NATIONAL WIDE-BAND FM
CALLING AND WORKING
FREQUENCIES
52.525 MC 146.94 MC

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BIG ERROR - PLEASE TURN IMMEDIATELY TO ERRATA SECTION ON PAGE 2. --- LONG PAUSE --- NOW WITH RED FACES WE STOP THE EDITORIAL AND BRING FORTH 1.833 CENTS WORTH OF REPEATER INFORMATION. (35 CENTS / 6 ISSUES EQUALS 5.833, MINUS 4 CENT STAMP - EQUALS 1.833 CENTS)

V.H.F. - F.M. REMOTE CONTROL AND REPEATERS

I. INTRODUCTION

A. TERMINOLOGY - REMOTE CONTROL MEANS TO CONTROL A BASE STATION FROM A DISTANCE. TWO USUAL METHODS ARE BY A WIRE LINE AND BY RADIO CONTROL.

"REPEATER" IS A GENERAL TERM FOR WHAT THE FCC CALLS A MOBILE RELAY. THIS IS A STATION DESIGNED TO RECEIVE A VHF FREQUENCY AND SIMULTANEOUSLY RETRANSMIT THE MESSAGE ON ANOTHER FREQUENCY.

YOU SHOULD THINK OF REMOTE CONTROL AND REPEATERS AS SEPARATE FUNCTIONS AT ALL TIMES. WE WILL DESCRIBE THEM SEPARATELY IN GENERAL AND SHOW HOW THEY ARE OFTEN COMBINED FOR AMATEUR USE. SEE ALSO PART "E" FOR DEFINITIONS.

B. REMOTE CONTROL - NOW AN AMATEUR MAY USE REMOTE CONTROL TO BE ABLE TO PLACE HIS BASE STATION ON THE TOP OF A MOUNTAIN WITH ITS OBVIOUS VHF ADVANTAGES. HE MAY DECIDE TO USE THE SIMPLEST METHOD OF REMOTE CONTROL -- WIRE LINE. THIS INVOLVES RENTING A PAIR OF TELEPHONE LINES FROM HIS HOME TO THE MOUNTAIN TOP. IN SOME LOCALITIES THIS IS AN INEXPENSIVE SOLUTION AND SINCE IT IS A MORE POSITIVE METHOD OF CONTROL IS EASIER TO INSTALL AND MEET FCC LICENSE REQUIREMENTS. IF OUR HAM GETS HIS STATION BUILT AND LICENSED, HE HAS THE PLEASURE OF EXTREME RANGE AND ULTRA RELIABLE COMMUNICATION COMPARED TO HIS FELLOW HAMS. NO BIG PROBLEMS ARE PRESENTED AND LOGGING AND IDENTIFICATION ARE CONVENTIONAL.

BUT SAY OUR HAM FRIEND CANNOT GET A PHONE LINE OR THAT A LINE IS TOO EXPENSIVE. SO HE MUST RESORT TO RADIO CONTROL WITH ITS INITIAL EXPENSE OF EXTRA TRANSMITTERS AND RECEIVERS FOR HIS "CONTROL LINK". HE MUST BE CAREFUL BECAUSE THE FCC REQUIRES POSITIVE CONTROL AND THE USE OF FREQUENCIES 220 MC AND ABOVE WHERE OBSTRUCTIONS OFTEN ARE A PATH PROBLEM. HE MUST ALSO CONSIDER THAT THIS RADIO REMOTE CONTROLLED STATION IS A SMALL REPEATER IN ITSELF SINCE HE RETRANSMITS FROM HIS CONTROL OR "UP-LINK" AND RECEIVES VIA A "DOWN-LINK". NOW HE HAS RUN INTO PROBLEMS INVOLVING LOGGING AND IDENTIFICATION. HE MUST LOG AND I.D. NOT ONLY WHEN TRANSMITTING BUT WHENEVER HE IS RECEIVING SINCE A TRANSMITTER IS ON THEN ALSO. THIS CAN BE DONE MANUALLY OR AUTOMATICALLY. A COMPLETE UNDERSTANDING OF FCC REQUIREMENTS AS OUTLINED FURTHER IS RECOMMENDED BEFORE ANY PLANNING IS UNDERTAKEN. VARIOUS FEATURES NOT INCLUDED IN A NORMAL STATION ARE NECESSARY IN A REMOTE CONTROL STATION.

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"FM NEWS" IS PUBLISHED BI-MONTHLY BY K4FSU AND K4ZAD. THE PUBLICATION OF THE "NEWS" IS ON A STRICTLY NON-PROFIT BASIS. A 35 CENT SUBSCRIPTION RATE COVERS THE COST OF PAPER AND POSTAGE FOR SIX ISSUES. ADVERTISING IS NOT ACCEPTED BY THIS PUBLICATION. EVERY ATTEMPT IS MADE TO KEEP THE INFORMATION GIVEN AS ACCURATE AND AS COMPLETE AS POSSIBLE. HOWEVER, THE EDITORS ACCEPT NO RESPONSIBILITY FOR ERRORS. ALL MAIL SHOULD BE SENT TO: SEYMOUR PAUL JR.; K4FSU, RT. 2, WATERLICK RD., LYNCHBURG, VA. TELEPHONE 703-239-2520. IF DUE CREDIT IS GIVEN TO OUR AUTHORS ANY PART OF THIS PUBLICATION MAY BE REPRODUCED WITHOUT FURTHER PERMISSION.

ERRATA ------ WHEN WE MAKE A BOOBOO WE DO IT THOROUGHLY. THE TWO METER FM RTTY FREQUENCY IS --- 146.70 --- NOT 147.70. WE HOPE NO ONE BOUGHT CRYSTALS! REMEMBER, 2 METER RTTY ON 146.70 MC. PLEASE SPREAD THE WORD.

CONTINUED FROM PAGE ONE

SO A HAM TO LOCATE A STATION IN A HIGH LOCATION MUST FIRST CONSIDER CONTROLLING IT. HE CAN: 1. LIVE IN A GOOD LOCATION AND CONTROL IT "LOCALLY", 2. USE WIRE LINE REMOTE CONTROL, OR 3. USE RADIO REMOTE CONTROL. ONE OF THESE IS THE FIRST CONSIDERATION IN ESTABLISHING EXTENDED VHF-FM COMMUNICATION IN AN AREA.

C. REPEATING - THE LEGAL AND TECHNICAL ASPECTS OF A REPEATER ARE DISCUSSED LATER BUT THERE ARE OTHER POINTS TO CONSIDER WHENEVER A HAM DECIDES TO "GO REPEAT". WHAT ARE YOUR MOTIVES? THE LOGICAL ONE WOULD BE TO ALLOW OTHERS, PARTICULARLY MOBILES, TO USE THE ADVANTAGES YOU HAVE OR CAN ATTAIN VIA REMOTE CONTROL.

BUT WHAT ARE THE DISADVANTAGES INVOLVED? ONE OF THE MOST IMPORTANT IS YOUR PERSONAL TIME! FOR INSTANCE: HOW DO YOU STAY HOME AND CONTROL THE REPEATER ALL THE TIME? WHAT HAPPENS WHEN YOU WANT TO GO TO A MOVIE ONE EVENING AND AT THE SAME TIME SOMEONE WANTS TO USE "THE REPEATER"? SOMEONE MAY GET DISGRUNTLED. HOW DO THE OTHERS FEEL WHEN YOU GET TIRED OF LOGGING THEM TALKING BACK AND FORTH AND DECIDE TO SHUT DOWN.

WHEN ONE PERSON UNDERTAKES BUILDING AND OPERATING A REPEATER MANY OF THESE AND OTHER PROBLEMS ARISE. WHAT ARE THE BEST WAYS TO SOLVE THEM? WE DO NOT KNOW. IN SOME AREAS THE UNWRITTEN LAW IS TO WORK DIRECT AND THE ONLY TIME THE CHANNEL "B" TRANSMIT OR REPEATER INPUT FREQUENCY IS USED IS IN TIME OF URGENT NEED. ANOTHER WAY TO HELP THE PRESENT SITUATION MIGHT BE TO HAVE A REPEATER LICENSED AND OPERATED BY A CLUB AND RUNNING SHIFTS AND OPERATING DURING CERTAIN TIMES OF THE DAY. (WE DON,T KNOW IF THIS CAN BE LICENSED) MANY HAVE FOUND THAT THE MOST SATISFACTORY SOLUTION IS TO LIMIT THE STATION TO REMOTE CONTROL OPERATION.

AS MENTIONED IN THE LEGAL PORTION OF THIS ARTICLE, THE F.C.C. IS SO UNDEFINED IN THE REPEATER AREA THAT THE ONLY REAL SOLUTION THAT WILL BE EFFECTIVE IS FOR THE F.C.C. TO DETERMINE AND ISSUE A CLEAR SET OF REPEATER REGULATIONS FOR AMATEURS.

WHAT ARE SOME OTHER THINGS TO CONSIDER WHEN CONTEMPLATING REPEATERS? MAINTENANCE CAN BE A BIG PROBLEM IF THE STATION IS LOCATED FAR AWAY. (IMAGINE: 30 MILES ON A ROUGH ROAD, 6000 FEET UP, TWO FEET OF SNOW, ACROSS A CREEK, AND YOU FORGOT YOUR MULTIMETER!) ANOTHER PROBLEM (THERE ARE MORE) IF PEOPLE HAVE ACCESS TO A REPEATER. THIS ENCOURAGES 18 INCH COAT HANGER BASEMENT ANTENNAS AND OTHER LOW PERFORMANCE OPERATION. LIMITING THE USE TO MOBILES HELPS - SOME.

D. FREQUENCIES - FREQUENCY CHOICES FOR REPEATER INPUTS AND OUTPUTS SHOULD BE MADE WITH FUTURE PROBLEMS IN MIND. DISREGARDING THE TECHNICAL PROBLEMS; YOU MUST CONSIDER HOW YOUR REPEATER WILL FIT IN WITH BOTH LOCAL AND NATIONAL OPERATION.

WE HAVEN'T GOT THE ANSWERS BUT WE CAN POINT OUT A FEW OF THE PROBLEMS. THE FIRST IS WHAT ABOUT THE NATIONAL FREQUENCY? IF THE ACTIVITY IN YOUR AREA IS AND WILL BE LIMITED TO A FEW, THE SIMPLEST THING WOULD BE TO REPEAT TO OR FROM THE NATIONAL FREQUENCY. HOWEVER, THIS WILL NORMALLY BECOME A PROBLEM AND HAVE TO BE CHANGED. SO THE BEST WAY MIGHT BE TO REPEAT TO ANOTHER CHANNEL AND MONITOR THE NATIONAL. FOR INSTANCE IN THIS SYSTEM A MOBILE WOULD NEED TWO FREQUENCY TX AND RX. IN CHANNEL "A" HE DOES NOT REPEAT AND WORKS DIRECT (TX AND RX ON 146.94 MC.). IN CHANNEL "B" HE MIGHT TX ON 146.34 MC AND RX ON 146.76 MC.

OTHER THINGS TO REMEMBER: ON SIX METERS REMEMBER THE SKIP SEASON, AND ON TWO METERS AN INPUT ABOVE 147 MC. WILL ELIMINATE TECHNICIANS AND NOVICES. SUGGESTED REPEATER INPUT FREQUENCIES ARE DISCUSSED IN THE TECHNICAL CONSIDERATIONS WITH THE REPEATER DESIGN CURVES. THEY ARE: 2 METERS - 146.34 MC.
6 METERS - 53.00 MC.

E. REPEATER DEFINITIONS - BELOW ARE LISTED VARIOUS TERMS THAT MAY BE HEARD WHEN DISCUSSING REPEATERS. SOME OF THEM ARE USED ONLY LOCALLY AS FAR AS WE KNOW, AND WE ARE NOT ADVOCATING THEIR USE. IT WAS FELT THEY SHOULD BE DEFINED AS WE USED THEM WHILE WRITING THIS ARTICLE.

1. REPEATER OR MOBILE RELAY - SEE PAGE 1, PART I-A.
2. TX - TRANSMIT OR TRANSMITTER.
3. RX - RECEIVE OR RECEIVER.
4. CONTROL LINK - A RADIO FREQUENCY ABOVE 220 MC. USED TO CONTROL A REMOTE STATION.
5. UP LINK - A FREQUENCY, USUALLY THE SAME AS THE CONTROL LINK, USED FROM THE CONTROL POINT TO THE REMOTE STATION TO TALK OR TRANSMIT ON.
6. DOWN LINK - A FREQUENCY USUALLY DIFFERENT THAN 4 OR 5 ABOVE WHICH TRANSMITS A RECEIVED SIGNAL FROM THE REMOTE STATION TO THE CONTROL POINT.
7. DIRECT - TX AND RX ON THE SAME FREQUENCY. NO REPEATER INVOLVED.
8. CHANNEL "A" - AN UNSPECIFIED FREQUENCY, USUALLY THE DIRECT FREQUENCY.
9. CHANNEL "B" - AN UNSPECIFIED FREQUENCY DIFFERENT THAN CHANNEL "A". USUALLY THE REPEATER INPUT FREQUENCY.
10. CARRIER - THE RF COMPONENT OF A TRANSMITTED SIGNAL UPON WHICH AUDIO CAN BE IMPRESSED.
11. C.O.R. - A CARRIER OPERATED RELAY IS A RELAY THAT CLOSES AND OPENS WHEN THE SQUELCH OPENS AND CLOSES.
12. DROP OUT - THE ACTION OF A TRANSMITTER SHUTTING OFF OR A SIGNAL LEVEL DROPPING BELOW READABILITY.

13. DESENSITIZATION - LOSS IN RECEIVER SENSITIVITY CAUSED BY THE PRESENCE OF A HIGH LEVEL RF SIGNAL ON A FREQUENCY NEAR THE RECEIVER CHANNEL FREQUENCY.
14. DIALED UP - TURNING ON A REPEATER WHEN DIGITIAL CONTROL IS USED.
15. DIALED DOWN - THE CONVERSE OF THE ABOVE.
16. TRANSLATOR OR RF REPEATER - A REPEATER IN WHICH THE SIGNAL IS NEVER DEMODULATED, BUT IS ALWAYS HANDLED AS RF. THE PROJECT OSCAR REPEATER IS AN EXAMPLE OF THIS TYPE. WE WILL NOT DISCUSS TRANSLATORS IN THIS ARTICLE.

II. TECHNICAL CONSIDERATIONS - MOBILE RELAY

A. SYSTEM DESIGN - IN THE DESIGN OF A MOBILE RELAY SYSTEM ONE OF THE FIRST QUESTIONS WHICH MUST BE SETTLED IS HOW THE TWO FREQUENCIES INVOLVED WILL BE USED TOGETHER. THE POSSIBLE SYSTEMS ARE:

	MOBILE UNIT		RELAY STATION	
	DIRECT	REPEAT	DIRECT	REPEAT
SYSTEM NR. 1 -	TX-A/RX-A	TX-B/RX-A	TX-A/RX-A	TX-A/RX-B
SYSTEM NR. 2 -	TX-A/RX-A	TX-A/RX-B	TX-A/RX-A	TX-B/RX-A

SINCE THE RELAY STATION IS OF SPECIAL CONSTRUCTION ANYWAY IT IS MORE IMPORTANT TO FIT THE SYSTEM TO THE MANY MOBILES WHICH WILL BE USING IT EVEN IF IT MEANS THAT THE RELAY STATION ITSELF IS A LITTLE MORE DIFFICULT. KEEPING THIS IN MIND, SYSTEM 1 INVOLVES THE USE OF A MOBILE UNIT WITH A TWO FREQUENCY TRANSMITTER AND A SINGLE FREQUENCY RECEIVER. THIS USAGE FITS THE AVAILABLE GEAR MUCH BETTER THAN SYSTEM 2, WHICH WOULD REQUIRE TWO FREQUENCY RECEIVERS FOR THE MOBILE UNITS. SYSTEM 1 ALSO HAS THE ADVANTAGE OF NOT REQUIRING ANY DECISION ON THE PART OF THE MOBILE OPERATOR AS TO WHERE TO LISTEN. THEREFORE NO CALL WILL BE MISSED BECAUSE OF LISTENING ON A DEAD CHANNEL.

THE DISADVANTAGE OF SYSTEM 1 IS THAT A STATION EQUIPPED FOR ONLY DIRECT CHANNEL "A" OPERATION COULD NOT BREAK IN IF THE RELAY WERE ON. SYSTEM 2 WOULD OVERCOME THIS DISADVANTAGE BUT WOULD HAVE DISADVANTAGES ON OTHER POINTS OF COMPARISON. IT IS OUR OPINION THAT SYSTEM 1 INVOLVING TWO FREQUENCY TRANSMITTERS AND SINGLE FREQUENCY RECEIVERS IN THE MOBILE UNITS IS BEST FOR HAM BAND MOBILE RELAY SYSTEMS AND ALL FURTHER DISCUSSION WILL INVOLVE THIS TYPE OF SYSTEM.

B. THE RELAY STATION - IN ITS SIMPLEST FORM (I.E. LOCAL CONTROL) A MOBILE RELAY STATION USES ONLY A SINGLE RECEIVER WITH TWO FREQUENCIES (TO PERMIT DIRECT OPERATION ALSO) AND A SINGLE FREQUENCY TRANSMITTER. HOWEVER, WE DO NOT RECOMMEND THIS SIMPLEST SYSTEM BECAUSE THE RELAY OPERATOR CANNOT MONITOR THE CHANNEL ON WHICH HE IS TRANSMITTING AND BECAUSE OF THIS A MOBILE WITH CHANNEL "A" ONLY, CANNOT BREAK IN EVEN WHEN THE RELAY STATION "DROPS OUT" OR STOPS TRANSMITTING. A BLOCK DIAGRAM OF A STATION USING 2 RECEIVERS TO OVERCOME THIS PROBLEM IS SHOWN AS FIGURE 1.

OPERATION OF THE STATION IS AS FOLLOWS: THE OPERATOR COMPLETES THE CONNECTION AT "X" AND THE SYSTEM IS READY TO RELAY OR "REPEAT". CARRIERS RECEIVED ON CHANNEL "B" CLOSE THE "C.O.R." OR "CODAN" WHICH KEYS THE CHANNEL "A" TRANSMITTER. AUDIO FROM THE CHANNEL "B" RECEIVER DISCRIMINATOR IS FED THRU A SET OF CONTACTS ON THE C.O.R. (WHICH KEEPS NOISE FROM BEING REPEATED DURING THE TIME DELAY), AND THEN THE AUDIO GOES INTO THE CATHODE FOLLOWER TO THE CHANNEL "A" TRANSMITTER AUDIO (MIKE) INPUT. REMOVAL OF CARRIER FROM THE CHANNEL "B" RECEIVER CAUSES THE C.O.R. TO DROP OUT WHICH UNKEYS THE TRANSMITTER. SIMPLE SO FAR!

A DELAY RELAY IS ADDED IN THE KEYING CIRCUIT TO HOLD THE TRANSMITTER ON THE AIR FOR A FEW SECONDS AFTER THE C.O.R. OPENS THIS WILL KEEP THE TRANSMITTER ON EVEN THOUGH THE SIGNAL RECEIVED ON CHANNEL "B" MAY NOT BE CONSISTENTLY STRONG ENOUGH TO KEEP THE C.O.R. CLOSED ALL THE TIME. IT ALSO KEEPS THE TRANSMITTER FROM EXCESSIVE ON-OFF KEYING WHEN MOBILE UNITS ARE TALKING BACK AND FORTH RAPIDLY. THE CHANNEL "A" TRANSMITTER MUTES THE CHANNEL "A" RECEIVER AS IN A NORMAL STATION.

A COMPLETE INTERCONNECTION DIAGRAM FOR THE TRANSMITTER, TWO RECEIVERS, C.O.R., CATHODE FOLLOWER AND DELAY RELAY IS SHOWN AS FIGURE 2. THE CIRCUIT FOR THE C.O.R. IS SHOWN AS FIGURE 3. THE CATHODE FOLLOWER IS FIGURE 4.

C. FREQUENCY SEPARATION - THE FREQUENCY SEPARATION WHICH MUST BE USED BETWEEN THE "A" CHANNEL AND THE "B" CHANNEL TO PREVENT LOSS OF THE WEAK INCOMING CHANNEL "B" SIGNALS IS DEPENDANT ON SEVERAL FACTORS. THESE ARE: 1. THE CHANNEL "B" RECEIVER. 2. THE CHANNEL "A" TRANSMITTER, 3. THE ANTENNA SYSTEM. THESE FACTORS DETERMINE THE MINIMUM FREQUENCY SPACING WHICH CAN BE USED.

THE LIMITATION OF THE MOBILE TRANSMITTERS IS WHAT DETERMINES THE MAXIMUM FREQUENCY SPACING TO BE USED IN THE SYSTEM. THESE MAXIMUM SEPARATIONS WILL VARY WITH FREQUENCY AND EQUIPMENT, BUT SPACING OF 300 KC AT 6 METERS AND 720 KC AT 2 METERS SHOULD BE POSSIBLE WITH ONLY A SLIGHT LOSS IN POWER OUTPUT/INCREASE IN FINAL STAGE DISSIPATION. OPERATION AT GREATER SPACINGS SHOULD BE POSSIBLE WITH MANY TYPES OF GEAR.

TO UNDERSTAND WHY THE REPEATER EQUIPMENT AND ANTENNA SYSTEM ARE SO IMPORTANT ONE MUST BE AWARE OF THE TREMENDOUS DIFFERENCE IN LEVEL BETWEEN THE WEAK SIGNAL WHICH MUST BE RECEIVED ON CHANNEL "B" AND THE STRONG CARRIER WHICH MUST BE RADIATED ON CHANNEL "A". FOR A SYSTEM WITH A .5 MICROVOLT CHANNEL "B" DESIRED SIGNAL AND A CHANNEL "A" POWER OUTPUT OF 50 WATTS THIS DIFFERENCE IS ON THE ORDER OF 160 DB. THEREFORE THE RECEIVER SELECTIVITY AND THE ATTENUATION DUE TO ANTENNA SPACING MUST GIVE A TOTAL OF 160 DB PROTECTION FROM THE CHANNEL "A" TRANSMITTER CARRIER AT THE CHANNEL "B" RECEIVER FREQUENCY.

IN ADDITION THE TRANSMITTER PUTS OUT A NOISE SPECTRUM WHICH MUST BY ATTENUATED BY THE ANTENNA SPACING. FOR THESE REASONS IT CAN BE SEEN THAT CAREFUL SELECTION OF THE EQUIPMENT AND A GOOD ANTENNA INSTALLATION CAN PAY BIG DIVIDENDS IN THE DESIGN OF A MOBILE RELAY STATION.

D. THE RELAY STATION RECEIVER - THE FOLLOWING HINTS SHOULD BE HELPFUL IN PICKING A RECEIVER WHICH WILL GIVE GOOD PERFORMANCE AS A CHANNEL "B" RECEIVER.

1. PICK A RECEIVER WITH THE MAXIMUM NUMBER OF TUNED CIRCUITS BETWEEN THE ANTENNA AND THE SECOND MIXER.

2. CHOOSE A RECEIVER WITH THE MINIMUM NUMBER OF TUBES BETWEEN THE ANTENNA AND THE LOW I.F. INPUT. THE MINIMUM NUMBER IS PROBABLY 3, (R.F. AMPLIFIER, FIRST MIXER AND SECOND MIXER).

3. PICK A RECEIVER WITH ONE R.F. AMPLIFIER, FIRST MIXER, ONE HIGH I.F. AMPLIFIER AND SECOND MIXER OVER ONE WITH TWO R.F. AMPLIFIERS, FIRST MIXER AND SECOND MIXER.

4. PLAN ON SHIELDING (LIKE TRANSMITTER TVI SHIELDING) THE BOTTOM OF THE RECEIVER AND PLACE THE RECEIVER PHYSICALLY AS FAR FROM THE TRANSMITTER AS IS POSSIBLE.

5. DON,T USE A RECEIVER FOR A REPEATER JUST BECAUSE IT IS YOUR .2 MICROVOLT PRIDE. A RECEIVER WITH JUST A LITTLE POORER SENSITIVITY MAY GIVE MUCH BETTER PROTECTION FROM THE ASSOCIATED TRANSMITTER.

6. DON,T PLAN ON ADDING A NUVISTOR (OR OTHER) PREAMP AHEAD OF THE CHANNEL "B" RECEIVER TO "SOUP IT UP".
7. MORE THAN TWO FREQUENCY CONVERSIONS ARE UNDESIRABLE IN A SIX OR TWO METER RECEIVER.
8. DON,T PAY TOO MUCH ATTENTION TO THE ADVERTISED SELECTIVITY IN PICKING A RECEIVER. MANUFACTURERS USUALLY QUOTE 20 DB QUIETING SELECTIVITY WHICH IS OF LITTLE VALUE.
9. DO CALCULATE THE COMMON SPURIOUS RESPONSES FOR THE RECEIVER TO BE USED. SEE APPENDIX "A" FOR AN EXAMPLE OF THIS TYPE OF CALCULATION. THE SPURIOUS FREQUENCIES SHOULD BE CHECKED OUT AGAINST THE REPEATER TRANSMITTER FREQUENCY AND AGAINST OTHER CLOSE BY AND/OR HIGH POWER TRANSMITTERS. EVEN THOUGH THE SPURIOUS RESPONSES MAY BE MORE THE 100 DB DOWN THEY MAY CAUSE TROUBLE IN REPEATER SERVICE. CHANGING THE CRYSTAL(S) TO PUT THE INJECTION VOLTAGE TO THE MIXER(S) ON THE OTHER SIDE (FREQUENCY WISE) CAN OFTEN CURE THIS PROBLEM.
10. LATER MODEL RECEIVERS ARE GENERALLY BETTER.

E. THE RELAY STATION TRANSMITTER - THE FOLLOWING HINTS MAY HELP IN CHOOSING A TRANSMITTER SUITABLE FOR USE IN A REPEATER.
1. PICK A TRANSMITTER WITH A LOW TOTAL MULTIPLICATION (HIGH FREQUENCY CRYSTAL) OVER ONE WITH THE CONVERSE.
2. PICK A TRANSMITTER WITH THE MAXIMUM NUMBER OF TUNED CIRCUITS.
3. A LOW ORDER OF MULTIPLICATION IN THE STAGE FOLLOWING THE OSCILLATOR IS TO BE PREFERRED.
3. USE OF A TRANSMITTER WITH MODULATION LIMITING IS PREFERABLE.
4. LATER MODEL TRANSMITTERS ARE GENERALLY BETTER.

F. METHODS OF ATTENUATION - HERE ARE SOME IDEAS WHICH SHOULD HELP WHEN SETTING UP A SYSTEM TO PROVIDE MAXIMUM PROTECTION FROM PROBLEMS NORMALLY ENCOUNTERED.
1. IT SHOULD BE POSSIBLE TO REPEAT ON ON TWO METERS USING ANTENNA SEPARATION ONLY.
2. SIX METER REPEATERS WILL PROBABLY REQUIRE CAVITIES IN ADDITION TO ANTENNA SEPARATION UNLESS A LOT OF SEPARATION IS AVAILABLE.
3. VERTICAL AND HORIZONTAL SEPARATION CANNOT BE COMBINED TO PICK UP DB,S. ONCE THE ANTENNAS GET VERY FAR OUT OF A ONE OVER THE OTHER CONFIGURATION THE ATTENUATION BECOMES ESSENTIALLY AS IT IS FOR HORIZONTAL SEPARATION ALONE. SEE THE REPEATER DESIGN CURVES (FIGURES 5 AND 6).
4. OMNIDIRECTIONAL VERTICALLY POLARIZED GAIN ANTENNAS WILL GENERALLY GIVE GREATER ATTENUATION THAN WILL GROUND PLANES WHEN SEPARATED VERTICALLY.
5. TO CHECK TO SEE WHETHER IT IS TRANSMITTER NOISE OR RECEIVER DESENSITIZATION WHICH IS BOTHERING A CHANNEL "B" RECEIVER, PLUG A METER INTO A LIMITER WHICH IS UNSATURATED BUT WHICH GIVES SOME INDICATION ON NOISE ALONE. READ THE METER ON NOISE. KEY THE CHANNEL "A" TRANSMITTER. IF THE METER READING RISES YOU ARE PROBABLY BOTHERED BY TRANSMITTER NOISE. IF THE METER READING DECREASES LOOK FOR RECEIVER DESENSITIZATION.
6. MEASURING YOUR ANTENNA ATTENUATION. IF YOU HAVE ACCESS TO A CALIBRATED SIGNAL GENERATOR YOU CAN FAIRLY EASILY MEASURE THE ATTENUATION BETWEEN THE TWO ANTENNAS IN YOUR ANTENNA SYSTEM. BY COMPARING THE RESULTS OF YOUR MEASUREMENTS WITH THE ANTENNA INFORMATION ON THE REPEATER DESIGN CURVES YOU WILL GET A FAIRLY GOOD IDEA OF HOW WELL YOUR ANTENNA SYSTEM IS WORKING ATTENUATION WISE. THERE ARE TWO STEPS INVOLVED IN DETERMINING THE ANTENNA SYSTEM ATTENUATION. FIRST: CONNECT THE SIGNAL GENERATOR DIRECTLY INTO THE RECEIVER AND ADJUST THE GENERATOR OUTPUT TO GIVE SOME CONVENIENT LIMITER READING. READ THE SIGNAL GENERATOR OUTPUT (USE THE DB SCALE IF THERE IS ONE ON THE GENERATOR)

SECOND: CONNECT THE SIGNAL GENERATOR TO ONE OF THE ANTENNAS AND THE RECEIVER TO THE OTHER ANTENNA. RAISE THE LEVEL OF THE SIGNAL GENERATOR OUTPUT UNTIL THE LIMITER READS THE SAME AS IN THE FIRST STEP. AGAIN READ THE SIGNAL GENERATOR OUTPUT. THE DIFFERENCE BETWEEN THE READINGS OBTAINED IN THE TWO STEPS IS THE ATTENUATION BETWEEN THE TWO ANTENNAS.

G. REPEATER DESIGN CURVES - A SET OF CURVES FOR 6 AND 2 METER REPEATERS ARE SHOWN AS FIGURES 5 AND 6. THESE CURVES SHOW LEVELS OF TX NOISE AND RECEIVER DESENSITIZATION AND THE ANTENNA SEPARATION NECESSARY TO OVERCOME THESE EFFECTS. THE CURVES ARE REPRESENTATIVE OF GOOD EQUIPMENT OF THE 1950 TO 1954 PERIOD. THE FEET SEPARATION SCALE GOES WITH THE ANTENNA CURVES WHILE THE FREQUENCY SEPARATION SCALE GOES WITH THE RECEIVER DESENSITIZATION AND TRANSMITTER NOISE CURVES. THE LEFT HAND OR DB SCALE SHOULD BE CONSIDERED TO GIVE ATTENUATION REQUIRED WHEN USED WITH THE TRANSMITTER AND RECEIVER CURVES, AND THEY SHOULD BE CONSIDERED TO INDICATE ATTENUATION YIELDED WHEN USED WITH THE ANTENNA CURVES. THE EQUIPMENT CURVES ARE FOR THE SENSITIVITY AND AND POWER LEVELS SHOWN. HIGHER POWER TRANSMITTERS AND MORE SENSITIVE RECEIVERS WILL GIVE DB FOR DB WORSE FIGURES. FOR EXAMPLE A 3Ø DB HIGHER TX POWER OUTPUT WOULD HAVE A 1Ø DB HIGHER NOISE OUTPUT, AND WOULD REQUIRE 1Ø DB MORE ATTENUATION TO OVERCOME THIS HIGHER NOISE LEVEL.

YOU WILL NOTICE THAT CLOSE IN (SMALL FREQUENCY SEPARATION) THE PROBLEM IS MOST LIKELY TO BE CAUSED BY TX NOISE WHILE AS THE FREQUENCY SEPARATION IS INCREASED THERE WILL BE A CROSSOVER POINT AFTER WHICH THE RECEIVER DESENSITIZATION WILL BE THE LIMITING FACTOR.

IF THE ATTENUATION TO BE HAD FROM ANTENNA SEPARATION IS NOT SUFFICIENT AND CAVITIES HAVE TO BE USED THEIR PLACEMENT IS IMPORTANT. FOR EXAMPLE ASSUME AT A SPECIFIC FREQUENCY THAT THE TRANSMITTER NOISE IS 1Ø DB. WORSE THAN THE RECEIVER DESENSITIZATION, THEN A CAVITY IN THE TRANSMITTER OUTPUT LEAD WILL HELP REDUCE THE NOISE LEVEL. ASSUME THE CAVITY HAS AN ATTENUATION OF 2Ø DB. AT THE RECEIVER FREQUENCY THEN THE TRANSMITTER NOISE WILL BE REDUCED BY 2Ø DB. BUT ONLY THE FIRST 1Ø DB OF THIS WILL HELP TO IMPROVE THE EFFECTIVE RECEIVER SENSITIVITY BECAUSE THE RECEIVER DESENSITIZATION WILL THEN BECOME THE LIMITING ITEM. A CAVITY IN THE RECEIVER INPUT LEAD WILL HELP REDUCE THE DESENSITIZATION PROBLEM.

H. EXAMPLE OF USE OF REPEATER DESIGN CURVES - TO SHOW HOW THE REPEATER DESIGN CURVES ARE USED LET US CONSIDER THE DESIGN OF A TWO METER REPEATER. ASSUME THAT IT IS DESIRED TO USE 146.34 AS THE CHANNEL "B" AND 146.76 AS THE CHANNEL "A". THIS WOULD PUT THE RECEIVER AT THE REPEATER SITE ON 146.34 AND THE TRANSMITTER ON 146.76. THIS IS A SPACING OF 42Ø KC. BY LOOKING AT THE TWO METER REPEATER DESIGN CURVE YOU WILL SEE THAT AT 42Ø KC RECEIVER DESENSITIZATION IS THE LIMITING FACTOR. FROM THE CURVE IT CAN BE SEEN THAT ABOUT 65 DB OF ATTENUATION WILL BE REQUIRED TO INSURE SATISFACTORY PERFORMANCE. THE VERTICAL ANTENNA SEPARATION CURVE INDICATES THAT A LITTLE OVER 5Ø FEET OF VERTICAL ANTENNA SEPARATION WILL GIVE THE REQUIRED ATTENUATION. ABOUT 5ØØ FEET OF HORIZONTAL ANTENNA SEPARATION WOULD MANCE. THE TRICK. THE USE OF VERTICAL SEPARATION AND GAIN ANTENNAS SHOULD MAKE IT POSSIBLE TO GET THE REQUIRED ATTENUATION WITH LESS THAN 5Ø FEET OF SEPARATION. A SYSTEM USING 4Ø FEET OF VERTICAL ANTENNA SEPARATION WITH GAIN ANTENNAS, AND A FREQUENCY SEPARATION OF 42Ø KC WAS SUCCESSFULLY OPERATED IN THE LYNCHBURG (VA) AREA FOR A PERIOD OF SEVERAL YEARS. NO CAVITIES WERE USED, RECEIVER SENSITIVITY WAS .4 MICROVOLTS AND TX POWER WAS 5Ø WATTS.

III. TECHNICAL CONSIDERATIONS - REMOTE CONTROL

A. INTRODUCTION - IN THE NEXT FEW PARAGRAPHS WE WILL BE CONSIDERING MEANS AND METHODS OF CONTROLLING A VHF FM STATION AT SOME REMOTE POINT. AS THE OPERATOR SEES FIT THE STATION MAY OR MAY NOT BE A MOBILE RELAY. AS FAR AS THE REMOTE CONTROL ASPECTS GO IT REALLY DOESNT MAKE MUCH DIFFERENCE. IF THE STATION IS A MOBILE RELAY THEN WE ARE PRIMARILY CONCERNED WITH COMPLETING THE CONNECTION AT "X" IN FIGURE 1. IF THE STATION IS NOT A MOBILE RELAY THERE ARE STILL FUNCTIONS WHICH MUST BE PERFORMED FROM THE CONTROL POINT. IF THE CONTROL SYSTEM IS MADE FLEXIBLE ENOUGH THERE IS ALMOST NO END TO THE THINGS WHICH CAN BE DONE AT THE REMOTE STATION FROM THE CONTROL STATION. MANY HAVE FOUND THE REMOTE CONTROL ASPECT SO CHALLENGING THAT THEY FIND MOBILE RELAY A DULL THING BY COMPARISON. THE IDEA OF DIALING A NUMBER AND HAVING AN ELECTRO-MECHANICAL MONSTER ON A HILL 15 MILES AWAY RESPOND IS QUITE A THING IN ITSELF.

IN THE PARAGRAPHS WHICH FOLLOW WE WILL BE CONSIDERING BOTH THE MEANS USED TO GET THE CONTROL SIGNAL TO THE REMOTE LOCATION (WIRE AND RADIO) AND THE METHODS USED TO CONTROL (TONE, MULTIPLE TONE, DIGITAL TONE, ETC). THE FIGURES SHOW ONLY A FEW OF THE MANY WAYS IN WHICH EQUIPMENT CAN BE INTERCONNECTED TO FORM VARIOUS TYPES OF REMOTE STATIONS, MOBILE RELAY STATIONS, ETC.

B. REMOTE CONTROL BY WIRE LINE - WIRE LINE CONTROL OF A REMOTE VHF FM STATION IS NOT TOO OFTEN USED IN THE HAM SERVICE. IF IT IS USED IT IS USUALLY FOR ONE OR MORE OF THE FOLLOWING REASONS: NO 450 MC FM GEAR AVAILABLE, CANT GET A RELIABLE RADIO PATH FOR THE CONTROL LINK, AND SECURITY (CONTROL BY THE DESIRED STATION ONLY).

LETS TAKE UP THE MATTER OF WIRE EXPENSE FIRST. WIRE EXPENSE SEEMS TO VARY OVER A RATHER WIDE RANGE FROM PLACE TO PLACE. IF YOU ARE CONSIDERING WIRE LINE CONTROL IT IS SUGGESTED THAT YOU PAY A VISIT TO YOUR LOCAL PHONE COMPANY AND FIND OUT WHAT THEY CAN DO FOR YOU AND AT WHAT RATES. YOU WILL PROBABLY FIND THAT THEY HAVE SEVERAL DIFFERENT TYPES OF LINES AVAILABLE AT DIFFERENT RATES. BY CAREFUL PLANNING YOU SHOULD FIND THAT IT IS POSSIBLE TO FIT YOUR SYSTEM TO ONE OF THE CHEAPER RATES. ABOUT THE CHEAPEST RATE THAT WE HAVE HEARD OF FOR A WIRE LINE IS $5.00 PER MONTH WITHIN AN EXCHANGE AREA. THAT IS YOU COULD CONNECT YOUR HOUSE WITH A REMOTE HILLTOP LOCATION FOR THIS FEE PROVIDED THAT BOTH WERE SERVED BY THE SAME TELEPHONE EXCHANGE. ABOUT THE MOST EXPENSIVE THAT WE HAVE HEARD OF, RUN $4.00 FOR THE FIRST QUARTER MILE, AND $1.75 FOR EACH ADDITIONAL QUARTER MILE, PLUS 75 CENTS FOR EACH TERMINATION. ALL MILEAGES ON AN AIRLINE BASIS, AND ALL COSTS ON A PER MONTH BASIS. THESE FIGURES WILL GIVE YOU SOMETHING OF AN IDEA OF WHAT TO EXPECT FOR WIRE LINE EXPENSE.

WIRE LINE OPERATION ALSO IMPOSES SOME VERY DEFINITE LIMITATIONS AS TO THE VOLTAGE, CURRENT, AND AUDIO LEVEL WHICH THE LINES WILL TOLERATE. THESE LIMITATIONS WILL BE SPELLED OUT FOR YOU BY THE PHONE COMPANY WHEN YOU CONTRACT FOR THE LINE. THE LINE IMPEDANCE IS NORMALLY CONSIDERED TO BE 600 OHMS, AND THE LINE SHOULD BE TERMINATED IN THIS IMPEDANCE AT EACH END. IN MAKING MEASUREMENTS ON LINES YOU SHOULD REMOVE THE DEVICE TERMINATING THE LINE AND SUBSTITUTE A 600 OHM RESISTOR. USING A 1000 CYCLE TONE, MEASUREMENTS OF AUDIO LEVEL CAN THEN BE MADE WITH AN AUDIO VOLTMETER (HEATH AV2 OR AV3) ACROSS THE 600 OHM TERMINATING RESISTOR. THE MAXIMUM AUDIO LEVEL WHICH CAN BE FED INTO A LINE WITHOUT CAUSING OBJECTIONABLE CROSSTALK IS NORMALLY CONSIDERED TO BE PLUS 5 DBM AT 1000 CYCLES. IN FEEDING A LINE YOU SHOULD TAKE CARE NOT TO EXCEED THIS LEVEL. AS A ROUNDHOUSE (SAME AS BALLPARK) FIGURE YOU CAN EXPECT 10 TO 15 MILES OF LINE TO HAVE A LOSS OF ABOUT 15 DB.

THEREFORE WHEN YOU FEED AUDIO AT A LEVEL OF PLUS 6 DBM IN, YOU WILL HAVE MINUS 10 DBM AT THE OUTPUT END. MINUS 10 DBM IS STILL AN ADEQUATE LEVEL FOR MOST JOBS. IF YOUR LINE IS ALSO A DC LOOP (PROBABLY USED TO KEY THE REMOTE TRANSMITTER) SOME MEANS WILL HAVE TO BE PROVIDED TO SEPARATE THE AUDIO AND THE DC. THE USE OF TRANSFORMERS IN CONJUNCTION WITH THE BLOCKING CAPACITORS IS STRONGLY RECOMMENDED AS THEY WILL ALSO PERMIT IMPEDANCE MATCHING.

FIGURES 7 AND 8 SHOW GOOD WAYS TO CONNECT A RECEIVER TO A LINE AND A LINE TO A TRANSMITTER. SO MUCH FOR WIRE LINE CONTROL.

C. REMOTE CONTROL BY RADIO - A RADIO LINK IS THE USUAL MEANS WHICH HAMS EMPLOY TO CONTROL A REMOTE STATION. THIS METHOD IS EMPLOYED BECAUSE IT IS USUALLY MUCH CHEAPER FOR THE HAM THAN IS WIRE LINE CONTROL. USED 450 MC GEAR IS AVAILABLE AT ABOUT THE SAME PRICES AS HIGH AND LOW BAND GEAR, SO PROBABLY FOR LESS THAT A YEARS LAND LINE BILLS A HAM CAN GO RADIO CONTROL.

THE 420 TO 450 MC BAND HAS ENJOYED THE MOST USAGE FOR REMOTE CONTROL LINKS BECAUSE OF THE AVAILABILITY OF USED GEAR FOR THIS BAND. 220 MC ALSO ENJOYS SOME USAGE FOR THIS PURPOSE, BUT AS EQUIPMENT HAS TO BE EITHER BUILT OR EXTENSIVELY MODIFIED FOR THIS BAND IT IS NOT AS HEAVILY USED AS THE HIGHER BAND. THE BETTER RECEIVER SENSITIVITIES AND THE HIGHER TRANSMITTER POWER OUTPUTS AVAILABLE IN THE 220 MC BAND MAKE IT THE LOGICAL CHOICE FOR CONTROL LINKS WHERE THE PATH IS QUITE LONG OR NOT LINE OF SIGHT. HOWEVER, THE 420 MC BAND ALSO HAS ITS ADVANTAGES. THIS BAND IS WIDE ENOUGH TO PERMIT DUPLEX OPERATION WITH ONLY ONE ANTENNA. IF YOU DESIRE TO HAVE THE UP LINK AND THE DOWN LINK BOTH IN THE SAME BAND THIS CAN BE A REAL ADVANTAGE TO YOU.

IN ORDER TO DUPLEX ON 420 MC IT WILL BE NECESSARY TO USE A FREQUENCY SEPARATION OF 10 MC OR GREATER. WITH DIFFERENT TYPES OF EQUIPMENT IT MAY ALSO BE NECESSARY TO USE A SMALL CAVITY IN EITHER THE RECEIVER OR THE TRANSMITTER TRANSMISSION LINE. IF CLOSER FREQUENCY SEPARATION IS DESIRED IT SHOULD BE POSSIBLE TO OPERATE WITH A 1 TO 2 MC SEPARATION IF TWO ANTENNAS WITH A VERTICAL SEPARATION OF 10 FEET ARE USED. IN SHORT, DUPLEX ON 420 IS EASY.

THE UP LINK RECEIVER AND THE DOWN LINK TRANSMITTER ARE CONNECTED TO THE OTHER PIECES OF EQUIPMENT USING CATHODE FOLLOWERS, C.O.R.,S ETC. IN MUCH THE SAME MANNER THAT THE MOBILE RELAY EQUIPMENT IS CONNECTED IN FIGURE 2. USUALLY THE DELAY RELAY WHICH KEEPS THE DOWN LINK TRANSMITTER ON THE AIR FOR A FEW SECONDS AFTER THE LAST TRANSMISSION IS HEARD IS ADJUSTED SO THAT THE DELAY IS SOMEWHAT LONGER THAN IT IS FOR THE MOBILE RELAY SYSTEM ITSELF. ALSO IT IS QUITE COMMON TO CONNECT THE UP LINK RECEIVER TO THE DOWN LINK TRANSMITTER. THIS ALLOWS YOU TO MONITOR YOUR OWN UP LINK WHICH CAN BE A VERY HANDY THING. IDENTIFICATION CAN PROBABLY BEST BE DONE BY A CONTINUOUS CODE WHEEL WHICH IS ARRANGED TO TONE MODULATE (AT LOW DEVIATION) THE DOWN LINK TRANSMITTER. AUTOMATIC LOGGING CAN BE DONE AT THE CONTROL STATION BY TAPING OFF THE DOWN LINK RECEIVER OUTPUT. FIGURE 9 SHOWS A BLOCK DIAGRAM OF A REMOTE RADIO CONTROLLED STATION. THE STATION IS SHOWN AS A REMOTE STATION ONLY. HOWEVER, NOTICE THAT BY THE ADDITION OF A SECOND RECEIVER (6 OR 2 METERS) AND ANTENNA (SHOWN DOTTED) IT IS POSSIBLE TO MAKE THE REMOTE RADIO CONTROLLED STATION INTO A REMOTE RADIO CONTROLLED MOBILE RELAY STATION.

D. GENERAL CONTROL METHODS - THERE ARE SEVERAL DIFFERENT METHODS WHICH MAY BE USED TO GET THE REMOTE STATION FROM AN INACTIVE STATUS TO AN ACTIVE STATUS AND BACK AGAIN. MOST OF THESE METHODS ALLOW YOU TO PERFORM ONLY ONE OR TWO ACTIONS AT THE REMOTE STATION. IF YOU ARE ONLY INTERESTED IN ACTIVATING AND DEACTIVATING A MOBILE RELAY THEN PERHAPS ONE OF THESE SIMPLE CONTROL METHODS IS FOR YOU.

MOST OF THE CONTROL SYSTEMS WILL FIT INTO ONE OF THE FOLLOWING CATEGORIES: 1. SINGLE FREQUENCY RF CONTROL. THIS IS A SYSTEM WHERE THE THE PRESENCE OF THE UP-LINK RF CONTROL CARRIER IS REQUIRED IN ORDER FOR THE MOBILE RELAY STATION TO REPEAT. REMOVAL OF THE CONTROL CARRIER DEACTIVATES THE MOBILE RELAY STATION. 2. MULTIPLE FREQUENCY RF CONTROL. WE HAVE NEVER HEARD OF THIS ONE BEING USED. BUT ANYTHING IS POSSIBLE. USING THIS SYSTEM SEVERAL FUNCTIONS COULD BE PERFORMED AT THE REMOTE STATION. THE SELECTION OF FUNCTION WOULD DEPEND UPON WHICH CONTROL FREQUENCY CARRIER WAS BEING RECEIVED. THIS COULD TIE UP A LOT OF EQUIPMENT AS WELL AS FREQUENCY SPACE. FCC MIGHT NOT APPROVE. 3. SINGLE FREQUENCY TONE CONTROL. USING THIS SYSTEM RECEIPT OF A BURST OF A PARTICULAR TONE FREQUENCY ON THE CONTROL LINK WOULD ACTIVATE THE MOBILE RELAY STATION. THE NEXT BURST OF TONE WOULD DEACTIVATE THE STATION. USING THIS SYSTEM THE UP-LINK TRANSMITTER WOULD NOT HAVE TO BE ON THE AIR ALL THE TIME THAT THE MOBILE RELAY STATION WAS IN SERVICE. THIS SYSTEM IS ALSO MORE SECURE IN THAT IT REQUIRES MORE THAN JUST CARRIER TO ACTIVATE THE STATION TO THE REPEAT CONDITION. 4. MULTIPLE TONE SYSTEMS. WITH THESE SYSTEMS EACH FUNCTION REQUIRES ITS OWN TONE FREQUENCY. FOR EXAMPLE REPEAT-ON MIGHT BE 800 CYCLES WITH REPEAT-OFF BEING 1000 CYCLES. ONLY A BURST (3 TO 5 SECONDS) OF TONE WOULD BE REQUIRED SO THE CONTROL LINK TRANSMITTER WOULD NOT HAVE TO BE ON THE AIR ALL THE TIME. ADDING MORE FUNCTIONS REQUIRES THE ADDITION OF MORE TONE TRANSMITTERS AND TONE RECEIVERS. FOR MORE THAN A FEW FUNCTIONS THIS ONE GETS IMPOSSIBLE ALSO. ALTHOUGH ONE OF THESE SIMPLE SYSTEMS MAY DO YOUR JOB AT FIRST, WE WILL BET THAT YOU WILL SOON BECOME DISSATISFIED WITH THE LACK OF FUNCTIONS AVAILABLE AND WILL DESIRE SOMETHING MORE FLEXIBLE.

E. DIGITAL TONE CONTROL SYSTEMS - THE FIFTH OF THE POSSIBLE CONTROL SYSTEMS INVOLVES THE USE OF DIGITAL TONE. IN A DIGITAL TONE SYSTEM A SINGLE TONE FREQUENCY IS PULSED BY A STANDARD TELEPHONE DIAL AT THE CONTROL STATION END. AT THE REMOTE STATION THESE TONE PULSES ARE CONVERTED BACK INTO DC PULSES, AND THE DC PULSES ARE USED TO STEP A STEPPING RELAY. THE STEPPER IS WIRED FOR DIFFERENT FUNCTIONS ON ITS DIFFERENT CONTACTS. USING THIS SYSTEM ONLY ONE RF FREQUENCY AND ONE TONE FREQUENCY ARE REQUIRED FOR A LARGE NUMBER OF FUNCTIONS. IN THIS PART OF THE COUNTRY SEVERAL REMOTE STATIONS HAVE BEEN BUILT USING THIS SYSTEM WITH AS MANY AS 40 DIFFERENT FUNCTIONS AVAILABLE. PERHAPS THIS MAY SEEM LIKE AN UNNECESSARILY LARGE NUMBER OF FUNCTIONS. HOWEVER, CONSIDER A TWO BAND (SIX AND TWO METERS) REMOTE STATION WITH THREE FREQUENCIES AVAILABLE ON EACH BAND, PROVISION FOR OPENING AND CLOSING THE SQUELCH ON ALL RECEIVERS, AND MOBILE RELAY ON ONE OF THE BANDS. THE NUMBER OF FUNCTIONS REQUIRED GOES UP FAST, AND IT IS QUITE EASY TO GET UP TO 30 OR SO.

SINCE THE DIGITAL TONE EQUIPMENT REQUIRED FOR THIS TYPE OF SERVICE IS SO SIMILAR TO THE EQUIPMENT WHICH WE WILL BE DESCRIBING IN OUR TONE ALERT AND TONE CALLING ISSUE (WHICH IS DUE IN A FEW MONTHS) WE ARE NOT GOING TO GO INTO ANY DETAIL ON IT HERE. FOR THOSE WHO LIKE TO EXPERIMENT WE WILL GIVE A FEW DETAILS ON THE SYSTEM, BUT WILL LEAVE THE CIRCUITS FOR LATER.

FIRST OF ALL YOU WILL NEED A TONE GENERATOR AND A TONE RECEIVER. WE ARE SUGGESTING THAT 600 CYCLES OR 2805 CYCLES BE THE STANDARD TONE FREQUENCIES FOR REMOTE CONTROL APPLICATIONS. YOUR TONE EQUIPMENT SHOULD PROBABLY BE BUILT FOR ONE OF THESE. IN BUILDING THIS TYPE OF GEAR YOU CAN TAKE SOME HINTS FROM THE RTTY CIRCUITS. FOR EXAMPLE THE RTTY TONE GENERATORS SHOULD WORK VERY FINE. YOU REALLY ONLY NEED ONE FREQUENCY, BUT YOU MIGHT AS WELL BUILD IN THEM BOTH, MAKING THE SECOND ONE 1500 CPS. FOR TONE CALLING LATER ON. THE DESIRED OUTPUT FREQ. CAN THEN BE SELECTED BY A SWITCH.

THE OUTPUT FROM THE TONE GENERATOR IS [illegible] TO GENERATE THE TONE PULSES. TO PREVENT [illegible] IT IS SUGGESTED THAT NEGATIVE KEYING BE USED. BY THIS WE MEAN THAT THE DIAL SHOULD INTERRUPT A CONTINUOUS TONE RATHER THAN HAVING THE DIAL ARRANGED TO PUT OUT OUT A SHORT PULSE OF TONE FOR EACH DIGIT. IT IS ALSO DESIRABLE TO HAVE THE STEPPER RESET AFTER EACH DIALING. FOR THIS REASON FUNCTION RELAYS SHOULD BE USED FOR EACH FUNCTION. THE ONLY JOB OF THE STEPPER WOULD THEN BE TO APPLY OR REMOVE THE VOLTAGE FROM THE FUNCTION RELAYS. EACH FUNCTION RELAY IS SELF LATCHING THRU ONE OF ITS OWN CONTACTS. THE SYSTEM IS SET UP SO THAT THE TONE REMAINS ON FOR 3 OR 4 SECONDS AFTER THE LAST DIGIT IS DIALED. THE REMOVAL OF THE TONE AFTER THIS DELAY THEN RESETS THE STEPPER.

IT IS FURTHER SUGGESTED THAT FOUR DIGITS BE USED TO PERFORM A GIVEN FUNCTION. THE FIRST TWO DIGITS SHOULD BE ACCESS DIGITS WHICH SHOULD DO NOTHING MORE THAN PROTECT THE REMOTE STATION FROM UNAUTHORIZED DIALING OR CHANCE COMBINATIONS OF PULSES. THE LAST TWO DIGITS SHOULD BE THE ONES WHICH ACTUALLY DO THE WORK OF STEPPING THE STEPPER AND SELECTING THE DESIRED FUNCTION RELAY. IN ORDER TO DO THIS TWO STEPPERS WILL PROBABLY BE REQUIRED. ONE SHOULD BE WIRED TO ACCEPT ONLY THE ACCESS DIGITS AND THE SECOND ONE SHOULD BE WIRED WITH A FUNCTION RELAY ON EACH CONTACT.

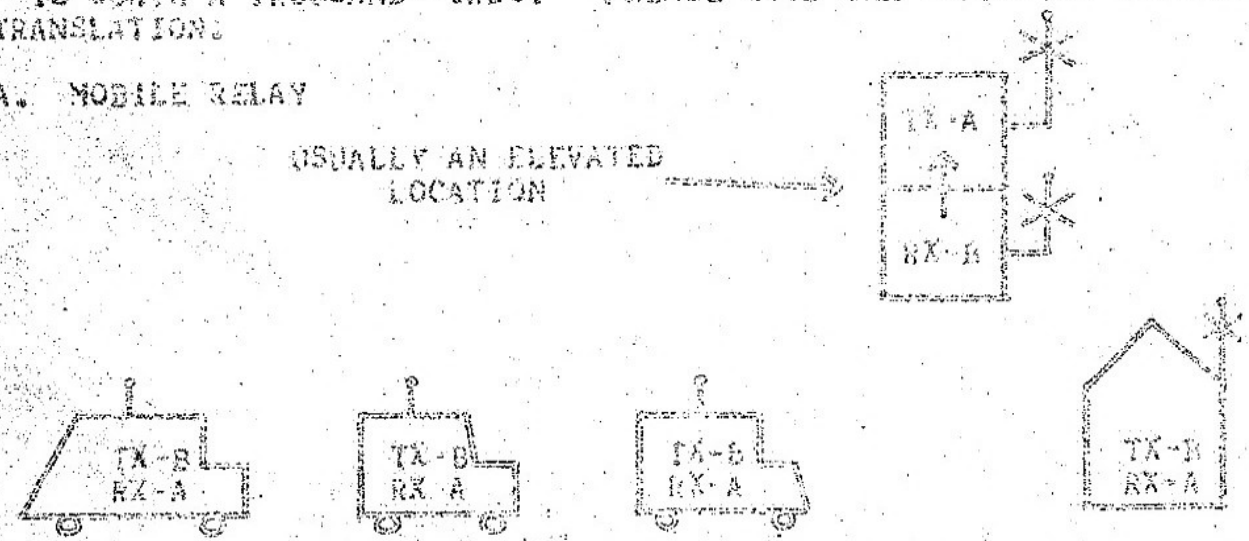
THOSE ARE THE BASICS OF THE SYSTEM. IF YOU LIKE TO EXPERIMENT TRY YOUR HAND AT IT. OUR CIRCUITS WILL FOLLOW IN A FEW ISSUES.

IV. LEGAL CONSIDERATIONS.

"A ROSE BY ANY OTHER NAME, ETC."

THERE APPEARS TO BE A REAL NEED TO STANDARDIZE ON TERMS SUCH AS "REPEATERS, RELAYS, REMOTE CONTROL" AND THE LIKE IN THE AMATEUR RANKS. ALTHOUGH THE FCC AMATEUR RULES (PART 12) DON'T GO INTO THESE AT ANY LENGTH, OTHER PARTS FOR COMMERCIAL USERS DO DEFINE THEM PRETTY WELL SO LETS PIN DOWN A FEW TERMS BY DESCRIBING A COUPLE OF TYPES OF SYSTEMS. CONFUSIOUS SAID THAT A PICTURE OF JAYNE WHATEVER HER NAME WAS - IS WORTH A THOUSAND WORDS. PLEASE NOTE THE FOLLOWING MODERN DAY TRANSLATION:

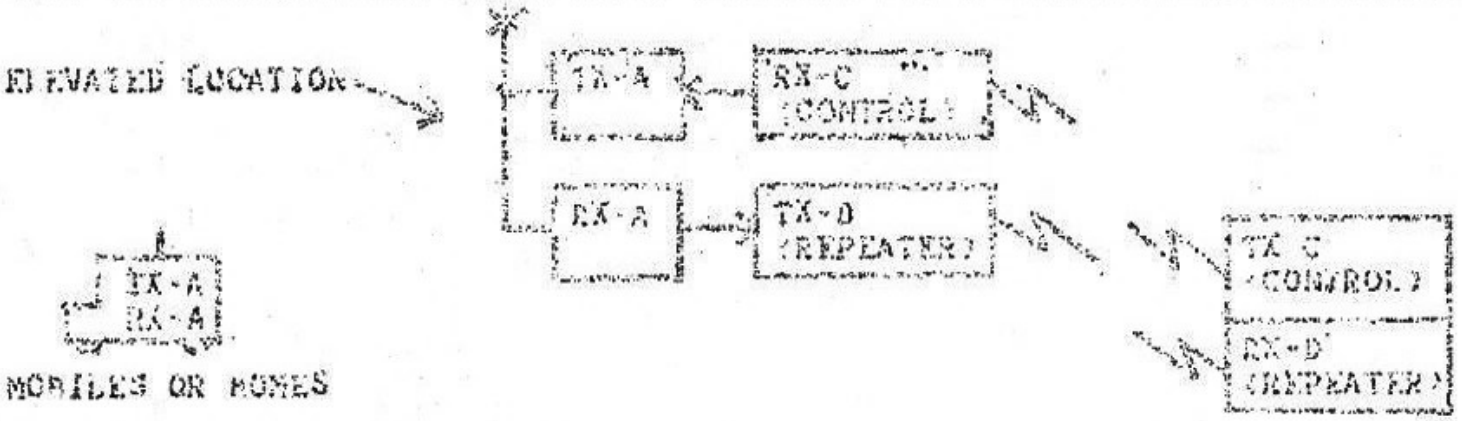
A. MOBILE RELAY



HERE EACH MOBILE AND HOME STATION TRANSMIT ON ONE FREQUENCY (B) AND RECEIVE ON ANOTHER (A). HERE THE MOBILES AND HOMES TRANSMIT THEIR INFORMATION TO THE STATION ON THE HILL AND IT RELAYS TO ALL THE RECEIVERS IN THE SYSTEM SO THAT EVERY UNIT GETS THE ADVANTAGE OF THE HIGH LOCATION. IN FCC PARLANCE THIS IS A "MOBILE RELAY" SYSTEM.

3. CONTROL AND [illegible] TYPE OF [illegible] OPERATION OF REMOTE CONTROL BY RADIO IN WHICH THE CONTROL [illegible] THE BASE TRANSMITTER TO BE ENERGIZED AND TO RETRANSMIT ANY INFORMATION TO THE MOBILE AND HOME STATIONS.

RECEPTION OF A SIGNAL FROM THE MOBILE CAUSES THE REPEATER TRANSMITTER TO ENERGIZE AND RETRANSMIT THE RECEIVED INFORMATION TO THE RECEIVER AT THE CONTROL POINT. NOTE HERE THAT THE REPEATER DIFFERS FROM THE RELAY IN THAT THE REPEATER TRANSMITTER TRANSMITS ONLY TO SPECIFIC POINTS -- NOT TO ALL THE RECEIVERS. NORMALLY THE CONTROL LINK AND THE REPEATER LINK USE DIRECTIONAL ANTENNAS AND ARE HIGHER IN FREQUENCY THAN THE BASE STATION WHICH WOULD COMMONLY USE A NONDIRECTIONAL ANTENNA.



ANY SYSTEM OR STATION MAY BE DESIGNED AROUND EITHER OR BOTH OF THESE BASIC SYSTEMS WHICH MAKES THE TERMINOLOGY A LITTLE MORE HAZY AND TO SOME EXTENT DEPENDS ON THE PARTICULAR WAY THE INFORMATION IS FLOWING AT THE MOMENT. WIRE LINE REMOTE CONTROL CAN ALSO BE USED HERE.

THIS EXAMPLE OF TERMINOLOGY IS NOT INTENDED TO STATE OR IMPLY WHAT IS OR IS NOT PERMISSIBLE UNDER AMATEUR PART 12 RULES. THAT INFORMATION IS IN THE THE FOLLOWING ARTICLE.

V. SOME LEGAL ASPECTS OF AMATEUR "MOBILE RELAY" AND "REPEATER-CONTROL"

BY H.W.MIDDLETON,JR., WA4VE

UNDER TODAYS AMATEUR RULES (PART 12 AS SET OUT IN VOLUME VI TEN 62 THRU REV. TRANSMITTAL VI-62-4) THERE ARE RATHER SEVERE LIMITATIONS AS TO WHAT MAY OR MAY NOT BE DONE IN AMATEUR RELAY OR REPEATER TYPE OPERATION. SECTION 12.64 DESCRIBES IN SOME DETAIL THE "REMOTE CONTROL" OF AN AMATEUR TRANSMITTER INCLUDING THE USE OF RADIO CONTROL. NO SPECIFIC MENTION OF MOBILE RELAY OR REPEATERS IS MADE AT ANY POINT.

PERHAPS THE TWO MOST CRITICAL POINTS IN SECTION 12.64 ARE THE REQUIREMENTS THAT:

1. A DULY LICENSED AMATEUR OPERATOR MUST BE PRESENT AT THE LOCATION OF THE APPARATUS OR AT A SPECIFIC REMOTE CONTROL POINT IN LIEU OF THE REMOTE TRANSMITTER LOCATION.
2. THE "CONTROLLING" TRANSMITTER AT THE REMOTE CONTROL LOCATION MUST OPERATE WITHIN THE AMATEUR BANDS 220 MC OR HIGHER.

THE FIRST OF THESE POINTS MAKE TODAYS AMATEUR "MOBILE RELAY" OPERATION PRETTY MUCH A MATTER OF TWO CONVERSTATIONS OR QSO,S. THAT IS. THE FIRST MOBILE IS IN REALITY TALKING WITH THE STATION DOING THE RELAYING AND THE RELAY STATION IS "PASSING ALONG" THE AUDIO AS HIS TRANSMISSION IN THE SECOND QSO GOING ON BETWEEN HE AND THE SECOND MOBILE. THE FACT THAT THE OPERATOR AT THE RELAY STATION IS RETRANSMITTING THE AUDIO AND NOT NECESSARILY SPEAKING HIMSELF HAS NO BEARING ON THE CONTROL OF THE RELAY STATION WHICH IS UNDER HIS SOLE CONTROL. HE MUST BE PRESENT THERE OR AT ITS AUTHORIZED CONTROL LOCATION.

POINT NUMBER TWO FURTHER RESTRICTS A RADIO CONTROL LINK BETWEEN THE AUTHORIZED CONTROL POINT AND THE REMOTE TRANSMITTER LOCATION. MOST AMATEUR FM OPERATION TAKES-PLACE IN THE SIX AND TWO METER BANDS AND IT IS THEREFORE NECESSARY THAT ADDITIONAL FREQUENCIES (AND TRANSMITTERS AND RECEIVERS) MUST BE TIED UP FOR CONTROL PURPOSES.

PERHAPS THE SIMPLEST AMATEUR MOBILE RELAY STATION IS ONE WHERE THE HAM LIVES OR WORKS ON A HIGH HILL (LIKE SOMEBODY WHO WORKS AT A TV TRANSMITTER AND IS SNOWED IN ALL WINTER). HERE IT IS MERELY NECESSARY THAT HE ARRANGE HIS TRANSMITTER AND RECEIVER ON TWO ANTENNAS (SO THEY CAN RUN AT THE SAME TIME) AND PUT AN AUDIO FEED THRU SWITCH BETWEEN THEM, SO THAT WHILE HE IS TRANSMITTING HE CAN THROW THE SWITCH AND REPEAT WHAT IS BEING SAID ON THE RECEIVER. THIS SYSTEM DOES NOT REQUIRE ANY ADDITIONAL APPROVAL FROM THE FCC OR A SPECIAL LICENSE.

MORE COMPLEX IN MANY WAYS ARE THE STATIONS THAT ARE REMOTELY CONTROLLED BY RADIO. HERE IT IS NECESSARY TO CAREFULLY ANALYZE THE FCC RULES IN ORDER TO COMPLY WITH THEM AND COME AS CLOSE AS POSSIBLE TO THE DESIRED OPERATION WHILE STAYING WITHIN THE LIMITATIONS. IN ADDITION TO THE MOST IMPORTANT SECTION (12.64) COVERING REMOTE CONTROL. ATTENTION SHOULD BE GIVEN TO SECTIONS 12.82 (TRANSMISSIONS OF CALL SIGNS) AND TO 12.136&7 (LOGS). THE FOLLOWING SECTIONS SHOULD ALSO BE CONSIDERED WITH RELAY AND REPEATER OPERATION: 12.7, 12.28, 12.62, 12.66, 12.101, 12.103 (NOTE HERE THE IMPLICATION THAT RETRANSMISSION OF AMATEUR SIGNALS IS ALRIGHT BY THE PROHIBITION OF "OTHER CLASSES" OF STATIONS), 12.104 (FOR TRANSMISSION OF TONE), 12.106C, 12.113, AND LAST BUT NOT LEAST 12.114A. NATURALLY, I,M SURE THAT YOU UNDERSTAND THAT BY MENTIONING THESE SECTIONS THAT I DON,T IN ANY WAY FEEL THAT THE SECTIONS NOT MENTIONED ARE NOT APPLICABLE, THEY ARE OF COURSE AS ON ANY OTHER TYPE OF AMATEUR STATION.

AFTER STUDYING THESE RULES, I,M SURE THERE WILL BE MANY QUESTIONS IN YOUR MIND ON SPECIFIC POINTS. I AGREE THAT IT IS UNFORTUNATE THAT THE FCC RULES ARE SO VAGUE ON THIS TYPE OF OPERATION. HOWEVER, THEY COULD BE VERY TIGHT AND AN EXAMPLE ARE THE RULES COVERING AMATEUR RTTY WHICH HAVE VERY TIGHT SPECIFICATIONS TO BE MET. I AGREE SOMEWHAT TO THE NECESSITY WITH RTTY BECAUSE IT WOULD BE DIFFICULT TO EQUIP EACH MONITORING STATION WITH MACHINES FOR ALL SPEEDS AND ALL KINDS OF SHIFTS.

IN FM VOICE COMMUNICATIONS THE REGULATION SHOULD NOT NEED TO BE SO RESTRICTIVE. IN VIEW OF THE VAGUENESS OF THE CURRENT REGULATIONS IT IS DIFFICULT TO DESCRIBE EXACTLY HOW THE FCC WOULD DECIDE A "GREY-AREA" QUESTION. PERHAPS ONE REASON IS BECAUSE DECISIONS WILL BE MADE BY MORE THAN ONE PERSON IN THE FCC, AND ONE MIGHT SAY YES ON A PARTICULAR QUESTION WHEREAS ANOTHER MIGHT SAY NO TO EXACTLY THE SAME QUESTION. IT IS THE WRITER,S FEELING (AND I JUST MAY BE OUT IN LEFT FIELD) THAT PERHAPS THE BEST COURSE TO FOLLOW IS TO NOT INDIVIDUALLY DISTURB THE FCC ON EITHER DISTRICT OR HIGHER LEVEL WITH YOUR QUESTIONS BUT TO SIT DOWN AND TRY HARD TO INTERPRET THE RULES AS THEY APPLY TO YOUR QUESTION. THEN MAKE NOTES OF WHAT YOUR INTERPRETATION WAS AND MOST IMPORTANT HOW YOU ARRIVED AT IT. IN OTHER WORDS- WHAT WAS THOUGHT ABOUT, WHAT WAS REJECTED AND WHY, WHAT WAS ACCEPTED AND WHY, AND EXACTLY HOW WHAT YOU ARE DOING DOES COMPLY WITH THE RULES. THEN YOU ARE PREPARED FOR A VISIT FROM THE INSPECTOR WITH WRITTEN ANSWERS THAT HE CAN SIT DOWN AND COMPARE WITH THE RULES. I FEEL AND MY LIMITED EXPERIENCE HAS BORNE OUT THAT THIS IS A REASONABLE WAY TO APPROACH THE PROBLEM AND HAS PRODUCED BETTER RESULTS THAN STAMMERING AROUND TRYING TO THINK UP AN ANSWER ON THE SPUR OF THE THE MOMENT.

THERE IS SOME ACTIVITY AFOOT TO SEE IF CHANGES MAY BE MADE IN THE FCC RULES TO MORE CLEARLY DEFINE AMATEUR MOBILE RELAY AND REPEATER OPERATION AND PERHAPS RELEASE OR EASE SOME OF THE CURRENT RESTRICTIONS THAT HAVE BEEN POINTED OUT ABOVE.

FOR THOSE NOT AWARE OF THE ARTICLE REFERENCE IS MADE TO "SCATTER BY ASDKE" JIM KYLE JR. ON PAGE 3 OF THE JAN 63 ISSUE OF "VHF HORIZONS MAGAZINE". THIS IS GOOD READING ON THE MATTERS WE ARE DISCUSSING HERE. JIM'S ARTICLE DOES HOWEVER RAISE SOME QUESTIONS AND COMMENTS IN MY MIND AND I HOPE THAT HE WILL NOT OBJECT TO MY VOICING THEM HERE - HE IS NOT EASILY REACHED ON THE PHONE.

PERHAPS THE FOREMOST QUESTION CONCERNS HIS SUGGESTION THAT THE AMATEUR MOBILE RELAY STATION BE AUTHORIZED FOR A SPECIFIC AMATEUR BAND ONLY. THIS WORDING MAY BE A LITTLE TROUBLESOME FOR TWO REASONS: FIRST, IT IS RESTRICTIVE BECAUSE SOME AMATEUR OPERATION IS DONE ON A CROSS-BAND BASIS NOW (THAT IS FROM SIX TO TWO AND VICE VERSA). SECOND, IT MAY NOT BE RESTRICTIVE ENOUGH BY NOT LIMITING THE MOBILE-RELAY OPERATION TO THE HIGHER FREQUENCIES.

ACTUALLY A MOBILE RELAY DOESN'T SERVE ANYWHERE NEAR AS VALID A PURPOSE ON FREQUENCIES BELOW TEN METERS BECAUSE OF THE PROPAGATION CHARACTERISTICS WHERE HILLTOPS ARE OF NO GREAT ADVANTAGE - SUCH AS THEY ARE ON THE VHF FREQUENCIES WHERE LINE OF SIGHT PROPAGATION IS SO IMPORTANT. CONSIDERING THE PRESENT DAY USAGE OF THE BANDS BELOW TEN METERS (AS WELL AS THE PROPAGATION) I DOUBT THAT THE FCC WOULD LOOK FAVORABLY UPON MOBILE RELAYS UNLESS THEY WERE LIMITED TO THE FREQUENCIES TEN METERS OR HIGHER. PERHAPS BETTER WORDING OF THIS PART WOULD BE ALONG THE LINES "WITHIN AMATEUR BANDS ABOVE 28 (OR 50) MC." THE CHOICE OF 28 OR 50 MC IS BEYOND THE SCOPE OF THIS ARTICLE.

A QUESTION ALSO ARISES CONCERNING "SPECIFIC SHOWING BY THE APPLICANT THAT THE PUBLIC INTEREST WILL BE SERVED BY SUCH AUTHORIZATION WILL BE REQUIRED". NO DOUBT JIM WISHED TO SHOW HOW TIMELY STATIONS WOULD BE OF VALUE IN TIMES OF CIVIL EMERGENCY, SUCH AS FLOODS, FOREST FIRES, AND THE LIKE. CERTAINLY AMATEUR-RADIO WOULD NOT BE PERMITTED AT ALL IF IT WAS NOT RECOGNIZED TO SERVE THE PUBLIC INTEREST, AND IT APPEARS THAT SPECIFIC SHOWING WOULD BE HARD TO DESCRIBE UNTIL THE EVENT OCCURS. THE JUDGEMENT OF WHETHER A SPECIFIC STATEMENT WAS ADEQUATE WHEN CONSIDERED BY DIFFERENT PEOPLE PROCESSING THE APPLICATION MIGHT VARY. LETS NOT HAMPER OURSELVES WITH ADDITIONAL VAGUENESS IN WHAT IS REQUIRED TO SATISFACTORILY COMPLY WITH THE RULES.

LASTLY AND LEASTLY, THE STATEMENT SAYING THAT THE STATION BE DESIGNED AND INSTALLED SO THAT IT MAY BE DEACTIVATED BY REMOTE CONTROL IN CASE OF EMERGENCY COULD PERHAPS BE IMPROVED IN WORDING BY USE OF A DIFFERENT WORD INSTEAD OF EMERGENCY. CERTAINLY WE WISH THE STATION TO BE AVAILABLE IN THE CASES OF CIVIL EMERGENCY SO THAT WE MAY PERFORM IN THE PUBLIC INTEREST. BETTER WORDING PERHAPS COULD INDICATE THE STATION BE DEACTIVATED BY REMOTE CONTROL IN CASE IT IS FOUND VARYING FROM FCC RULES OR MILITARY EMERGENCY.

EVEN THOUGH I HAVE PICKED AT THE ABOVE POINTS, I WANT TO CONGRATULATE JIM AND THANK HIM FOR STARTING THE BALL ROLLING AND WANT TO COMPLIMENT HIM ON THESE POINTS IN HIS ARTICLE:

1. THE TIE-IN TO PUBLIC INTEREST AND SERVICE.
2. A GOOD BALANCE OF TECHNICAL REQUIREMENTS, NOT TO MANY OR TOO FEW.
3. THE MENTION OF COMMERCIAL USE OF SIMILAR TYPES OF STATIONS BY RULE NUMBER.

IN THE DRAFTING OF PROPOSED RULE CHANGES, WE SHOULD TRY HARD TO LOOK THROUGH THE EYES OF THE FCC, SO TO SPEAK. BY THIS I MEAN THAT WE SHOULD CONSIDER AND TRY TO DRAFT SO AS TO NOT INCREASE THE WORK LOAD OF THEIR ALREADY SHORT STAFF, BOTH IN THE HANDLING OF APPLICATIONS AND IN THE MONITORING GROUP. THEY HAVE A FULL-TIME JOB NOW AND WE WILL STAND A MUCH BETTER CHANCE OF GETTING WHAT WE DESIRE IF WE DO NOT GIVE THEM ADDITIONAL WORK TO DO; ESPECIALLY IF IT REQUIRES ADDITIONAL PERSONNEL.

THIS ARTICLE IS ALREADY TOO LONG, HOWEVER BEFORE CLOSING I WILL MENTION THAT I HAVE DISCUSSED AND ASSISTED IN COMPLETING INFORMATION NECESSARY FOR SEVERAL SUCCESSFUL APPLICATIONS FOR REMOTE CONTROL BY RADIO IN WHICH MOBILE RELAY AND REPEATER-CONTROLS WERE INVOLVED. MANY TIMES A SIMPLE BLOCK DIAGRAM SHOWING WHAT IS LOCATED WHERE, AND WHAT TALKS TO WHAT, IS EXTREMELY VALUABLE. OFTEN TRYING TO GO THROUGH A WORD DESCRIPTION BECOMES EITHER VERY DIFFICULT OR ENTIRELY HOPELESS, ESPECIALLY IF THE TERMINOLOGY ISNT WELL PINNED DOWN. INCIDENTALLY, ONE POINT OF INTEREST IS THAT MY EXPERIENCE INDICATES THAT THE FCC DESIRES TO SEE THE SIGNALS TO SUSPEND TRANSMISSION (12.64B5) BE ABLE TO ENTER BY MORE THAN ONE FREQUENCY SO THAT IF THE NORMAL CONTROL RECEIVER IS INOPERATIVE OR BLOCKED BY ANY OUTSIDE CARRIER OR INTERFERENCE, THE SIGNAL COULD GO IN BY ANOTHER RECEIVER AND HAVE THE DESIRED EFFECT. THIS CAN BE DONE BY TWO RECEIVERS ABOVE 220 MC, HOWEVER MY OWN APPLICATION WAS APPROVED WITH THE STATEMENT THAT THE "BASE" (TWO OR SIX METER) RECEIVER WOULD ALSO BE CAPABLE OF RECEIVING THE SIGNALS TO SUSPEND.

I WELCOME YOUR COMMENTS ON THESE MATTERS, AND THOUGH IT MAY TAKE A WHILE, I WILL TRY TO OFFER MY ANSWERS AND ADDITIONAL COMMENTS IN RETURN. MAIL CAN BE SENT EITHER IN CARE OF THE EDITORS OF THE "FM NEWS" OR DIRECT TO ME AT 1223 FENWICK DRIVE, LYNCHBURG, VA. PHONE 703-239-0444.

WARREN MIDDLETON, W4DYE

VI. SUGGESTED READING.

A. "REMOTE CONTROL WITH A 420 MC LINK" BY W2ZGP AND W2TTU, QST, JULY, 1953, PAGE 32.
B. "VHF REPEATER PROBLEMS AND POSSIBLLITIES" BY K6QNY, QST, JULY, 1962, PAGE 26.
C. "SCATTER BY K5JKX", VHF HORIZONS, JANUARY, 1963, PAGE 3.
D. "MORE MOBILE RELAY" BY K5JKX, VHF HORIZONS, APRIL, 1963, PAGE 6.

VII. CONCLUSION.

WE HAVE INCLUDED THE BASIC PROBLEMS AND TECHNIQUES INVOLVED WITH AMATEUR REPEATERS. THE SPECIFIC MANNER IN WHICH THEY ARE USED OR ARE BUILT IS UP TO THE INDIVIDUAL. WE REALIZE THAT FOR SOMEONE EXPERIENCED IN BUILDING REPEATERS OUR ARTICLE IS SKIMPY AND LACKING IN TECHNICAL INFORMATION. BUT WE FEEL THAT A HAM UNFAMILIAR WITH THE SUBJECT CAN GET A GOOD GENERAL PICTURE FROM THIS MATERIAL. WE DIDNT MENTION A NUMBER OF SMALL BUT IMPORTANT AIDS SUCH AS A CODE WHEEL FOR IDENTIFICATION, THE USE OF A TAPE RECORDER FOR LOGGING, CROSS BAND REPEATING AND SO FORTH. THE COMMONLY USED NEGATIVE KEYING TONE CONTROL WILL BE COVERED IN OUR UPCOMING TONE ISSUE.

ANOTHER THING TO REMEMBER IS THAT YOU MUST MONITOR ALL FREQUENCIES AT YOUR CONTROL POINT THAT YOU TRANSMIT REMOTELY. QUESTIONS SENT US THAT ARE OF GENERAL INTEREST WILL BE ANSWERED IN THE "NEWS". WE WILL WELCOME ANY COMMENTS ON HOW TO DO THE JOB IN AN EASIER OR BETTER WAY THAN WE SUGGEST. ALSO IF A LIST OF PERSONS OPERATING HAM REPEATERS COULD BE ASSEMBLED WE WILL BE GLAD TO PUBLISH IT.

IT TOOK US TWO MONTHS TO WRITE, PUT ON RTTY TAPE, MAKE STENCILS, REPRODUCE, COLATE, ETC THIS ISSUE (300 COPIES) SO WE FEEL WE HAVE AN EXCUSE FOR A LATE ISSUE. FOR THOSE OF YOU READING THE "NEWS" FOR THE FIRST TIME MAKE NOTE THAT A NORMAL ISSUE IS 5 TO 7 PAGES LONG-NOT 24. IN OUR NEXT ISSUE WE WILL HAVE SOME NEWS TO REPORT FROM THE WORLD OF HAM FM, SOME OF OUR READERS COMMENTS, AND A SHORT TECHNICAL SECTION.

FOR THOSE OF YOU WHO HAVE REQUESTED BACK ISSUES WE ARE KEEPING A RECORD AND WHEN WE REPRINT YOU WILL GET THEM (NOT SOON).

ANY ERRORS THAT WE OR YOU FIND WILL BE CORRECTED IN THE ERRATA SECTION OF FOLLOWING ISSUES.

LOCALLY CONTROLLED MOBILE RELAY - BLOCK DIAGRAM

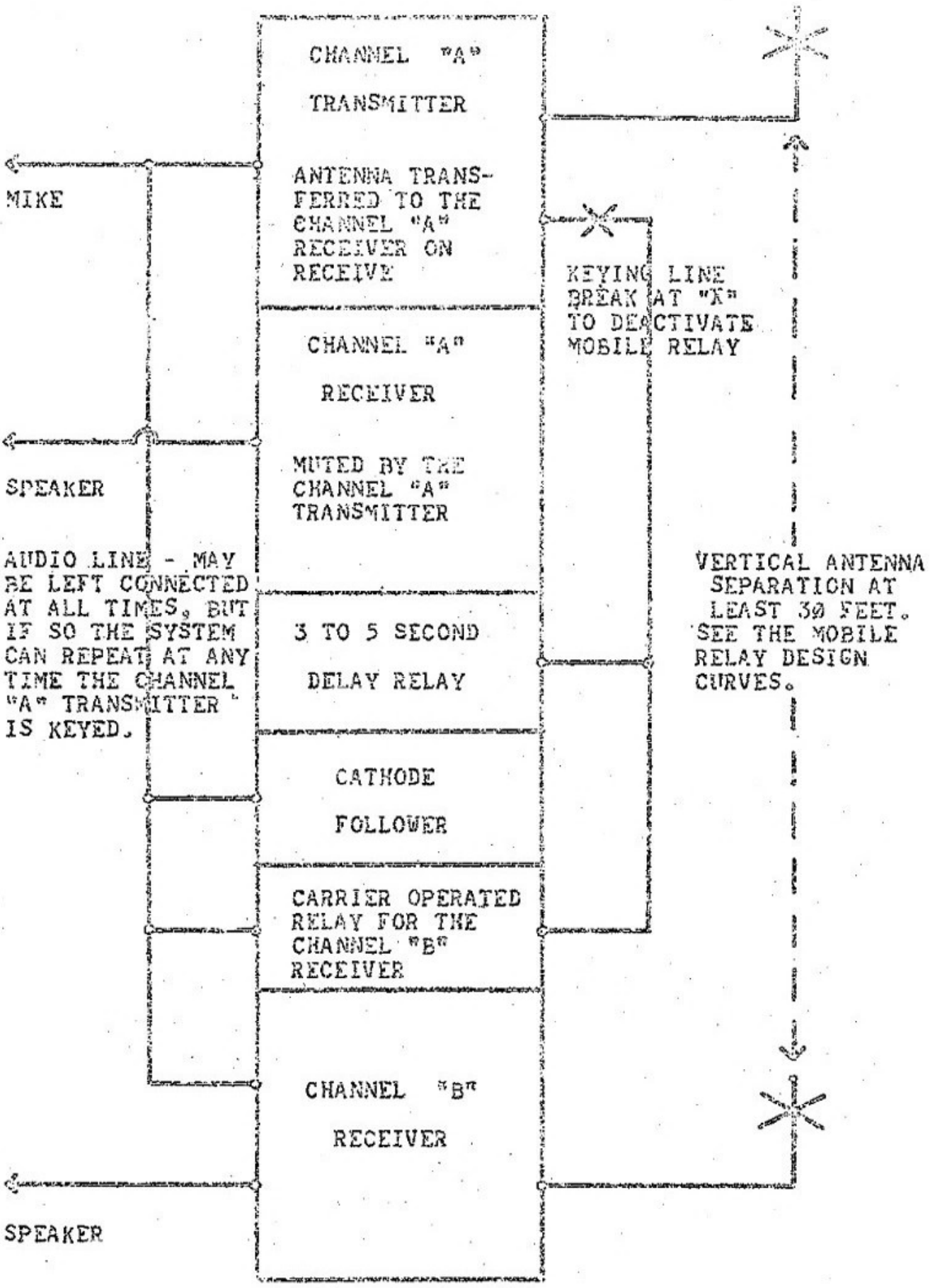
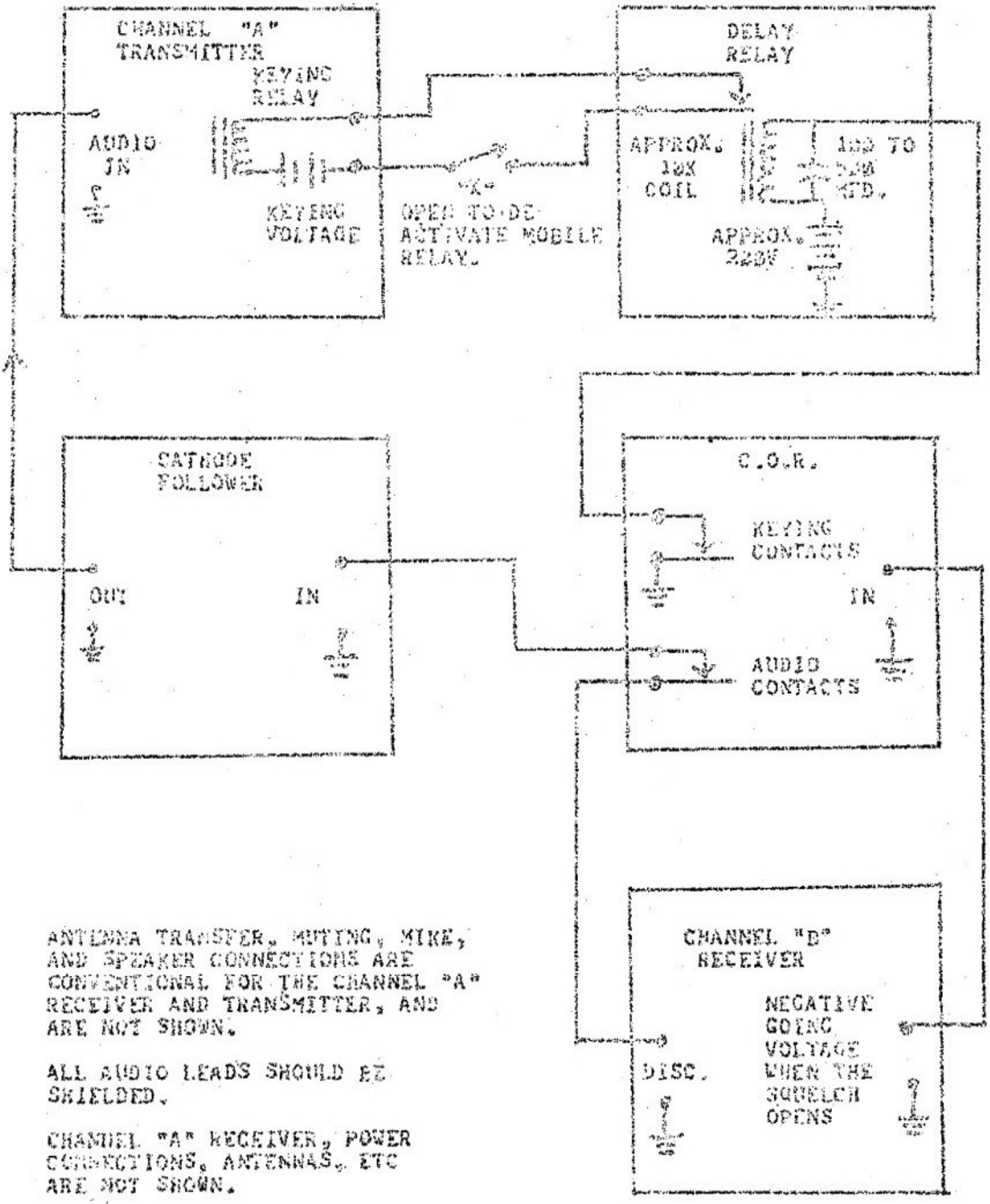


FIGURE 1

LOCALLY CONTROLLED MOBILE RELAY STATION — INTERCONNECTION DIAGRAM

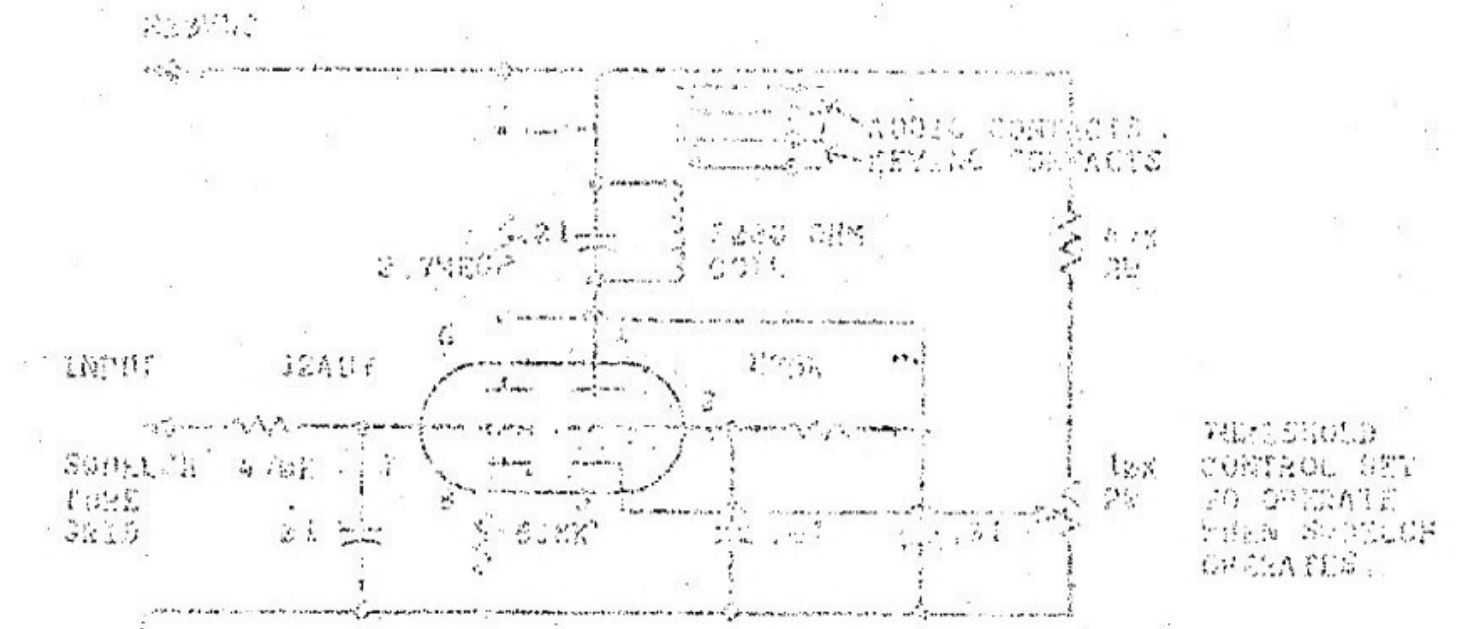


ANTENNA TRANSFER, MUTING, MIKE, AND SPEAKER CONNECTIONS ARE CONVENTIONAL FOR THE CHANNEL "A" RECEIVER AND TRANSMITTER, AND ARE NOT SHOWN.

ALL AUDIO LEADS SHOULD BE SHIELDED.

CHANNEL "A" RECEIVER, POWER CONNECTIONS, ANTENNAS, ETC ARE NOT SHOWN.

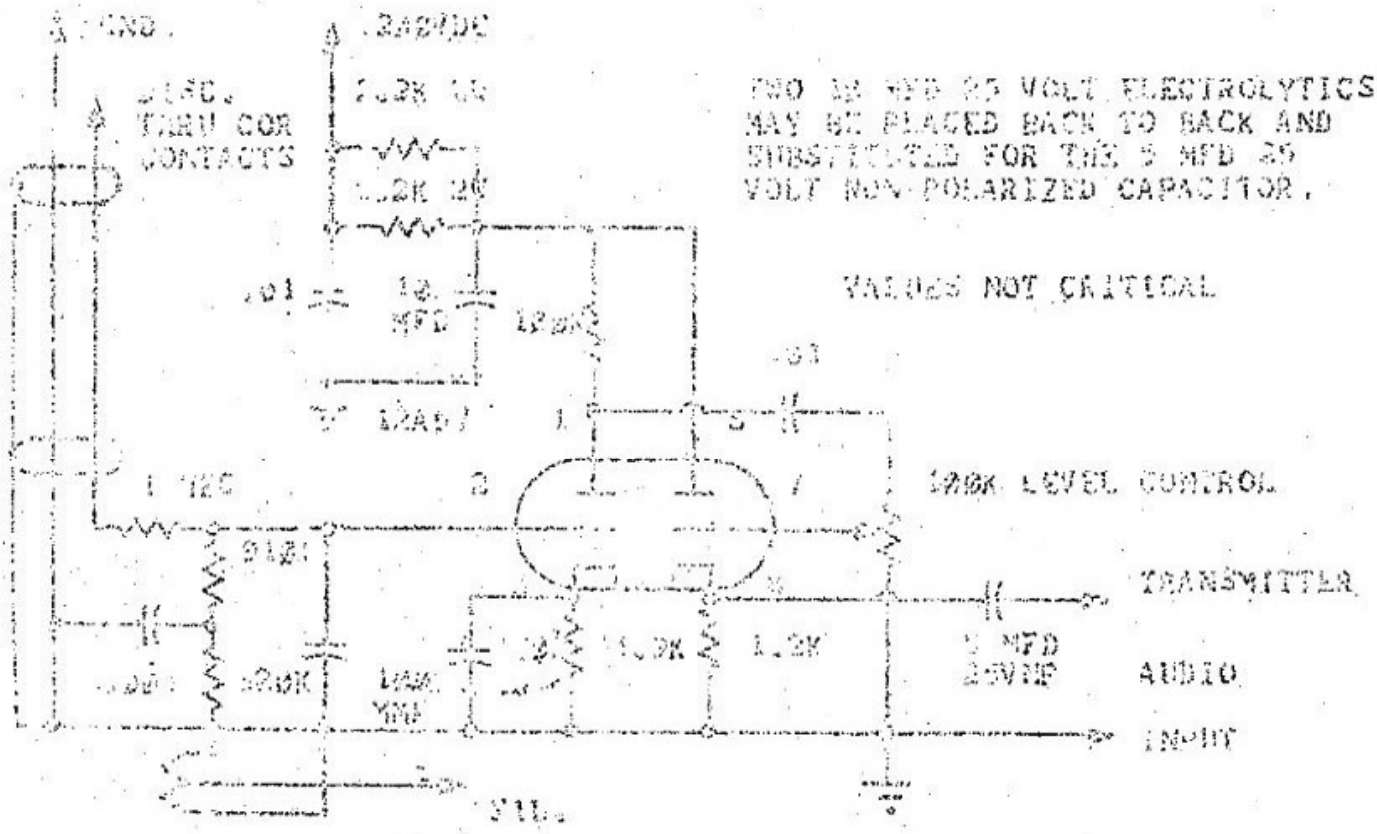
FIGURE 2 (USE WITH FIGURE 1)



THE INPUT CONNECTION SHOULD GO TO A GRID WHICH PROVIDES A NEGATIVE GOING VOLTAGE AS THE SQUELCH OPENS.

CATHODE FOLLOWER CIRCUIT

FIGURE 7



MOBILE RELAY DES CURVES 6 METERS

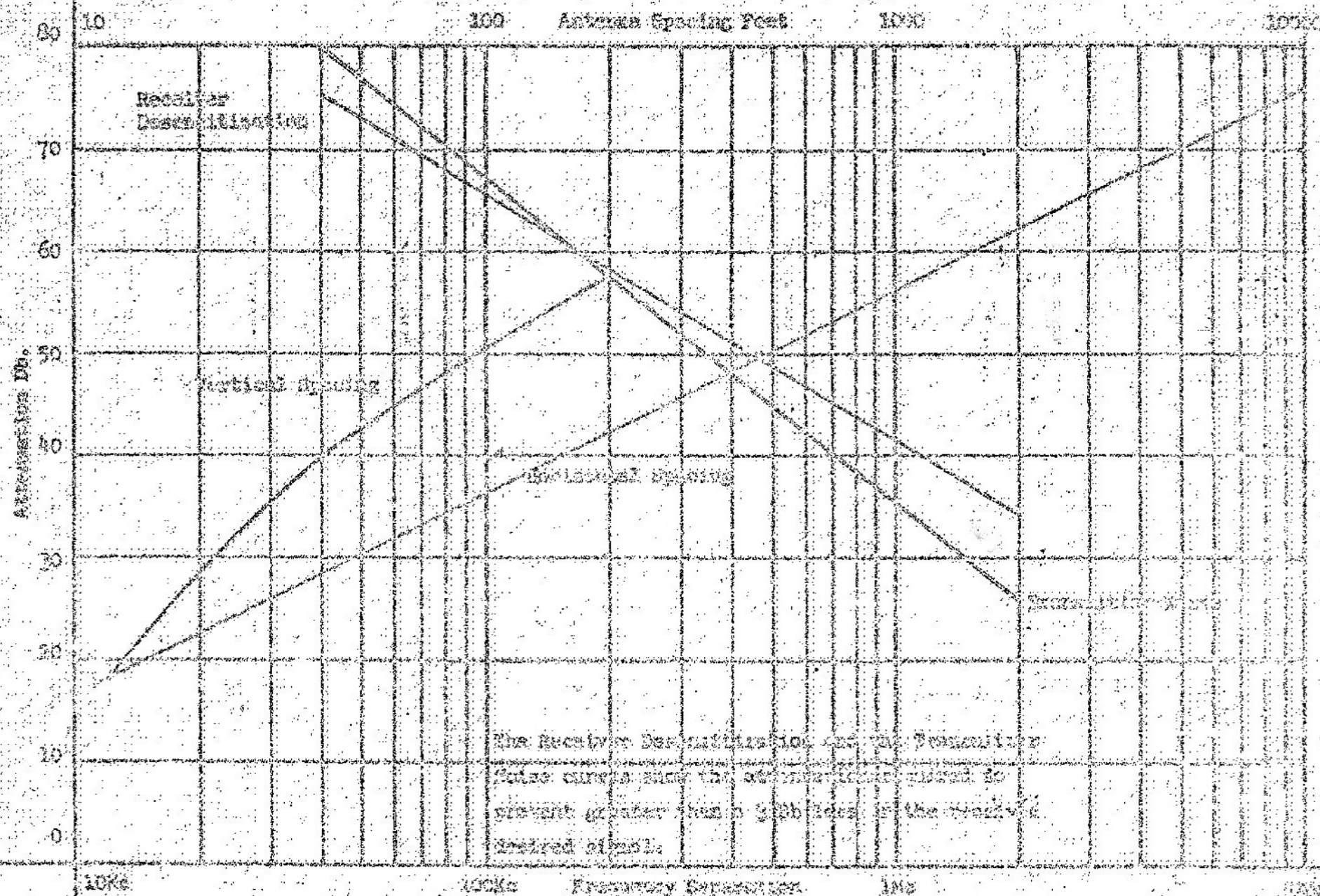


FIG. 5

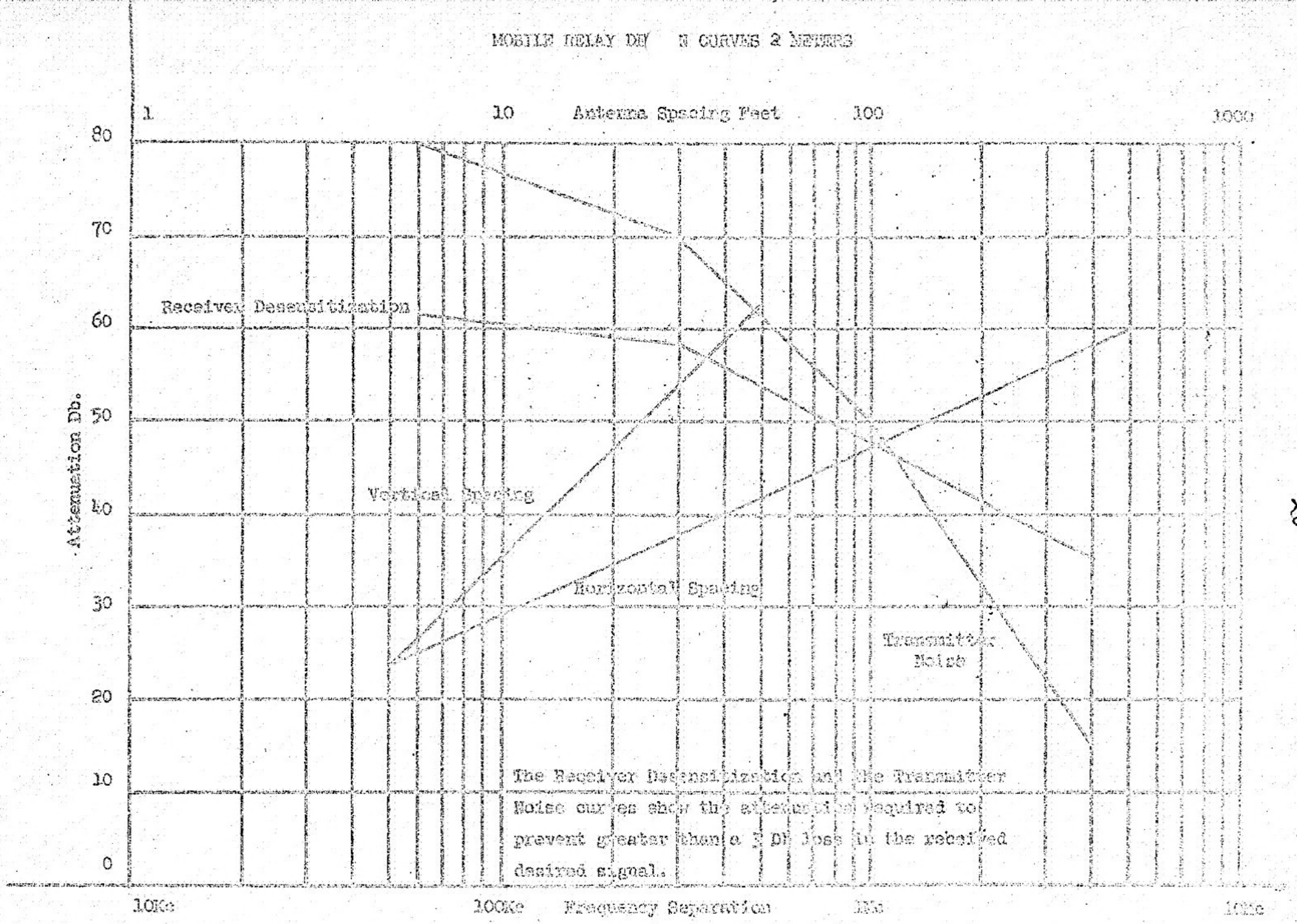
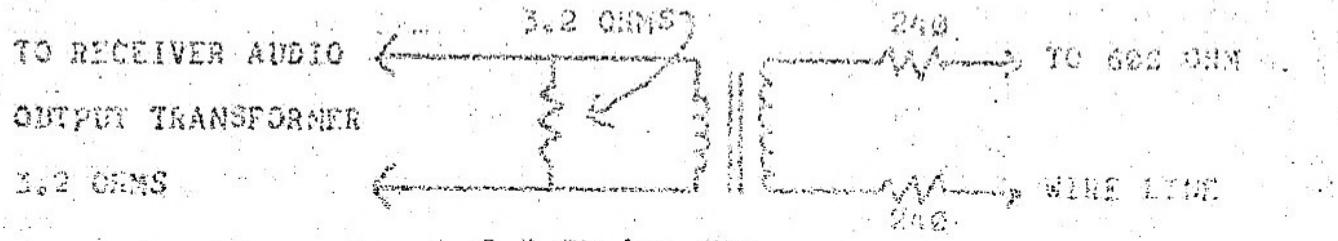

MOBILE RELAY DAY N CURVES 2 METERS
1
10
Antenna Spacing Feet
100
1000
80
70
60
50
40
30
20
10
0
Attenuation Db.
Receiver Desensitization
Vertical Spacing
Horizontal Spacing
Transmitter Noise
The Receiver Desensitization and the Transmitter Noise curves show the attenuation required to prevent greater than a 3 Db loss in the received desired signal.
10Kc
100Kc
Frequency Separation
1Mc
10Mc

FIG. 6

CONNECTING A RECEIVER TO A WIRE LINE

FIGURE 7



3.2 TO 600 OHM
TRANSFORMER

THE VOLUME CONTROL SHOULD BE ADJUSTED SO THAT THE MAXIMUM AUDIO LEVEL APPLIED TO THE LINE (WHEN RECEIVING 1000 CYCLE TONE TRANSMITTED AT 10 KC DEVIATION) IS PLUS 5 DBM.

OTHER SYSTEMS OF FEEDING A RECEIVER TO A LINE ARE POSSIBLE. HOWEVER, IT IS IMPORTANT TO USE SOME MISMATCH IN CONNECTING THE TWO TOGETHER. IF NO MISMATCH IS USED THE SETTING OF THE RECEIVER VOLUME CONTROL FOR THE MAXIMUM LINE LEVEL WILL BE VERY LOW. THIS WILL MAKE THE HUM LEVEL HIGH IN RELATION TO THE DESIRED AUDIO. ON THE OTHER HAND, IF TOO MUCH MISMATCH IS USED THEN THE VOLUME CONTROL WILL HAVE TO BE RUN WIDE OPEN TO GET SUFFICIENT LEVEL TO FEED THE LINE. THIS WILL RESULT IN THE RECEIVER AUDIO STAGES RUNNING AT MAXIMUM DISTORTION. A GOOD RULE OF THUMB HERE IS TO HAVE THE VOLUME CONTROL SET AT SOMEWHERE NEAR MID-RANGE WITH THE MATCHING SYSTEM SET UP TO GIVE THE DESIRED LINE LEVEL.

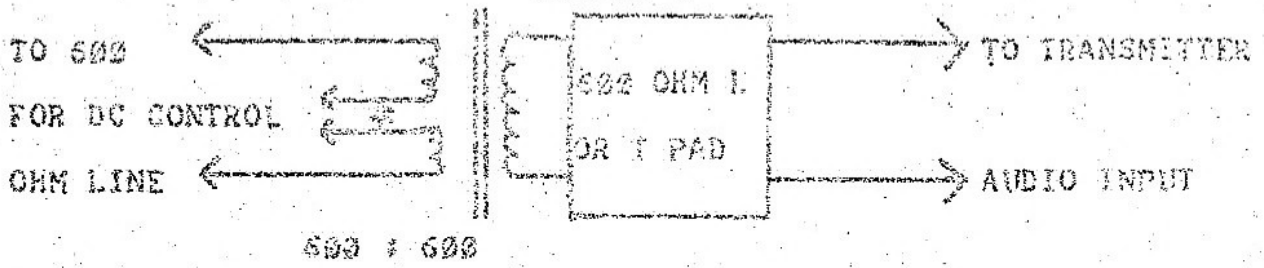
ANOTHER GOOD CIRCUIT WOULD INVOLVE THE USE OF A 3.2 TO 600 OHM TRANSFORMER AND A 600 OHM PAD (BALANCED TYPE) FEEDING THE LINE.

REMEMBER THAT IT IS IMPORTANT THAT THE LINE BE KEPT BALANCED WITH RESPECT TO GROUND.

XXX XXX XXX XXX XXX XXX XXX XXX XXX XXX XXX XXX XXX

MATCHING A LINE TO A TRANSMITTER

FIGURE 8

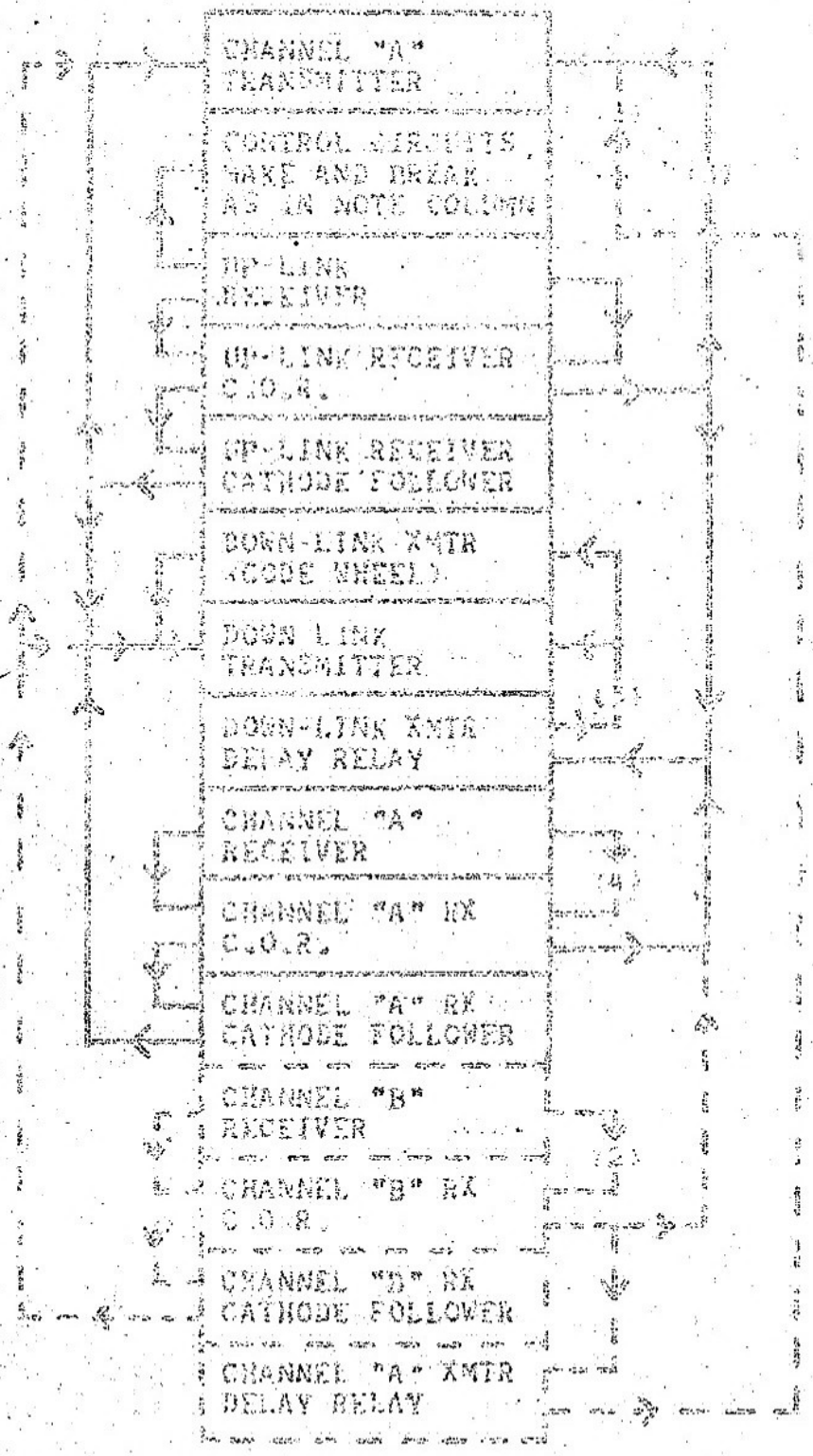


600 : 600

IN SETTING UP THE MODULATION ON A TRANSMITTER FED FROM A LINE FOLLOW THESE STEPS: (1) APPLY A SIGNAL (1000 CYCLES AT 1 VOLT) TO THE TRANSMITTER AUDIO INPUT. THIS LEVEL SHOULD CAUSE THE AUDIO LIMITERS IN THE TRANSMITTER TO SOLIDLY LIMIT. (2) SET THE MODULATION POT FOR MAXIMUM (15 KC) DEVIATION AND NEVER AGAIN TOUCH THE MODULATION POT. (3) APPLY TO THE L OR T PAD THE AUDIO (1000 CYCLE) WHICH EXISTS AT THE TRANSMITTER END OF THE LINE AS A RESULT OF FEEDING IN PLUS 5 DBM AT THE OTHER END OF THE LINE. (4) ADJUST THE L OR T PAD SO THAT THE DEVIATION OF THE TRANSMITTER IS 10 KC. WITH THE MODULATION SET UP IN THIS MANNER THE DEVIATION WILL AVERAGE AROUND 10 KC WITH THE PEAKS ON VOICE GOING TO 15 KC.

RADIO CONTROLLER OF THE FUTURE — BLOCK DIAGRAM

FIGURE 4



NOTES

BREAK AT (3) TO DEACTIVATE MOBILE RELAY OPERATION

BREAK AT (2) TO DEACTIVATE CHANNEL "B" RECEIVER

BREAK AT (1) TO DEACTIVATE CHANNEL "A" TRANSMITTER PERMITS TEST ETC ON UP AND DOWN LINK WITHOUT HITTING SIGNAL ON MAIN CHANNEL

BREAK AT (4) TO DEACTIVATE CHANNEL "A" RECEIVER - THIS PERMITS MONITORING THE "B" CHANNEL ONLY.

BREAK AT (5) AND (3) TO PLACE STATION ON A STANDBY BASIS

EXTRA EQUIPMENT FOR MOBILE RELAY IS SHOWN DOTTED

ANTENNAS ARE NOT SHOWN

APPENDIX "A" - RECEIVER SPURIOUS CALCULATIONS.

MOST OF US ARE FAMILIAR WITH THE IMAGE RESPONSE OF RECEIVERS. BUT THERE ARE ALSO A NUMBER OF OTHER SPURIOUS RESPONSES WHICH EXIST IN ALL RECEIVERS WHICH CAN GIVE US TROUBLE IF A HIGH POWER OR NEARBY TRANSMITTER HAPPENS TO LAND ON ONE OF THEM. THE FOLLOWING ARE THE SPURIOUS RESPONSES WHICH ARE MOST LIKELY TO GIVE TROUBLE IN REPEATER SYSTEMS:

1. FIRST IMAGE - OCCURS AT TWO TIMES THE HIGH I.F. FREQUENCY AWAY FROM THE DESIRED FREQUENCY. AS THE INJECTION VOLTAGE IS NORMALLY APPLIED ON THE LOW SIDE OF THE DESIRED SIGNAL THIS SPURIOUS WILL ALSO APPEAR ON THE LOW SIDE. IF THE INJECTION IS ON THE HIGH SIDE OF THE DESIRED, THE IMAGE WILL BE ALSO.
2. HALF HIGH I.F. - OCCURS AT ONE HALF OF THE HIGH I.F. FREQUENCY AWAY FROM THE DESIRED ON THE SAME SIDE AS THE FIRST IMAGE.
3. SECOND IMAGE - OCCURS AT TWO TIMES THE LOW I.F. FREQUENCY AWAY FROM THE DESIRED FREQUENCY. AS WITH THE FIRST IMAGE IT WILL APPEAR ON EITHER THE HIGH OR LOW SIDE OF THE DESIRED DEPENDING ON WHICH SIDE THE INJECTION VOLTAGE IS ON.
4. HALF LOW I.F. - OCCURS AT ONE HALF THE LOW I.F. FREQUENCY AWAY AWAY FROM THE DESIRED ON THE SAME SIDE AS THE SECOND IMAGE.
5. ALL MULTIPLES OF THE FIRST OSCILLATOR FREQUENCY PLUS OR MINUS THE HIGH I.F. FREQUENCY.

TO ILLUSTRATE THE ABOVE SPURIOUS AND HOW THEY CAN BE COMBATED LET US CONSIDER A HYPOTHETICAL RECEIVER WITH 146.00 MC AS THE DESIRED FREQ. THE HIGH I.F. WILL BE 10 MC AND THE LOW I.F. WILL BE 500 KC. THE FIRST OSCILLATOR WILL BE AT 13.6 MC WITH THE FREQUENCY MULTIPLICATION BEING TEN TIMES TO PRODUCE THE 136.00 MC INJECTION VOLTAGE. THE SECOND XTAL WILL BE AT 9.5 MC. LISTED ARE EACH OF THE SPURIOUS FOR THIS RECEIVER.

1. THE FIRST IMAGE WILL OCCUR AT 126.00 MC. THIS WILL NORMALLY NOT CAUSE ANY TROUBLE UNLESS THE RECEIVER WERE INSTALLED VERY NEAR SOME TYPE OF FAA INSTALLATION USING THIS FREQUENCY.
2. THE HALF HIGH I.F. WILL OCCUR AT 141.00 MC. THIS FREQUENCY WILL ALSO PROBABLY NOT CAUSE ANY TROUBLE IN MOST INSTALLATIONS.
3. THE SECOND IMAGE WILL OCCUR AT 145.00 MC. THE SECOND CRYSTAL COULD BE REPLACED WITH ONE AT 10.5 MC AND THIS WOULD PUT THE SECOND IMAGE AT 147.00 MC. AT ALL COSTS THE REPEATER STATION CHANNEL "B" RECEIVER FREQUENCY SHOULD BE CHOSEN SO THAT THE SECOND IMAGE DOES NOT FALL ON THE CHANNEL "A" TRANSMITTER FREQ.
4. THE HALF LOW I.F. WILL OCCUR AT 145.750 MC. THIS WILL ALSO BE SHIFTED TO THE HIGH SIDE AT 146.250 MC BY SHIFTING THE SECOND CRYSTAL TO 10.5 MC. AS WITH THE SECOND IMAGE THE CHANNEL "A" TRANSMITTER FREQUENCY SHOULD NOT LAND ON THIS FREQUENCY.
5. ONE EXAMPLE OF THE CRYSTAL FREQUENCY MULTIPLES, PLUS OR MINUS THE HIGH I.F., WILL HAVE TO DO. THIS RECEIVER SHOULD NOT BE INSTALLED AT A SITE WITH A BROADCAST FM TRANSMITTER ON 98.8 MC. THE EIGHTH HARMONIC OF THE FIRST CRYSTAL IS 108.8 MC AND THIS MINUS THE 10 MC HIGH I.F. FREQUENCY IS 98.8 MC. THIS TYPE OF SPURIOUS IS NORMALLY QUITE FAR DOWN, AND SHOULD NOT GIVE ANY TROUBLE UNLESS THE RECEIVER IS INSTALLED AT A SITE WITH A VERY HIGH POWERED TRANSMITTER ON ONE OF THE SPURIOUS RESPONSES.

ONE OTHER THING CONCERNING SPURIOUS. TAKE CARE IN PICKING YOUR FREQUENCIES SO THAT HARMONICS OR SUB-HARMONICS OF THE XMTR OUTPUT DO NOT FALL ON THE RECEIVER DESIRED OR RECEIVER SPURIOUS FREQ. FOR EXAMPLE 435 MC WOULD BE A POOR CHOICE FOR A UHF CONTROL FREQUENCY AS THE TRIPLER WOULD FALL ON THE 145 MC 2ND IMAGE OF THE ABOVE RECEIVER. HOWEVER, IF YOU HAD THIS TROUBLE IT COULD BE CURED BY SHIFTING THE SECOND XTAL TO 10.5 MC AND THUS MOVING THE SECOND IMAGE TO 147 MC.