THE KRAFT PROPORTIONAL

First in a series of basic introductions to the new proportional systems.

This is the first of a series of introductory articles describing the operational principles of the new proportional systems. The material contained herein is presented in answer to numerous requests for general information on current proportional developments, and is based on the latest available data. Unless otherwise stated, these are general descriptive articles only, and are not intended to be product evaluations, or endorsements.

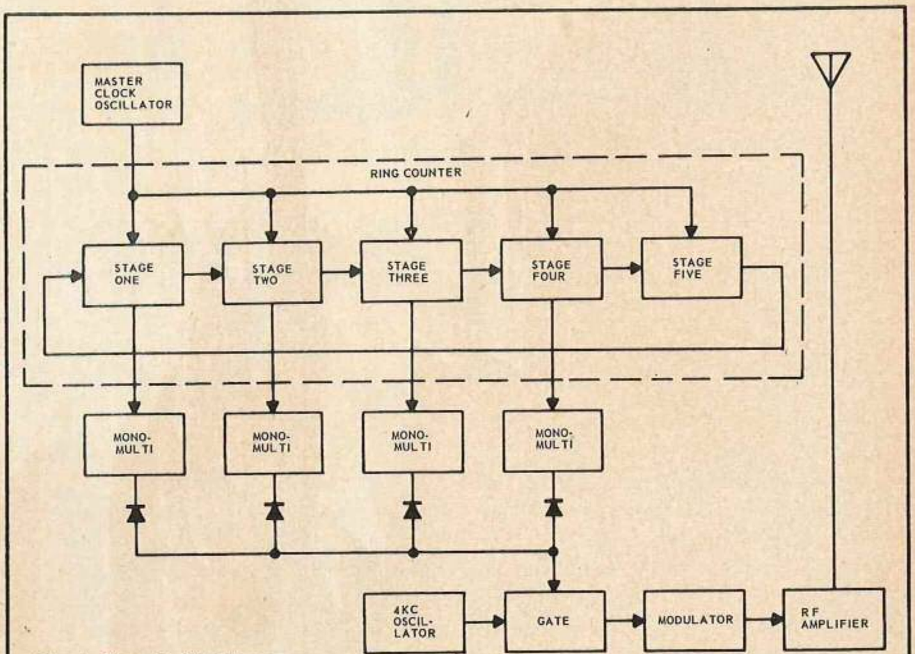

Figure 1. Transmitter Block Diagram

The production proportional system, developed and manufactured by Kraft Custom Radio, has had over five thousand test flights since its conception in 1962. Although based on digital logic techniques, the term "digital," as applied to proportional systems, does not indicate the actual method of supplying information. In reality, there are probably no true digital systems, although the old reliable reed system might be considered to be digital. The term is used, however, to describe systems which used digital **techniques** in transmitting, decoding, and applying the proportional information.

There are many possible digital methods of proportional control. One involves turning the RF carrier on and off and utilizing the length of both OFF and ON times in sequence to provide the proportional information. Similar results can be obtained by turning the RF carrier on and off in short duration spikes which reference to each other. Another system transmits these carrier off spikes to form reference pulses on a fixed time basis. Pulses are transmitted between the reference pulses and the information pulse, when decoded, produces the proportional output.

These digital systems have one thing in common. They do not utilize

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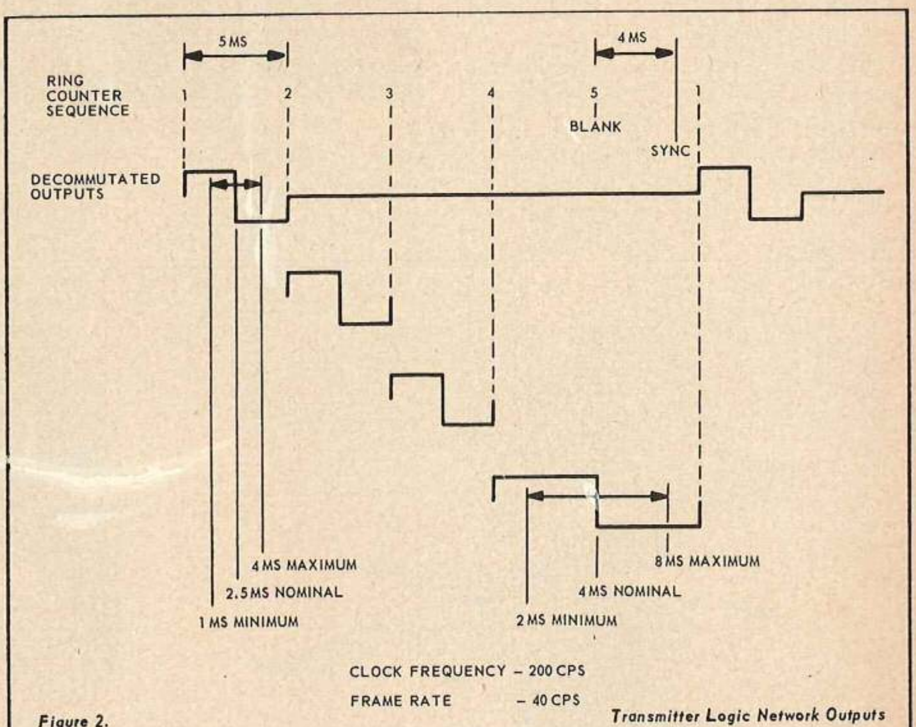

Figure 2. Transmitter Logic Network Outputs

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an audio subcarrier (tone) to transmit information. This is a distinct advantage from the standpoint of simplicity and smoothness. One disadvantage, however, is that these same systems have less discrimination against outside interference. The Kraft system utilizes a pulsed 4KC audio subcarrier to transmit the proportional information. The subcarrier, itself, does not contribute any information, but the filter circuit in the receiver will pass only a 4KC signal. Consequently, the system is highly resistant to interference and noise.

Referring to the transmitter Block Diagram (Fig. 1), the master clock oscillator is a highly stable emitter coupled multivibrator which oscillates at a 200 CPS rate. The pulses from the clock advance the ring counter one stage at a time. Consequently, the synchronizing pulses from the ring counter stages appear at a 40 CPS rate. These pulses fire a mono-multivibrator (one shot) who's timing period is controlled by potentiometers connected to the control and trim sticks of the transmitter. The timing period of the one shot is applied to a gate, which allows the 4KC signal to pass to the modulator for this timing period. Fig. 2 clearly illustrates the sequence and timing periods of the one shots.

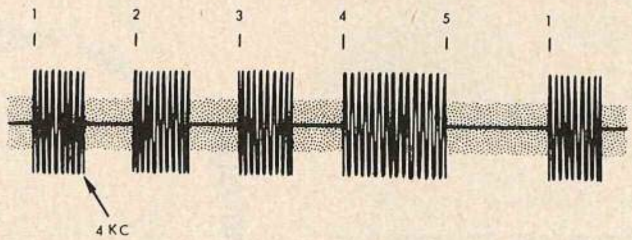

Figure 3. Representation of RF Output (all controls at neutral)

The modulated output of the transmitter is illustrated in Fig. 3. Great care was taken in the design of the modulator and 4KC oscillator to insure perfect sine-wave modulation at 80%. This provides "splatter free" transmitter operation eliminating interference to other R/C units on adjacent frequencies.

Input power to the RF final is .7 watts. The antenna is a base loaded 54" whip. Transmitter is completely transistorized.

Figure 4 is the Block Diagram of the receiver logic network. The superheterodyne receiver employs a forward AGC RF amplifier, mixer, two IF stages, crystal oscillator, detector, and AGC amplifier. Three AGC loops are used to provide a flat output under wide variations of signal strenkth.

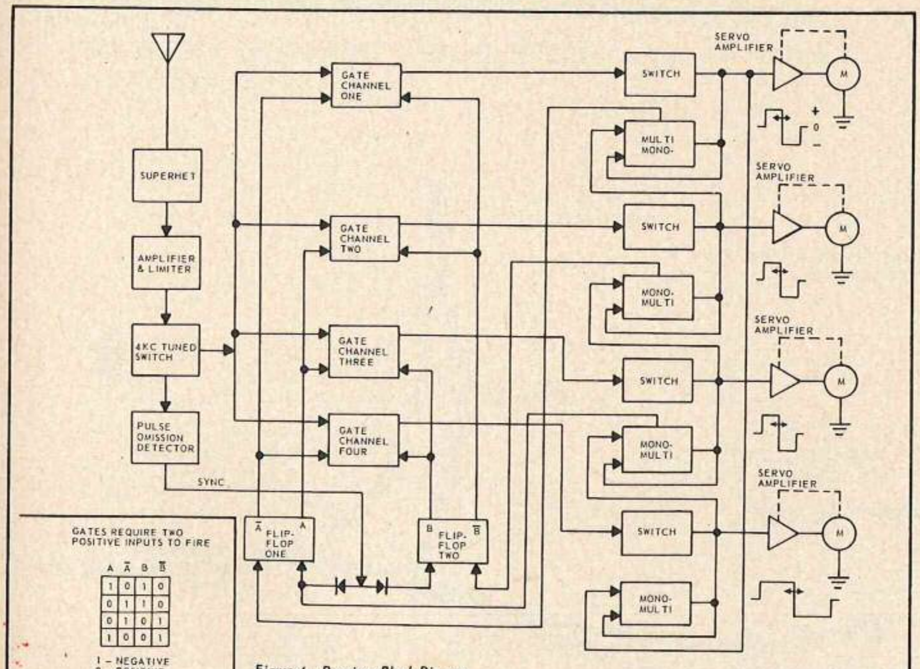

Figure 4. Receiver Block Diagram

The detected output from the receiver is applied to an amplifier and limiter which keeps the signal output at a constant level. The 4KC tuned switch detects the pulsed 4KC subcarrier and applies the resulting square wave pulses to the pulse omission detector and gates. Flip flops 1 and 2 are synchronized to open the gates in order, and in the manner indicated in the logis table. When the gate is open, the proper pulse is passed to the switch, which turns on for a positive time equal to the transmitted 4KC pulse. The negative going trailing edge of the square wave switch output fires a one shot, which provides the negative part of the signal to the servo. The one shot also applies a signal to the flip flop which closes the preceding gate and opens the next gate. The next signal pulse turns off the one shot completing the cycle of information applied to that servo. When the positive and negative pulses, applied to the integrating network of the servos, are equal in length, the input is at ground potential or servo neutral. When a negative or positive inbalance exists, the servo runs until this error signal voltage is cancelled by the feedback voltage.

There is no possibility of interaction between controls in this system. It is completely free from drift, simple to set up, and requires no further adjustment or maintenance. All switching and/or gating is via transistors or diodes. The design is considerably complicated by the 4KC subcarrier. The interference protection provided

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by the subcarrier, however, far outweights its disadvantages.

The mechanical layout of the Kraft system is characterized by a fairly thin transmitter case, allowing easy access to the control sticks with the thumbs. The distance beween the control sticks and the bottom of the case is such that the transmiter can be held against one's stomach while flying. The trim sticks are located for maximum convenience and the over-all balance of the output is excellent.

Control stick functions will be supplied in two optional layouts. One has the elevator and rudder function on the left hand stick, while the right hand stick has aileron and throttle. All functions, except throttle, are spring-loaded to neutral. The throttle control ratchets fore and aft on the aileron stick, allowing the engine speed to be changed without the necessity of removing the hands from other controls. The optional layout has the throttle and elevator controls interchanged so that rudder and throttle are on the left hand stick and aileron and elevator are on the right.

The transmitter battery pack consists of ten 500 mah rechargeable Ni-Cad cells to provide 12 volts. For serviceability, the cells are mounted flat on a phenolic plate which is attached to the inside front of the can. The charger for both receiver and transmitter battery packs is supplied separately in a metal can with suitable connecting plugs.

The receiver is assembled on two printed circuit decks. One deck mounts on the bottom of the .051 aluminum can; the other mounts on a .051 aluminum subchassis. The cover is .025 aluminum. These units together form an extremely strong case.

The wiring cables to the servos and batteries, junction in the receiver, and plugs are prewired to the cables.

The receiver and reference voltage battery pack consists of six 225 mah button cells. Four 500 mah cells furnish power to the servos. Receiver and servo batteries are housed in a single plastic case weighing 6½ ounces.

Manufacturer's specifications for the Kraft Proportional are as follows:

SPECIFICATIONS

RECEIVER: Single conversion crystal controlled superheterodyne with RF stage; has 6 transistors and 2 diodes.

Sensitivity: 5 microvolts for operation of gating circuitry.

Selectivity: −6 db at ± 5KC.

Logic Network: has 28 transistors and 34 diodes.

Can Size: Length 3-3/32"; Width 2-5/32"; Depth 1⅝".

Weight: Complete with all plugs — 6.5 ounces.

Receiver and Servo Battery Pack: Contains 6 —225 mah nickle cadmium cells and 4 —500 mah nickle cadmium cells. Battery life between charging is approximately the same as that of the familiar 10 channel, 5 servo reed installation or over 2 hours. Weight — 6.5 ounces.

TRANSMITTER: RF section has two transistors. Input to RF final is .7 watts. Class B modulator has 4 transistors.

Logic Network: has 23 transistors and 11 diodes.

Antenna: 54" 5 section collapsible whip, base loaded.

Meter. reads battery votage and relative RF output.

Batteries: 10 — 500 mah nickle cadmium cells.

Can size: Height 8⅞"; Width 8⅛"; Depth 2-7/16".

Weight: 3¾ lbs. complete.

Control Layout:

Standard: Elevator and rudder on left hand stick. Aileron and throttle on right hand stick.

Optional: Rudder and throttle on left hand stick, aileron and elevator on right hand stick.

All controls, including throttle, are individually trimmable by four trim sticks.

SERVO AND SERVO AMPLIFIER: 7 transistors, 2 diodes. DC type with output transistors operated at saturated switches. Amplifier is inherently self-neutralizing in absence of error signal. Centering accuracy is limited only by the servo gear train play.

Servo: Assembled from Bonner Duramite parts.

Thrust: 3½ — 4½ lbs.

Operating Temperature Range: Below 0° F to over 140° F without changes in performance characteristics or measurable drift in control positions.

FREQUENCIES AVAILABLE:

26.995 mc	52.950
27.045 mc	53.025
27.095 mc	53.100
27.145 mc	53.175
27.195 mc	53.250

Price: The price includes transmitter, receiver, servos, batteries, and battery charger. All plugs are wired and system comes ready for instalation. $599.95.