

15th Aug 2006

1 MICROPHONE AMPLIFIERS G. S. COHEN

WE 1930's : 1 . (WE: WESTERN ELECTRIC)

NOTICE: PHONE, MIC, METER, T.T.,  
STEPPED FADERS, PATCH PANELS {IN-OUT-  
MONITORING

WE 1930's : 2 .

LEFT NOTICE: SHIELDED VALVES, TRANSFORMERS  
, SLIDE OUT TRAY, LONG PATCH LEADS?

RIGHT NOTICE: LIFT UP PANEL FOR SERVICE,  
NEAT LAYOUT WIRING LEADS.

WE 1930's 3 SCHEMATIC 8-C AMP

NOTICE: BALANCED TRANSFORMER INPUT,  
PHANTOM POWER, INPUT FADER WITH 20dB  
STEP AFTER 1ST AMP,

ANODE CHOKES ALL STAGES

NO DC IN OUTPUT TRANSFORMER.

DC ON FILAMENTS

MONITORING JACK FOR METERING.

THIS CONSOLE HAD TWO INDEPENDANT  
PATHS I.E. FOR AM AND FM

BROADCASTING WITH GOOD ISOLATION.

SEE 2 PHOTO'S . THIS PROVED

GOOD ENOUGH LATER FOR STEREO USE!

2/

MICROPHONE AMPLIFIERS. G.S. COHEN

GERMAN BROADCASTING 1940'S 1

NOTICE! METAL VALVES, LARGE  
SHIELDED INPUT TRANSFORMER, <sup>MODULE</sup> SOCKETS,  
SHIELDED MAINS TRANSFORMER, VRR. ~~ATTEN~~

GERMAN BROADCASTING 1940'S 2

NOTICE! BALANCED TRANSFORMER INPUT,  
STEPPED ATTENUATOR ON FEEDBACK TO  
INPUT VALVE CATHODE,  
2ND AND 3RD STAGES TRIODE CONNECTED  
WITH ANODE CHOKES,  
SEPERATE OUTPUT TRANSFORMER

3/

MICROPHONE AMPLIFIERS, G.S. COHEN

EARLY RCA 1940's

NOTICE : OPTIONAL ATTEN. ON INPUT TRANSFORMER, FIXED FEEDBACK FROM OUTPUT TRANSFORMER TO INPUT VALVE TRANSFORMER, CATHODE METERING.

LANGEVIN PLUG IN AMPS. 1940's; 1950's 1

NOTICE : LARGE INPUT TRANSFORMER (SHIELDED) ON 116, SHIELDED TOP CAP-GRID.

LANGEVIN PLUG IN AMPS. 1940's; 1950's 2

NOTICE : OPTIONAL ATTEN PADS ON INPUT TRANSFORMER? PUSH PULL DESIGN, PUSH PULL FEEDBACK TO INPUT VALVE CATHODE'S; CANCELLATION OF 2ND ORDER DISTORTION, SEPERATE FEEDBACK WINDING ON OUTPUT TRANSFORMER, METERING OF VALVE CATHODE CURRENTS.

H/

MICROPHONE AMPLIFIERS, G.S. COHEN

SIEMENS & HALSKE V72-1952

1

NOTICE: PROVISION FOR EXT. PHANTOM POWER, FEEDBACK FROM OUTPUT TO CATHODE OF INPUT STAGE WITH SMALL ADJS. TO OPT. GAIN & FREQ. RESPONSE, SEPARATE OUTPUT TRANSFORMER AND CHOKE, UNBYPASSED CATHODE RESISTORS.

SIEMENS & HALSKE V72-1952 MODIFIED

2

NOTICE: MODIFIED FOR STEPPED GAIN OF PREVIOUS SCHEMATIC — 25 dB TO 55 dB IN 5 dB STEPS ALSO STEPPED CAPACITORS TO EQUALISE FREQ. RESPONSE.

TELEFUNKEN V72A-1962

3

NOTICE: SINGLE HIGH GAIN VOLTAGE AMPLIFIER (6AK5) — ANODE CHOKE & 500K $\Omega$ , THIS IS FOLLOWED BY A CATHODE FOLLOWER WITH SEPARATE CHOKE & OUTPUT TRANSFORMER, OVERALL FEEDBACK IN SERIES WITH INPUT TRANS. I CONSIDER A CLASSIC DESIGN FOR A MIC-PRE.

5 MICROPHONE AMPLIFIERS. G.S. COHEN

SIMPLE PRE-AMP. 1

NOTICE: SIMPLE HIGH GAIN TYPE,  
NO FEEDBACK, HIGH NOISE LEVEL,  
HIGH OUTPUT IMPEDANCE - SUITABLE  
ONLY FOR HIGH IMPEDANCE LOADS

BUFFERED SIMPLE PRE-AMP.

NOTICE: AS ABOVE WITH  
CATHODE FOLLOWER OUTPUT STAGE,  
SUITABLE FOR DRIVING  
UNBALANCED MEDIUM IMPEDANCE LINES.

BROADCAST STATION AMPLIFIER. 2

NOTICE: TWO TRIODE CONNECTED  
STAGE WITH OVERALL FEEDBACK FROM  
SEPARATE OUTPUT WIND, TO BOTTOM  
OF INPUT TRANSFORMER, THE FIRST  
VALVE USES THE SCREEN GRID ( $G_2$ )  
AS THE ANODE - THIS MEANS LOWER  
TOTAL CURRENT FOR A SIMILAR GAIN -  
I.E. LOWER NOISE, NOTE METERING KEYS.

6/ MICROPHONE AMPLIFIERS. B. J. COHEN

THREE STAGE BALANCED AMPLIFIER.

NOTICE: FULLY BALANCED DESIGN,  
PUSH PULL FEEDBACK TO BOTTOM OF  
INPUT TRANSFORMER — I.E. FEEDBACK  
IN SERIES WITH INPUT VOLTAGE, CROSS  
NEUTRALIZED ON ALL THREE STAGES.  
A COMMENDABLE DESIGN, NOTE  
BALANCED FEEDBACK CONTROL FOR GAIN.

AWA CONSOLETTA. PHOTO?

FOUR CHANNEL (8 MIC) MIXER — LINE DRIVER

NOTICE:

INPUT STAGE USES TRIODE CONNECTED  
PENTODE WITH ANODE ( $R_2$ ) TO GRID  
FEEDBACK

2ND. STAGE USES HIGH GAIN PENTODE  
WITH RESISTOR INPUT SUMMING —  
NOT DESIRABLE.

THE "B" AMPLIFIER IS THE OUTPUT  
STAGE LINE DRIVER WITH OVERALL  
FEEDBACK FROM SEPARATE WINDING.  
AN ATTRACTIVE UNIT — NO PHOTO.

M MICROPHONE AMPLIFIERS. B.S. COHEN

ALTEC LANSING CONDENSER MICROPHONE. 1

1950. SHOWN: MICROPHONE WITH BUILT-  
IN AMPLIFIER VALVE ON LEFT.

ALL OTHER AMPLIFIER COMPONENTS —  
EXCEPT THE VALVE — ARE IN THE  
POWER SUPPLY ON THE RIGHT,  
UP TO 400 FEET OF CABLE CAN BE USED

TOTAL SCHEMATIC MII SYSTEM. 2

NOTICE: , THE ONLY LOAD ON  
THE CONDENSER DIAPHRAGM IS THE  
VALVE GRID, — NO GRID BIAS RESISTOR  
AS THE VALVE IS USED AS A CATHODE  
FOLLOWER AND ESTABLISHES IT OWN  
GRID BIAS WHEN THE POSITIVE AND  
NEGATIVE GRID CURRENTS CANCEL,  
ALL OTHER GRIDS ARE "BOOTSTRAPPED"  
TO THE CATHODE TO REDUCE THE  
INPUT CAPACTANCE.

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## MICROPHONE AMPLIFIERS, G.S. COHEN

### COHEN HIGH DYNAMIC RANGE AMP.

- \* INPUT STAGE SWITCHED PENTODE-TRiode WITH FEEDBACK IN SERIES WITH INPUT TRANSFORMER.
- \* SWITCHED PHANTOM POWER.
- \* GANGED GAIN CONTROL BEFORE AND AFTER INPUT STAGE TO OPTIMISE NOISE FIGURE VS DYNAMIC RANGE.
- \* PUSH PULL PHASE SPLITTER AFTER 2ND STAGE ATTENUATOR AND DIRECT COUPLED TO INPUT STAGE.
- \* PUSH-PULL OUTPUT STAGE - LINE DRIVER.
- \* MAINS FILTERING & LOW NOISE RECTIFIERS.
- \* COMPENSATION OF INPUT AND OUTPUT TRANSFORMERS FOR FREQUENCY RESPONSE.



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MICROPHONE AMPLIFIERS, B.S. COHEN

MORGAN JONES BALANCED AMP.

1

THIS IS A PHONO STAGE AMP. BUT IS INCLUDED TO SHOW A BALANCED AND DIRECT COUPLED APPROACH EXCEPT FOR NEEDED OUTPUT CAPS. CROSS NEUTRALISATION IS USED ON THE OUTPUT STAGE.

AKG C24 CONDENSOR MIC (STEREO)

2

TWO DUAL CAPSULE MICROPHONE WITH FULLY SWITCHED PATTERN SELECTION. A TWIN TRIODE IS USED AS A DUAL VOLTAGE AMPLIFIER. DUAL SWITCHED LINE OUTPUT TRANSFORMERS ARE INCORPORATED. THE  $1000\text{ pF}$   $200\text{ M}\Omega$  INPUT NETWORK SETS THE LOW FREQUENCY LIMIT WITH THE SERIES CAPACITANCE OF THE CONDENSER CAPSULES.

TREHARNE INTERCOM AMP 1958

- \* INPUT PROTECTION USING GOLD BONDED GERMANIUM DIODES.
- \* EARLY GERMANIUM TRANSISTOR WITH SHUNT DC ONLY FEEDBACK FOR STABILITY.
- \* COUPLED DRIVER AND EARLY TYPE OUTPUT TRANSISTOR WITH OUTPUT TRANSFORMER AT FAR END OF LINE.
- \* OVERALL FEEDBACK TO EMITTER OF INPUT STAGE.
- ADJUSTABLE FEEDBACK COMPENSATION
- \* FOR LENGTH OF DRIVEN LINE. - I.E. 5 OR 10 MILES.

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MICROPHONE AMPLIFIERS G.S. COHEN

LANEVIN AM16 MODULE 1964

1

NOTICE: EASE OF SERVICING.

LONG AND NARROW PLUG IN MODULE  
1  $\frac{1}{4}$ " WIDE (232mm) 1  $\frac{3}{4}$ " HIGH (244.5mm)  
OR 1RU.

NOTE: INPUT TRANSFORMER AT PLUG END.

AM16 SCHEMATIC

2

BALANCED PUSH PULL DESIGN

ALL DIRECT COUPLED NO CAPACITORS  
EXCEPT FOR 1 ONLY NON ELECTROLYTIC  
HF BYPASS. PUSH PULL OVERALL FEEDBACK.  
DESIGN: \* 1ST STAGE VOLTAGE AMP.

- \* 2ND STAGE EMITTER FOLLOWER WITH  
COLLECTOR AND 1ST STAGE COLLECTOR  
LOAD "BOOTSTRAPPED" FROM OPPOSITE SIDE
- \* 3RD STAGE EMITTER FOLLOWER DRIVING  
OUTPUT STAGE -
- \* 4TH STAGE (OUTPUT) EMITTER AND  
COLLECTOR OUTPUT (E. ULTRALINEAR)  
NOTE TRANSFORMER PHASING \* 600  $\Omega$  IN/OUT  
45dB GAIN +24dBm OUTPUT.

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MICROPHONE AMPLIFIERS, G.S. COHEN

NEVE 1073 AND 1272 AMPS 1

MIC AMP ATTENUATOR PAN

CONTROL EQ STAGES AND LINE DRIVER

MODULE. TWO SHOWN IN PHOTO

NOTE: COUPLED MIC & LINE ATTEN SW<sup>ch</sup>.

NEVE 1073 CHANNEL AMP, 1972 2

1<sup>ST</sup> STAGE VOLTAGE AMP WITH

FEEDBACK TO EMITTER.

NOTE HEAVY RF BYPASSING ON

1<sup>ST</sup> STAGE.

2<sup>ND</sup> STAGE GIVES INVERTED

OUTPUT AND ACTS AS PHASE

SPLITTER FOR NON INVERTED

OUTPUT EMITTER FOLLOWER.

BALILEY PRE AMP, WW, 3

SWITCHED MULTIPLE INPUT STAGE

WITH MIC SHOWN POS. 1 FOR

FLAT RESPONSE.

SIMPLE BASIC DESIGN OF THIS ERA.

13 MICROPHONE AMPLIFIERS, G. J. COHEN

JENSEN 990 OP-AMP, 1988 1

USES MULTIPLE EMITTER DUAL  
INPUT TRANSISTORS WITH POS.-NEG.  
INPUT AND EMITTER JOINED.  
BASICALLY AN OP-AMP DESIGN  
CONCEPT WITH CLASS B OUTPUT.

JENSEN TWIN STEREO 990, 1997 2

USES TWO 990 AMPLIFIERS  
WITH ADJUSTABLE FEEDBACK TO  
THE INVERTING INPUT OF BOTH  
990 MODULES.

THE MODULES ARE DIRECT  
COUPLED WITH INVERTING  
INTEGRATORS TO GIVE DC STABILITY,  
AS WOULD BE REQUIRED WHEN SET  
FOR HIGH GAIN.

THE USE OF GANGED GAIN  
CONTROLS GIVES APPROX 30dB  
GAIN FOR EACH MODULE.

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MICROPHONE AMPLIFIER, P.S. COHEN

NE 5534 : —

NOTE FEED BACK

NOISE ETC.

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MICROPHONE AMPLIFIERS. G.S. COHEN  
COHEN: DOUBLE BALANCED

MICROPHONE AMPLIFIER

AES PREPRINT 2106, 1984

FIG. 1 SIMPLE INPUT STAGE 1

FIG. 2 AC FEEDBACK IN  
PUSH PULL TO SET GAIN

FIG. 3 INSTRUMENTATION TYPE 2

DC COUPLED — ENHANCED  
VERSION OF 3 OP-AMP TYPE.  
NOTE: 4 BASE EMITTER  
JUNCTIONS BETWEEN BOTH INPUTS.

FIG. 4 NEW INPUT STAGE (CIRCA 1984)

USING ONLY TWO BASE —  
EMITTER JUNCTIONS BETWEEN  
INPUTS. POWER FEEDBACK  
 $R_5, R_7$  IS USED TO ALLOW  
 $R_6$  TO BE A VERY LOW VALUE.  
 $R_1$  TO  $R_4$  SETS STANDING CURRENT  
IN  $Q_1, Q_2$  MULTIPLE EMITTER PAIRS.

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## MICROPHONE AMPLIFIERS. G.S. COHEN

### INPUT CONCEPT :

NOISE COMPONENTS :  $\gamma_{bb}$  &  $\gamma_e$   
PLUS ANY EXTRA SERIES RESISTORS  
FOR THE TWO DUAL MULTIPLE  
EMITTER TRANSISTORS USED —  
THE TOTAL RESISTANCE IS APPROX. 20  
OHMS PLUS FEEDBACK RESISTANCE  
OF  $\approx 1$  OHM AT MAX GAIN.

\* FOR A SOURCE IMPEDANCE  
OF 250 OHMS WE HAVE A  
NOISE FIGURE OF  $\approx 1/2$  dB

THE INPUT IMPEDANCE BETWEEN  
THE BASES IS APPROX.:

BETA ( $h_{fe}$ ) TIME TOTAL  
 $\gamma_e$  PLUS GAIN RESISTOR IN SERIES  
BETA FOR THESE MULTIPLE EMITTER  
TRANSISTOR AT THIS CURRENT IS  
BETWEEN 500 — 1000. SO INPUT  
IMPEDANCE IS APPROACHING 2K  $\Omega$   
AT MAX GAIN AND HIGHER AT LOWER GAIN.



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MICROPHONE AMPLIFIERS - G. S. COHEN  
SCHEMATIC COHEN MIC. AMP.

EXTERNAL GAIN SET RESISTOR : -  
1 OHM TO  $\approx 1 \text{ K}\Omega$  (OIC), (FOR 6dB GAIN)

TOTAL FEEDBACK RESISTANCE 600  $\Omega$

INPUT STAGE CURRENT SET BY

$R_I$  (EXT). THE TWO LEADS SET A  
VOLTAGE REF. FOR DC STABILITY AT  
ALL INPUT STAGE CURRENTS.

THE OUTPUT AMPLIFIERS ARE

CROSS COUPLED SUMMING AMPS, TO

GIVE A PUSH PULL OR SINGLE

ENDED OUTPUT FROM BOTH

INPUTS AND GIVES AN OUTPUT

GAIN OF 6 dB.

SO FOR NO EXTERNAL GAIN

SET RESISTOR ( $R_G$ ) THE GAIN IS

6 dB AND FOR  $R_G = 1 \text{ OHM}$  THE

GAIN IS 60 dB.

17 MICROPHONE AMPLIFIERS G.S. COHEN

NOISE FIGURE :

FOR 250 OHM SOURCE  $\approx 1/2$  dB

AND LOW FREQUENCY NOISE ONLY

INCREASES BY  $\approx 1 1/2$  dB AT 20 Hz.

FOR 40 OHM SOURCE  $\approx 2$  dB

INCREASE FROM 250 ABOVE AND

IS CONSISTANT WITH TRANSISTOR

EQUIVALENT NOISE STATED EARLIER OF 20<sub>2</sub>

DUAL DM1556 2006 ; DM1556 1984 2

COMPLETE DUAL MICROPHONE

PREAMPLIFIER :

GAIN CONTROL, 6-60dB 5dB STEPS

PHANTOM POWER ETC.

FOR THIS TOPOLOGY <sup>FEEDBACK</sup> THE DYNAMIC RANGE INCREASES FOR REDUCED GAIN.

40 dB GAIN 123 dB 20KHz BW

20 dB GAIN 140 dB " "

FAR EXCEEDING ANY FOLLOWING

DIGITAL PROCESSING.

TYPICAL APPLICATIONS

	<u>Microphone/Tape Head Preamplifier</u>	<u>Microphone/Moving Coil Cartridge Preamplifier</u>
Gain required for Balanced Output	20 dB	40 dB
Output Stage Gain	6 dB	6 dB
Input Stage Gain	14 dB	34 dB
Feedback Resistor, $R_G$	150 $\Omega$	12 $\Omega$
Feedback Noise Resistance	120 $\Omega$	11.5 $\Omega$
Allowing $r_e$ of 10 $\Omega$ and $r_b$ of 10 $\Omega$ then Feedback plus $r_e + r_b$	140 $\Omega$	31.5 $\Omega$
Equivalent Noise Voltage for 3dB Noise Figure in 20KHz Bandwidth and allowing for Output Stage	200 nV	140 nV
Referred to Output	2 $\mu V$	14 $\mu V$
Maximum Output Level	20 V	20 V
Input Overload	2 V	200 mV
Dynamic Range	140 dB	123 dB
Source Resistance	140 $\Omega$	31.5 $\Omega$

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MICROPHONE AMPLIFIERS. G. J. COLEMAN

PM1 SSM 2015, 16, 17 IC, 1  
REV 1990.

VIRTUALLY SAME AS MY 1984  
DESIGN INCLUDING:

SINGLE RESISTOR INPUT BIAS SET  
" " GAIN ADJUST

INPUT DIODE PROTECTION

BUT HIGHER FEEDBACK RESISTORS

SO FOR 55dB GAIN  $R_F$  IS

36  $\Omega$  WHERE AS FOR OM1556  $R_F \approx 2 \Omega$

IE WORSE NF THAN OM1556,

AND UNBALANCED OUTPUT!

AN 115 FOR SSM 2015 AP NOTE 2

AGAIN SAME AS MY 1984 PAPER.

THAT 1510 1512 1997-2006 3

AGAIN SAME AS THAT OM1556  
FROM 1984!

\* QUOTE :- MILLENNIA MEDIA &  
R-E-P MAGAZINE :- (JOHN LA GROU) "  
" THE DESIGN OF MICROPHONE PREAMPLIFIERS,  
" MASSED TRANSISTORS " " DOUBLE BALANCED " 1984 PAPER.

COHENSPLIT CASCODE AMPLIFIER 1996AES PREPRINT 4296.

CASCODE : DERIVED FROM THE  
INPUT VALUE DRIVING INTO THE  
CATHODE OF VALVE ON TOP

THIS TOPOLOGY HAD LOWER NOISE  
THAN A PENTODE (I.E. NO PARTIAL  
NOISE DUE TO SCREEN GRID CURRENT ( $G_2$ ))

THE CONCEPT SHOWN HAS THE  
BOTTOM TRANSISTORS DRIVING THE  
EMITTERS OF THE TOP TRANSISTORS.

THE TOP TRANSISTOR EMITTERS  
HAVE ADDED RESISTORS TO THEM  
MATCH CONNECTING CABLE IMPEDANCE,  
THIS CABLE CAN NOW BE VERY  
LONG ; POSSIBLY KILOMETRES? AS  
IT IS CURRENT DRIVEN AND TERMINATED.

SOME PROFESSIONAL IN THIS AUDIENCE  
USE THESE MODULES REGULARLY .

2)

MICROPHONE AMPLIFIERS. G. J. COHEN.

DUAL OM1556 2006 1  
FROM OM1556 CIRCA 1984.

INTERNAL VIEW, SHOWING: -

- \* DUAL HYBRIDS (LONG BLUE)
- \* GAIN SWITCHES UNDER PRINTING:  
OM1556 — HAVE A NICE DAY :)
- \* POWER SUPPLIES (REGULATED).
- \* PUSH BUTTON SWITCH BOARDS:  
INDEPENDANT FOR EACH CHANNEL.
- \* RFI FILTERING
- \* CANON CONNECTORS

EXTERNAL VIEW:

2

WHAT ELSE!

THANK TO IAN DU RIEU  
FOR HELP IN PRESENTATION.