into the vertical which shows up as an aberration in the vertical direction at the start of the sweep. This can be corrected by shielding the delay line from the CRT socket. A suitable shield has been designed, but a kit for field Mods is not yet available.

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FRANK HOOD

Dual Beam: The first engineering model of a dual beam scope has been constructed and seems to work fairly well. Some of the problems such as intercoupling between sweeps and vertical amplifiers and so forth, did not prove to be as serious as was expected. However, the mechanical problems of mounting the parts to permit easy access to all tubes and components has been more difficult than expected.

A second engineering model is being built and we hope that with this new layout most of the construction problems will be solved.

Since building this first model we have decided that there is a need for at least two dual beam instruments; one to have the same general performance as our 531-535 series and another to have the performance of our 541-545 series. We have felt that we can do best if we bring out the 531-535 type instrument first since the dual CRT patterned after the T51P's should be much easier to construct than the more sensitive T54 variety.

There will be little change in the general specifications of this instrument from those outlined in the first report. The only major specification change will be that the vertical amplifiers will have a bandwidth of 10 to 15 mc and the CRT will have increased deflection (at least 6 cm per beam.)

Dual Beam Tubes: The CRT department has supplied us with a couple of sample dual beam tubes. These seem to work fairly well, although problems still must be solved.

Chopper Stabilized DC Amplifier: Tommy Thompson has just started to work on a chopper stabilized DC amplifier with differential input. Not enough progress has been made as yet to give a report on it. Several types of electronic as well as mechanical choppers are being considered. He hopes to get an amplifier which will work as a plug-in to the 531-535 series or the 540 series.

Type 310: The 310 is going fairly smooth in production. We have recently made a few modifications in the pre-amp and in the high voltage supply which decreases the hum modulation in the pre-amp position and permits a better alignment of the input attenuator. See Bill Polit's report for complete details on these modifications.

A few instruments may have gone out which did not regulate too well at high line voltages. If you run into such an instrument, check R608 (on selenium rectifier bracket). This should be 2.5K. Some instruments had a 2.25K wired in by mistake. This causes loss of regulation on the -150 volt supply at high line voltages. Also, due to the improved efficiency of the selenium rectifiers some instruments go out of regulation on the +300 volt supply. This may be corrected by changing R668 to 2.25K (it is now 2K 25W). We have lowered the voltage on terminals 5 and 6 of the power transformers, but it may be some time until these transformers are used as we have about 200 of the old transformers in stock.

Leather Case for the 310: We have a sample of a good quality "top grain" leather case forthe 310. This should cost between $40 and $50.

Viewing Hood for the 310: Dick Rhiger has had samples made of

a plastic "wrap around" light shield. It is conical in shape, about 10 inches long, and can be unsnapped to fit easily in the carrying case.

310D: We have had many requests for a 310 with a delay line. We have tried most of the delay line cable made by GE and Columbia Technical Corp. and have found that the waveform is not good enough to use in the scopes. There is not enough room in the instrument to use our standard type of delay lines.

We have recently tried some lines using iron core inductances and have had a fair amount of luck with them. We have some special forms on order and it looks like we might be able to build a line small enough to package into the instrument. If so it would require a different amplifier chassis so it would be impossible to modify the present instrument.

Film on CRT Production: The film on cathode ray tube production has been finished and two prints are available for showing. We can get more prints made if they are needed. This film is in 16 mm sound and color. It is 1200 feet in length and runs for about 35 minutes. It shows the complete step by step process in the manufacturing of our CRT's. It is suitable for showing to any science group or any engineering group. Please contact me or Chuck Gasser in requesting reservations on this film. If any school or college would like a print of this for their film library, we would be glad to supply them at our cost.

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CLIFF MOULTON

We are continuing development work on the distributed deflection plate CRT. A new model now being built has jig-punched mica cards to support the delay line elements, which are photo-ethced from copper or stainless steel. The remaining problems are primarily these two:

1. Determining the easiest and best mounting system.
2. Establishing the correct geometry for exact and uniform deflection plate surge impedance.

Two models of this tube may be desirable, one for a combination of high sensitivity, small picture, and highest possible speed; another with a somewhat larger picture at a sacrifice in sensitivity and sweep speed. Both types would probably be adjusted for 24 kv applications.

We have also made several CRT's with extremely short vertical deflection plates, on the order of a few mm's. By designing these with coax input on one side and output on the opposite side, it has been possible to maintain 52 ohm surge impedance throughout the vertical deflection system. This construction avoids the ringing characteristics of standard CRT's and theoretically permits accurate display of rise-

times as short as 0.15 mμsec.

Recently we have constructed a simple high speed indicator using one of these tubes. (Characteristics of the tube are 100 v/cm vertical and 15 v/cm horizontal at 24 kv). Two EFP 60 tubes are used to provide unblanking and sweep. The first tube, used in a regenerative circuit, is triggered "externally" to produce approximately 500 ma current change for unblanking the CRT as well as providing drive for the second tube which is connected as a "turn on" pentode sweep generator. By virtue of the unusually high horizontal sensitivity, sweep speeds as fast as 2 mμsec/cm have been produced with fair stability and linearity. No vertical amplifier is used, the signal merely being delayed through 20 feet of RG 8/U cable.

In spite of its many obvious limitations, this indicator has proven extremely useful. When used in conjunction with the mercury pulser (which provides both "signal" and trigger) it has proved capable of resolving surge impedance variations in the experimental distributed deflection plates, as well as showing mismatches present in coax connectors, line to deflection plate transitions, and terminations. The system to be checked is normally used as a charge line for the pulser, though in some cases may be placed in series with the vertical delay cable. Incidentally, the risetime of the mercury pulser through 22 feet of RG 8/U cable appears to be approximately 0.5 mμsec.

(Note by Dick Ropiequet) Needless to say, this indicator is not a production instrument, nor even a production prototype. However, it is conceivable that something similar, perhaps using a distributed deflection CRT, might be desired by some of our customers. How about some discreet inquiries and feedback...

BOB POULIN

Noisy 700 ohm gain control pots: After talking with factory engineers we decided that the problem is one of inadequate resolution. They are working on improving the situation but there isn't too much hope. The new plug-in units will use Tek wire-wound pots.

Noisy and unstable axial lead wire wound resistors: Our present supplier still makes the best resistor of this type. Four other manufacturers have been tested. None, however, are suitable for our use.

Modified 180 fan ring: There was some question if the new 180 would need the fan ring with the decreased input power. We found a difference of 2-1/2 times air volume with and without. Needless to say it stayed, resulting in a "real cool" instrument.

6BQ7 life test: The test has gone about 500 hours total on time. Tubes are in a cathode coupled circuit with each section running about 8 ma. The tubes are cycled to simulate operating conditions. So far we have found tendencies towards grid cathode shorts, heater-cathode shorts, and large changes in gm. At this time the makes we are using in instruments seem to be the best. More conclusive results can be given later.

310 Life test: Serial #105 was operated in an ambient temperature of 105 deg. F for 1700 hours. It worked quite well except for a change in sweep timing which is attributed to 6BQ7's and possibly the cathode gain pot. See report for more details, "Type 310 Life Test," Oct. 21, 1955.

High voltage capacitor oil leakage: Recently we again had trouble with high voltage capacitors. This time, however, they didn't get into scopes, thanks to the sharp eyes of the Quality Control Group headed by Ken King. The problem is largely one of maintaining a good oil seal. If oil leaks, there is an air void between the insulation, allowing the formation of corona which soon results in a breakdown. After much phoning and gnashing of teeth, we are keeping production satisfied.

Ten turn precision pots: We are going to continue using our present 10-turn pots and dials. They are the best choice for quality, appearance, and price. The dial "feel" has been improved to the point of being fairly acceptable.

Power supply divider resistors: Considerable testing of carbon film and metal film resistors has been done to determine changes due to DC stress. It appears our best answer for good stability in the power supplies is to turn to precision wire wounds. If we can find suitable wire wounds in regard to cost, size, reliability, and availability, we will use them in the more popular scopes and eliminate a big headache.

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JIM DONOGHUE:

54A and 54B plug-in amplifiers: Final layout is in pre-production for these amplifiers. The circuitry has been revised to attain optimum transient response in 541-545 oscilloscopes. The characteristics in the 541 will be:

1. Both the 54A and the A-section the 54B will exceed 20 mc response.
2. The 54B pre-amp should exceed 12 mcs.
3. The variable gain control will have little or no effect on the step response over its range of 2-1/2 to 1.
4. Input capacitance is still 47 pf.

The vertical attenuator switches for these plug-ins will have a mounting bracket, developed by Henry Fritzler, which holds all the trimmer capacitors. All attenuation settings are free of spurious response, except for barely perceptible distortion of a unit step in the X400 (maximum attenuation) position. There is evidence that this distortion is due to a high frequency ringing in the inductance of the ground path from the first attenuator capacitor to the input grid. This actually will never be a problem for our customers since the distortion does not occur with slower rise than the mercury pulser.

Production dates will depend on the time required to procure switches with early March set as the goal.

Also, ceramic wafers will probably replace the present phenolic wafers in these switches, to completely eliminate hooks due to the inferior loss factor of the phenolic wafers. There is no control over the latter before punching, and punching may also increase the loss factor.

Recently, the majority of the 524, 514, and 513 vertical attenuator switches have also exhibited excessive hooks. A new switch has been designed incorporating the same bracket and wiring technique as for the 54A and will be substituted as soon as evaluation can be completed.

P500CF Probe: This is for use with the 524 and other oscilloscopes with power available within 6 inches of the signal output. Correction to the first newsletter: "The insertion loss of the probe is 2-1/2 per cent at 5 mc and 1/2 db at 10 mc; the loss reaches 3 db between 20 and 23 mc." The X10 attenuator head adds another 1/2 db or less to the loss at 10 mc.

Cables for non-ringing probes are now available from one cable manufacturer. We are now evaluating the first production run (100 standard lengths) of cables for the P400 series probes.

In addition, this source has supplied a small number of 8-ft. lengths with the inner conductor replaced by resistance wire. Our estimate of the resistance required was too low, as these samples have a small (1 to 2 per cent) overshoot characteristics of too little resistance in the inner conductor.

The rise time and bandwidth are only slightly inferior to the 3-1/2 ft cables. These losses follow the usual effect of increasing the input capacitance. A X50 probe on this cable with 25 μμf on the output had an input capacitance of 3 μμf and a rise time and bandwidth comparable to the X50 probes on 3-1/2 ft cables. Hence it appears that these probe cables will show but little, if any, loss added by the increasing length.

The overshoot in response will be corrected in the next lot, by using an inner conductor of higher resistance. Eight foot non-ringing probes will then be available. Longer lengths can also be supplied by the same manufacturer. It is desirable that customers be aware of the ringing problem with ordinary cable so that they will not employ such probe cables on an oscilloscope which passes the ringing frequency.

The longer inner conductor of the 8' and 10' cables makes them less suited for low level work, because of their tendency toward microphonics.

A precision resistor manufacturer has very generously supplied a large number of carbon-film resistors, made of differing film thickness, spirals, and lengths, to be studied for transient response in attenuator (probe) circuits. This study will select that configuration of length, diameter, and shield diameter which has satisfactory transient response, based on observations that some resistors have good transient response if the diameter of the coaxial shield is correctly chosen.

If this study arrives at a successful conclusion, we can then consider offering a compensated high voltage probe for high voltage low energy (low duty cycle) transients.

In reply to the Editor of the "Instruments and Automation" Magazine requesting we examine his description of our P510A probe, we enlarged the write-up to include a description of the non-ringing probes. This article is to appear in the monthly series on Electronic Circuitry. We also submitted a description of the cathode follower probes, which may also be published.

B170V: A new B170V attenuator box is under development. It employs 3-position lever action switches, which reduces the straight through capacitance to about half that of the old boxes. Initial photographs on a CRT with 50 ohm deflection plates (developed by Cliff Moulton) indicate the rise time of the new box is approximately half that of the B170V. We observed approximately three mμsec rise time on the B170V and half that on the new attenuator.

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HENRY SCOTT

Permanent manuals are finished for all instruments now in production except the 570 and that will probably be done by the time you receive this letter. New work in process: 525, 515, 53/54C, and the 53/54A,B, and G.

Still a little too soon to be working on the 536, 53/54S,555, etc., but we are girding our loins.

Lou Ballinger was transferred to the Instruction Manual Department from Test to further a threefold purpose:

1. to get waveform and voltage readings forthe manuals.
2. to help advertising with instruments set-ups and waveforms, photographs, etc.
3. to expand our instrument evaluation program.

We are starting to re-work all of our high-volume instrument manuals to expand the operating instructions and maintenance sections. A "trouble shooting" procedure will be added to the maintenance section along with waveforms and voltage readings printed on the diagrams. This will also be done with the new instrument manuals as soon as the instruments have settled down enough to allow this treatment. No promises on how soon we will have everything reworked, but some results should be apparent in the next few months. Any and all suggestions will be gratefully received.

JIM MORROW

The new cabinet design for the 531, 535, 541, and 545 embodies drawn front and sub panels to provide round corners and edges. Appearance will be improved and easier access to inside of the instrument will be provided by quickly removable side panels instead of our conventional cabinet.

The present plan is to incorporate the new design into such future instruments as the 515, 542, and others. Probable change to become effective sometime between March and July of 1956.

In approximately 30 - 60 days the new Baker Automatic press will be producing the knobs for the 530-540 series. The nylon knobs we are currently using will be replaced with a thermosetting material which will result in a much neater looking and harder knob. The knobs will be similar in design and texture to those in the 310. The 310 knobs we are now using will be used on the 315.

The vertical amplifier deck and power deck in the 535-540 series are being formed in our 100-ton hydraulic press. Greater accuracy and less trouble in assembling is possible with production of these decks in this manner.

A method is currently being developed of making the CRT adjustable around the axis to align the trace with the graticule.

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