July 15, 1958 L. I. DAVIS 2,843,381

AIR WAR GAME

Filed Oct. 6, 1954 5 Sheets-Sheet 1

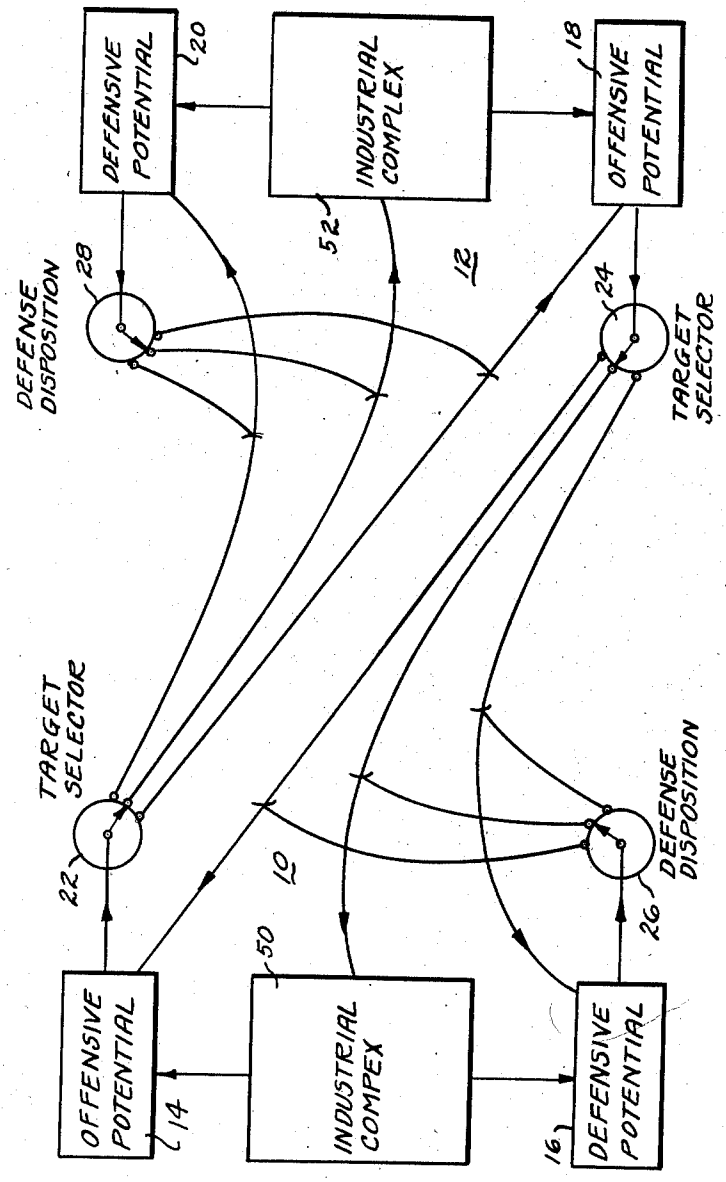


FIG. 1

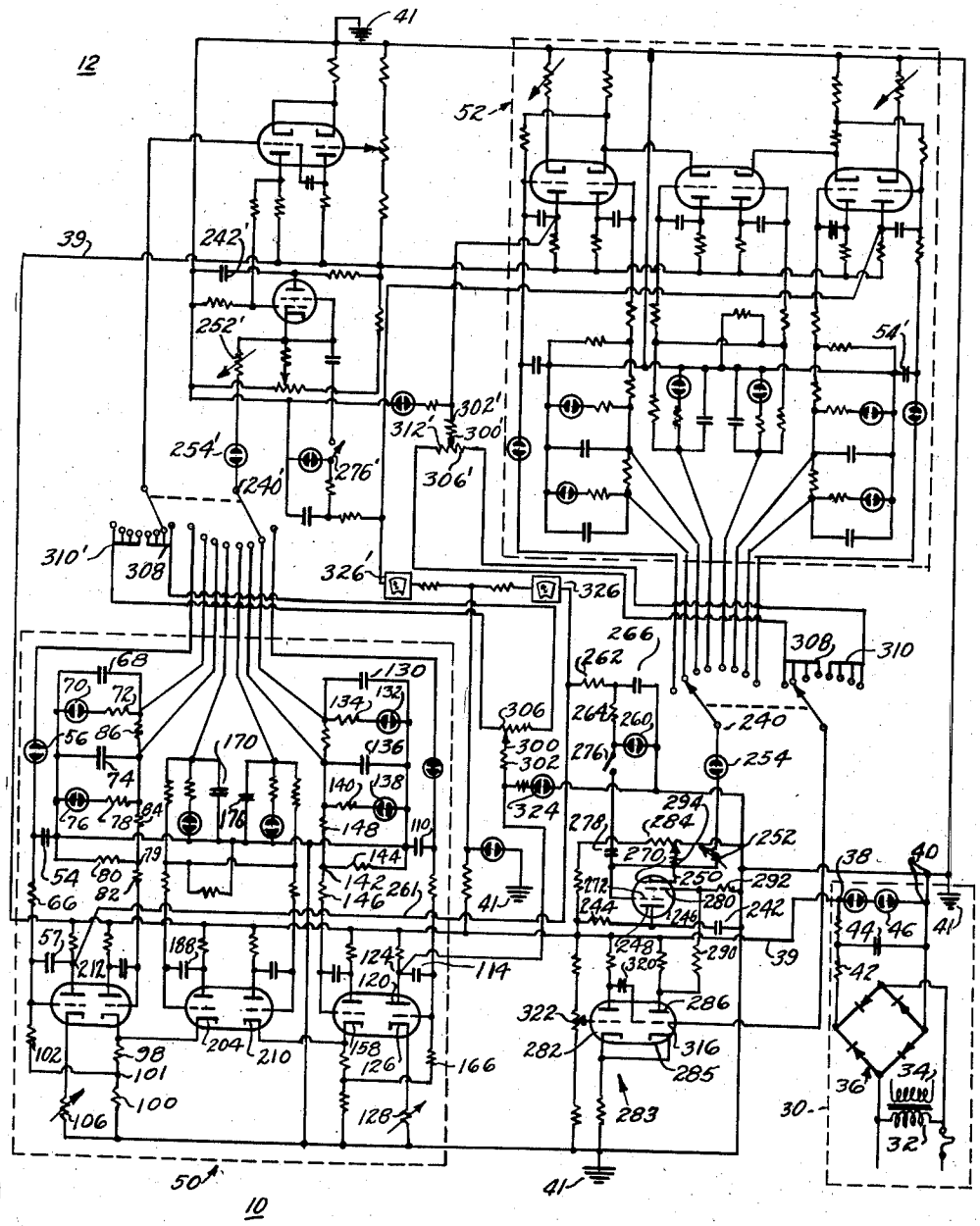
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AIR WAR GAME

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FIG. 2



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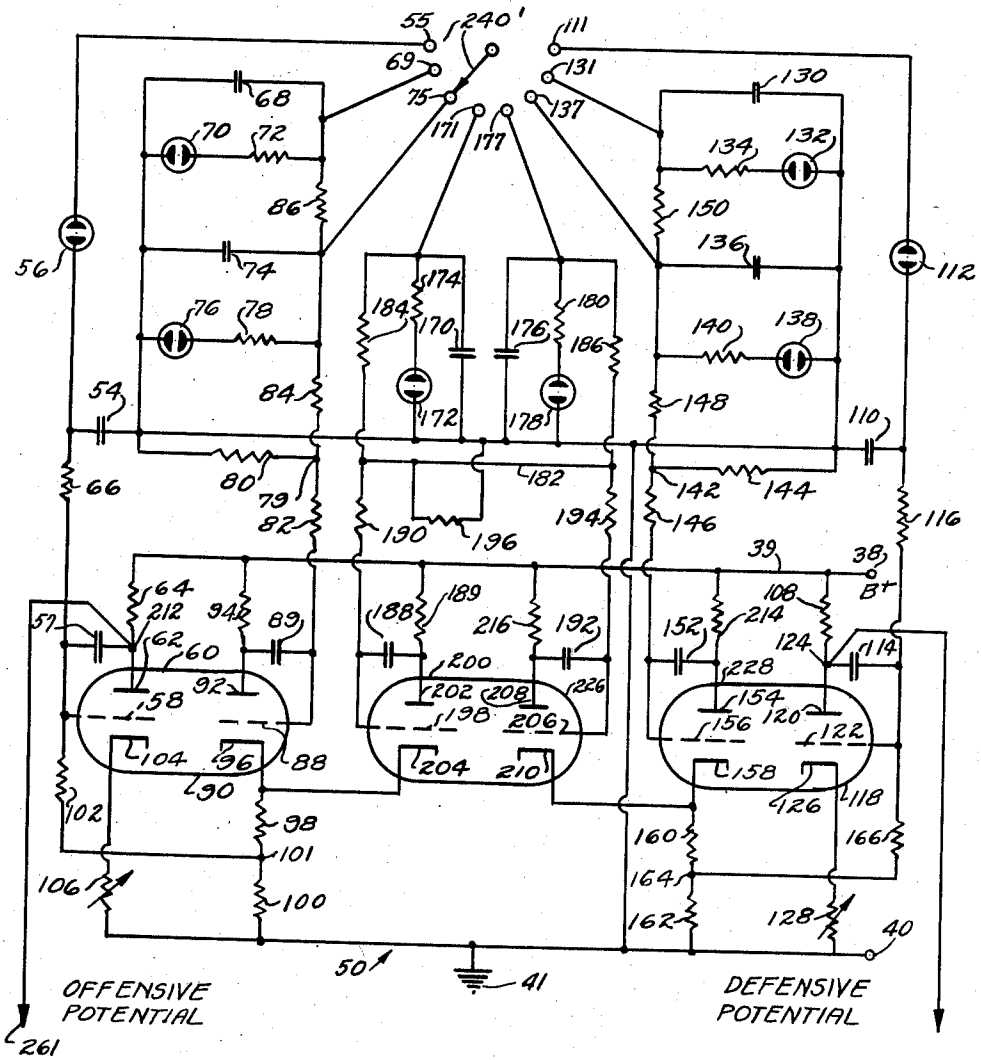
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AIR WAR GAME

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FIG. 3



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AIR WAR GAME

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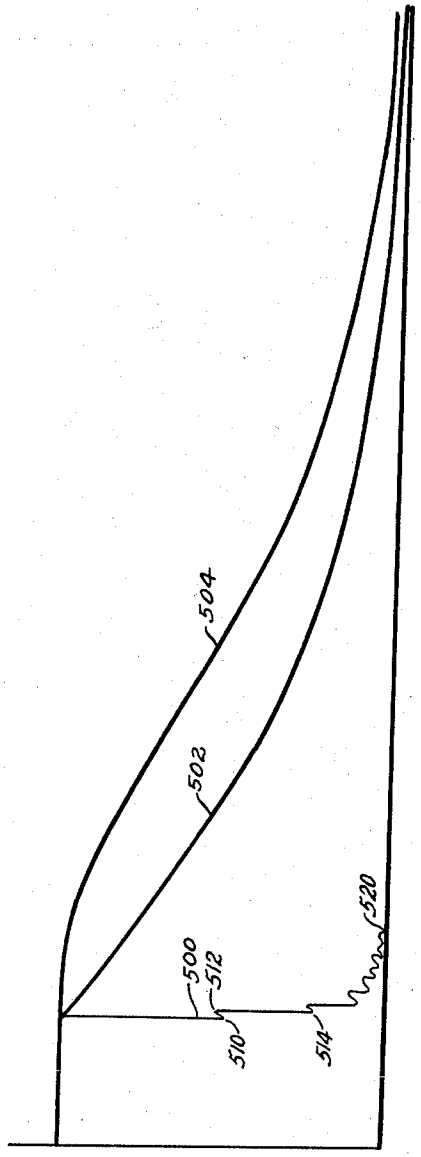


Fig. 4.

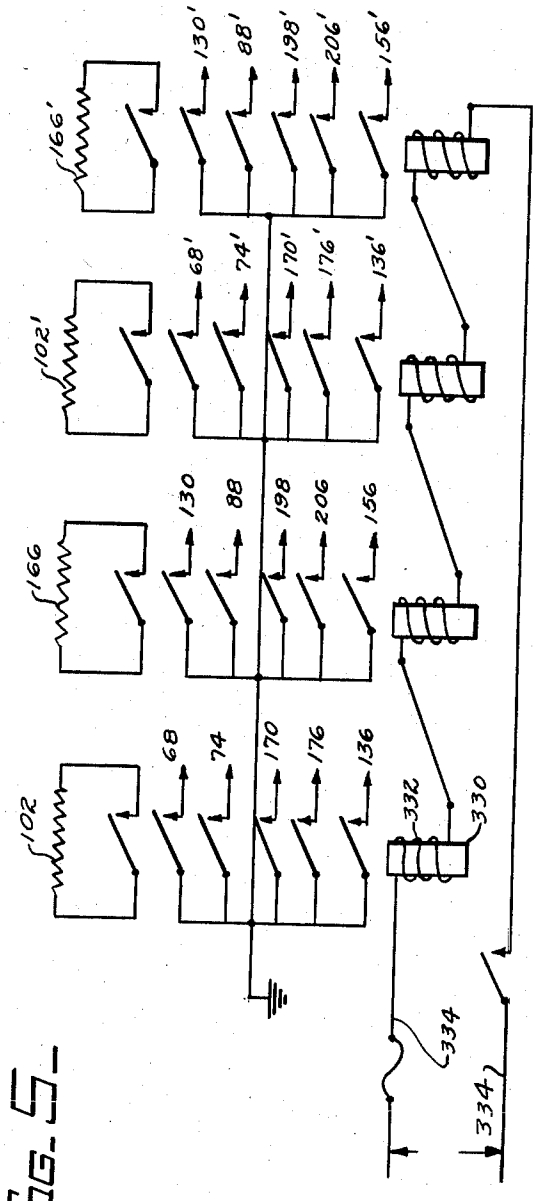


Fig. 5.

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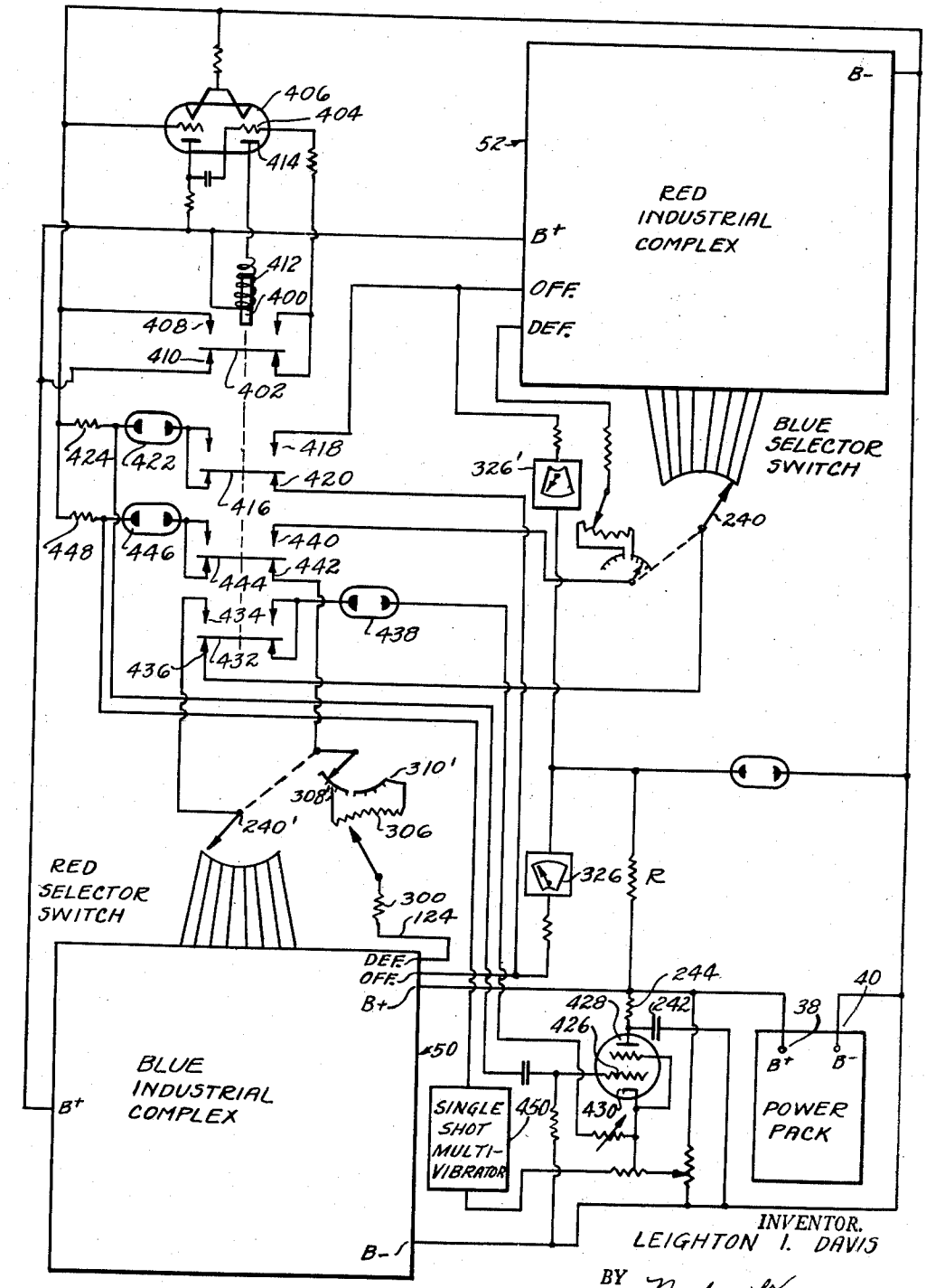


FIG. 6

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United States Patent Office

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AIR WAR GAME

Leighton I. Davis, Annapolis, Md.

Application October 6, 1954, Serial No. 466,783

7 Claims. (Cl. 273—1)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without payment to me of any royalty thereon.

This invention relates to an air-war game and particularly to a game device illustrating the principles of modern warfare in which the protection of your own base and industrial factories is as important as striking enemy targets.

In modern warfare the conflict is not only with the individual armed forces of the contending countries but strikes are directed against the factory components of the warring country in order to eliminate the effective operation of the armed forces.

The present device is an analog of two individual nations at war with the two sides being initially alike as in any game device. The game board, or playing area, is provided with a plurality of assemblies, at least two, representing belligerent nations. Each of these assemblies is provided with an industrial complex and armed forces in being. Each of these assemblies is provided with a plurality of units which simulate or represent the various industries of the country and the armed forces are represented by units which simulate the offensive forces and units which simulate the defensive forces.

Devices are provided in each assembly for directing attacks against the various units or targets of the opposite assembly. Also, each assembly is provided with a defensive mechanism for concentrating the defense potential of the country to protect individual units of the assembly. Certain of the manufacturing units, together with armed forces offensive units will be combined into an offensive system to control the offensive potential of the assembly. Certain other units, together with defense armed units, will be grouped together to provide the defense potential of the assembly. Certain other manufacturing units will be subsidiary to both the offensive and defensive potentials.

In the construction according to the invention, devices are provided for launching an attack against the enemy targets which will be governed in rate of attack by the offensive potential and interceptor devices will be provided which will be operable to intercept and thus defeat the launched attacks. Built-in chance devices are provided so that the opposing players may not mechanically manipulate the devices to substantially prevent successful strikes.

It is accordingly an object of the invention to provide a game simulating the effect of launching a strike on potential enemy targets, military as well as industrial.

It is a further object of the invention to provide a game device simulating the effect of protecting one's own bases and individual factories against enemy strike.

It is a further object of the invention to provide a war game having a speed up of time elements but operating at a duration such that significant decisions such as choice of targets, length of attack and disposition of defense can be logically made during the course of the war game.

It is a further object of the invention to provide a war game having means indicating to the participants the progress of the war.

It is a further object of the invention to provide a war game which provides a definite indication of the end of the war and the winner thereof.

It is a further object of the invention to provide a war game having reliable operation with a minimum of maintenance and adjustment.

Other objects and many of the attending advantages of the invention will be apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

Figure 1 is a schematic illustration of a war game according to the invention;

Figure 2 is a detailed wiring diagram of a war game involving two belligerent countries;

Figure 3 is an enlarged detail showing the arrangement of the target units and the manner of securing offensive and defensive potentialities therefrom;

Figure 4 is a graphic presentation of the effect of enemy strikes upon the offensive potential of one of the belligerents;

Figure 5 is a schematic wiring diagram of a reset adjustment for restoring the game to its initial condition; and

Figure 6 is a schematic diagram of a modified game according to the invention.

In the exemplification of the invention according to Figures 1 to 5, the game is laid out with a pair of assembly sections **10** and **12**, each section having an industrial complex **50** or **52** with the industrial complex **50** providing the offensive potential **14** and the defensive potential **16**. Likewise the industrial complex **52** provides the offensive potential **18** and the defensive potential **20**.

The offensive potential **14** is connected to a target selector device **22** and the offensive potential **18** is connected to a target selector device **24**. It will thus be seen that the offensive potential may be connected by means of target selectors **22** and **24** to the various composite portions or targets of the opposed assembly.

Defensive potential **16** is connected to an interceptor switch **26** which is operable to intercept any attacks or potential strikes launched by the target selector **24** and the defense potential **20** is connected to an interceptor switch **28** which is likewise provided with interceptor means for intercepting strikes launched by the target selector **22**.

In the detailed arrangement shown in Figure 2, power pack **30** contains a transformer device **32** having a secondary winding **34** for supplying filament potential to the various tube devices utilized in the game. A rectifying device **36** is connected across the terminals of transformer **32** and provides a positive terminal **38** to which is connected positive bus **39** and a negative terminal **40** to which is connected a low impedance ground return **41**, with a potential at the terminals **38** and **40** being stabilized by means of a filter containing a series impedance **42** and a shunt capacitor **44**, the value of the potential at the terminals **38** and **40** being maintained at a predetermined voltage, such as 210 volts, by means of voltage regulating tubes **46**.

The opposed assembly sections **10** and **12** are provided with complexes **50** and **52** respectively each including a combination of units representing industrial components and the armed forces to provide offensive potentials and defensive potentials proportional to the effective condition of the components. Each of the complexes **50** and **52** are identical and contain a plurality of units corresponding to, or simulating, the various industrial factories or plants, of the country. A first group of industrial units is combined with the offensive armed forces

units to control the offensive potential of the section. Likewise, a second group of industrial units is combined with the defensive armed forces to control the defensive potential of the section. A secondary group of industrial units will modify both the offensive and defensive potentials of the section.

The offensive armed forces in being, such as bombers, bomber bases and the like, are simulated by a variable electric storage device, such as, the capacitor 54. A plurality of prime industrial units supporting the offensive forces, such as, bomber factories, munitions assembly plants and the like, are simulated by capacitors 68 and 74.

The defensive armed forces in being, such as, interceptors, fighter bases, and the like, are simulated by a capacitor 110. Further prime industrial units supporting the defensive forces, such as arsenals, fighter factories and the like are simulated by capacitors 130 and 136.

Industrial plants supporting both the offensive and defensive forces, such as, food processing plants, oil refineries, rail yards, automobile factories and the like, are simulated by capacitors 170 and 176.

An "offensive" potential simulating the condition of the offensive forces is provided primarily in dependance on the electrical condition of the group of capacitors 54, 68 and 74 simulating the offensive forces in being and the industries most closely associated therewith. Likewise, a "defensive" potential simulating the condition of the defensive forces is provided primarily in dependance on the electrical condition of the group of capacitors 110, 130 and 136 simulating the defensive forces in being and the industrial support therefor.

Both potentials may be modified by the electrical condition of the group of capacitors 170 and 176 simulating the industrial plants contributing to both the offensive and defensive forces.

The magnitude of the "offensive" potential determines the rate at which a player may attack his opponent. The magnitude of the "defensive" potential determines the percentage of attacks that can be intercepted.

To simulate the long term effects of bombing and the like, an "offensive" potential is derived from positive bus 39 by means of a Miller integrating circuit (See MIT Radiation Laboratory Series, Electronic Instruments, pp. 80–81) including a main integrator and primary and secondary biasing integrators utilizing feedback to secure long term response.

The main integrator consists of a triode 60 having an anode 62 connected to the bus 39 by an impedance 64, a cathode 104 connected to ground return 41 by a variable bleeder impedance 106, a control grid 58 connected to point 212 between impedance 64 and anode 62 by feedback capacitor 57. Grid 58 is connected to ground return 41 through integrating impedance 102 and biasing impedance 100. Control capacitor 54 is connected between ground return 41 and grid 58 and feedback capacitor 57 by regulating impedance 66.

The primary biasing integrator consists of a triode 90 having an anode 92 connected to bus 39 by impedance 94, a cathode 96 connected to ground return 41 by series-connected impedances 98 and 100. A grid 88 is connected to anode 92 by feedback capacitor 89 and to ground return 41 by the voltage divider consisting of impedances 80 and 82 having an intermediate tap 79. Control capacitor 74 is connected to tap 79 by timing impedance 84 and capacitor 68 is connected to tap 79 by impedances 86 and 84.

A charge limiting circuit including glow-lamp 70 and impedance 72 is connected in shunt with capacitor 68 and a similar charge limiting circuit including glow-lamp 76 and impedance 78 is connected in shunt with capacitor 74.

The secondary biasing integrator consists of the triode 200 having anode 202 connected to bus 39 by impedance 189, cathode 204 is connected to ground return 41 over impedances 98 and 100 so that the current flow in both triodes 90 and 200 is combined in biasing impedance 100. Grid 198 is connected to anode 202 by feedback capacitor 188 and to ground return 41 by the voltage divider constituted by impedances 190 and 196 having an intermediate connection 182. Capacitor 170 is connected between ground return 41 and connection 182 by timing impedance 184.

A charge limiting circuit including glow-lamp 172 and impedance 174 is connected in shunt with capacitor 170.

Assuming that the system is deenergized either by allowing time to dissipate the energy or by short circuiting as will presently be described, the initial condition is obtained by energizing the supply to establish a potential of the order of 210 volts between bus 39 and ground return 41. The triodes 60, 90 and 200 will become conductive and impedance 106 will establish a minimum potential at point 212, also the combined currents of triodes 90 and 200 will establish a positive bias voltage at point 101. Simultaneously feedback capacitors 57, 89 and 188 will begin charging. Feedback capacitor 188 is charged by the potential of anode 202 in a time determined primarily by the impedances 190 and 196 plus a transient charge applied to capacitor 170 over impedance 184. At termination of the starting transient grid 198 will be at ground potential and current through triode 200 at a minimum. Likewise feedback capacitor 89 will charge to the potential of anode 92 at a time determined by impedances 82 and 80 and the transient charges of capacitors 68 and 74 to reduce grid 88 to ground potential and current through triode 90 to a minimum. This produces a minimum bias at point 101 which is integrated with the charge of feedback capacitor 57 by integrating impedance 102. Capacitor 54 will charge over impedance 66 to the potential of point 101 so that grid 58 is at the potential of point 101 and current through triode 60 is a minimum and potential of point 212 is raised to a maximum (of the order of 120 volts).

The defensive potential is likewise derived from bus 39 by means of an integrating circuit including a main, a primary biasing and a secondary biasing integrator.

The main defensive integrator consists of a triode 118 having an anode 120 connected to bus 39 by impedance 108, a cathode 126 connected to ground return 41 through bleeder impedance 128 and a grid connected to point 124 between anode 120 and impedance 108 by feedback capacitor 114 and to ground return 41 by integrating impedance 166 and biasing impedance 162. Control capacitor 110 is connected to feedback capacitor 114 and grid 122 by timing impedance 116.

The primary defensive biasing integrator consists of triode 228 having anode 154 connected to bus 39 by impedance 214, a cathode 158 connected to ground return 41 by impedance 160 and biasing impedance 162 and grid 156 connected to anode 154 by feedback capacitor 152 and to ground return 41 by the voltage divider composed of impedances 146 and 144 having a tap 142. Control capacitor 136 is connected to tap 142 through timing impedance 148 and capacitor 130 is applied through impedances 148 and 150.

A charge limiting circuit including glow-lamp 132 and impedance 134 is connected in shunt with capacitor 130. Likewise, a charge limiting circuit including glow-lamp 138 and impedance 140 is connected in shunt with capacitor 136.

The secondary defense biasing integrator consists of the triode 226 having an anode 208 connected to bus 39 by impedance 216, a cathode 210 connected to ground return 41 over impedances 160 and 162 and a grid 206 connected to anode 208 by feedback capacitor 192 and to ground return 41 over the voltage divider constituted by impedances 194 and 196 having the intermediate conductor 182.

Control capacitor 176 is connected to conductor 182 over timing impedance 186 and a charge limiting circuit

including glow-lamp 178 and impedance 180 is connected in shunt with capacitor 176.

The defense integrator circuit operates in the same manner as the offense integrator circuit to provide a defense potential varying from a minimum of the order of 60 volts to a maximum of the order of 120 volts.

Impedance 196 is common to both grids 198 and 206 so that triodes 200 and 226 both conduct whereby the secondary plants affect both defense and offense.

Capacitor 54 is connected through glow-lamp 56 to selector contact 55 which may be selectively engaged by opponents' strike switch 240 to simulate an "enemy" strike by applying a charge to capacitor 54. Similarly, capacitor 68 is connected to contact 69, capacitor 74 to contact 75, capacitor 170 to contact 171, capacitor 176 to contact 177, capacitor 136 to contact 137, capacitor 130 to contact 131 and capacitor 110 through glow-lamp 112 so that the operator of switch 240' may direct a strike against any unit of the complex. Obviously, the values of the capacitors and impedances are selected to produce time relations comparable with the rating of the unit simulated by the particular capacitor system. Since the potential providing assemblies of each of the simulated countries are identical, it will be unnecessary to apply reference characters to the individual complexes as it will be understood that each of the complexes are identical in construction and operation.

Each of the simulated nations is provided with a strike launching device including selector switches 240 and 240' by which strikes may be launched at the various target units. Each of the strike launching devices is indicated as a capacitor 242 which will be maintained in charged condition from the positive terminal 38 through bus 39 and an impedance 244. The capacitor 242 is discharged through selector device 240 by means of a thyratron 246 having a plate 248 connected to the capacitor 242 and a cathode 270 connected to the selector device 240 by means of a variable impedance 252 and a glow lamp 254.

The voltage that represents offensive potential is used to control the rate at which strikes are launched at the enemy. By assuming uniformly potent unit strikes, the effect of the size of the armed force in being is simulated by making the strike launching rate proportional to the offensive potential. This approximation greatly simplifies the circuit design, because the plate potential of 62 can be easily adjusted to 60 volts with respect to terminal 40 at the lower end of its excursion by cathode potentiometer 106 in Fig. 3. This plate voltage, applied to a neon bulb 260 through the network composed of lead 261, impedances 262 and 264 and capacitor 266 produces a saw tooth wave form with a steep negative front. At the upper end of the plate excursion, about 120 volts, the bulb 260 will fire about once a second. At the lower end, it will not fire at all, representing a loss of offensive potential.

The waveform, differentiated by the coupling capacitor-resistor combination, is applied to the cathode 270 of the thyratron 246. When the grid 272 of the thyratron 246 is at the proper level, this pulse will cause the thyratron tube 246 to ionize or fire, discharging capacitor 242 through neon bulb 254 and the variable resistance 252 to the target capacitor selected by switch 240.

Capacitor 242 is charged to 210 volts from positive terminal 38 through resistor 244. The neon bulb 254 serves to block the flow of current to and from the target capacitor except when the thyratron 246 fires. Variable resistance 252 serves to limit the current discharge and is used as a fine control on target damage per unit strike.

The launching switch or key 276 can be placed before or after the combination of capacitor 266 and neon bulb 260. Placed before the combination, the time required to charge the capacitor 266 simulates a delay between launching a strike and arrival at the target. Placed after the combination (between capacitor 266 and the cathode 270 of thyratron 246) the rate of flashing of neon tube 260 serves as a measure of the strength and readiness of the offensive force in being. In most operations it will be desirable to launch strikes at the maximum rate possible, in which case the key 276 may be closed, leaving the hands free to manipulate fighter defenses and target selector switches. The grid 280 of thyratron 246 is driven by the plate 286 of cathode-coupled multi-vibrator (282 and 283 in Fig. 2) through voltage-dividing resistors 290 and 292. The cathode 270 of 246 can be adjusted to the proper level by resistor 284. A negative pulse from the multivibrator drives the grid 280 negative and prevents the negative pulse on the cathode 270 from firing the thyratron 246. The negative signal on the grid 280 represents interception of the strike and is accordingly controlled by the strength and disposition of enemy defenses.

The circuits that accomplish control of defenses are also shown in Fig. 2. Enemy defensive potential is applied to the moving arm 300' on the enemy control panel through resistor 302'. The ends of potentiometer 306' are connected to the second deck of gang switch 240 one side to the first four contacts 308 and the other side to the other four 310.

The first deck of the gang switch 240 is the target selector switch of the friendly team. Accordingly, selection of targets 54', 68', 74', or 170' picks up the end 312' of the potentiometer 306' and places a resistance in the circuit that is determined by the setting of potentiometer 306'. The enemy defensive potential is thus connected to the multivibrator 283 constituted by triodes 282 and 284 through resistor 302' and potentiometer 306'. This circuit resistance affects the percentage of time that valve 285 is conducting.

When valve 285 is conducting, the plate 286 is at the lower level and the grid 280 of the thyratron 246 is too low to allow the tube 246 to fire. This, then, is the intercept condition. On the other hand, when the enemy defensive potential is low (60 volts), the grid 316 of 285 is below the cathode potential, and 285 is cut off. Under this condition the plate 286 remains at a high level and the voltage impressed on the grid 280 of the thyratron 246 is at such a level that a negative pulse on the cathode 270 will cause it to fire.

The defensive potential furnished by the industrial complex varies between 60 and 120 volts. At 120 volts, with optimum circuit values, the plate 286 will dwell about 50 percent of the multivibrator period in the down or no-go position when the sole circuit resistance between defensive potential and multivibrator is 300'. If the enemy guesses wrong and has placed his interceptors on the other side of the industrial complex (full potentiometer resistance in series with resistor 300') the plate 286 will dwell only about 15 percent of the time in the no-go position.

For values of the defensive potential between 60 and 120 volts and for different settings of potentiometer 306, the percentage of the time that the multivibrator will prevent the thyratron 246 from firing is determined by the time required for the defensive potential to charge capacitor 320 through resistor 300 and potentiometer 306. Here potentiometer 322 places the cathode of valve 282 in the proper operating range and provides a fine control for adjusting the no-go dwell time. The multivibrator operates at about 20 C. P. S. as an average. This circuit provides a chance element that cannot be outguessed by manually closing the strike key.

At the beginning of the game all the control capacitors will be discharged to minimum value either by allowing sufficient time to elapse to dissipate the charges or, preferably, by shorting the various elements as will be described hereinafter.

The triodes will then carry minimum current and glow-lamp 260 will flash rapidly indicating full offensive potential while glow-lamp 324 will glow brightly in-

dicating full defensive ability. At a predetermined signal the rival players begin actuating the selectors **300**, **300'**, **276**, **276'**; **240** and **240'** both to dispose the offensive potential to direct strikes, as simulated by the charges on capacitors **242** and **242'**, against opponents' targets and to protect their own complexes. Assuming that the operator of section **12** has closed switch **276'** and engaged selector switch **240'** with contact **55** while the operator of section **10** has guessed wrong with potentiometer **306**, then a successful strike destroying a portion of the bomber force or base will be simulated by the application of a charge to capacitor **54**. The success of the strike will be indicated by a flash of glow-lamps **56** and **254'**. The destruction of a portion of the offensive forces of course reduces the offensive potential and this is simulated by the integrator in that the charge on capacitor **54** is impressed on grid **58** and feedback capacitor **57** through impedance **66** to raise the grid potential to increase current in triode **60** and reduce the potential at point **212**. The degree of charge and the values of timing impedance **66** and integrating impedance **102** interacts with feedback capacitor **57** to determine the rate of decrease and recovery of the offensive potential. Successive strikes before the recovery is complete further reduces the offensive potential until the accumulation strikes indicating practical destruction of the offensive forces would directly reduce the offensive potential to the minimum. The reduction in offensive potential is directly responsive to the reduction of offensive forces or of first order of response.

If a strike is made on a prime industry such as a bomber factory the strike would slow down the production rate and reduce the offensive potential but not at as direct a ratio as would the destruction of a part of the offensive forces. This is simulated by applying a charge to capacitor **68**. The charge on **68** will be applied to point **79** and over impedance **82** to grid **88** and feedback capacitor **89**. The increase in potential of grid **88** increases current flow through triode **90** and a resultant voltage drop across impedance **100**. The increased potential at point **101** is applied to grid **58** and feedback capacitor **57** by integrating impedance **102** causing an increase of current in triode **60** and a reduction in offensive potential at point **212**. Successive strikes still further increase the potential applied to grid **88** resulting in further reduction in offensive potential. If sufficient strikes are accomplished to completely destroy the bomber factory the failure of delivery of bombers would eventually reduce the offensive potentail to a minimum. This is simulated when successive charges have fully charged capacitor **68**. The complete destruction of the bomber factory would be indicated by glow-lamp **70** as the discharge circuit limits the charging of capacitor **68**.

The reduction of offensive potential by completely destroying a prime industry is illustrated in Figure 4. The first strike would reduce the production rate **500** a distinct amount as shown at **510**, then recovery would start as shown at **512**, and a second strike would lower production a further amount as indicated at **514**, continued strikes would still further reduce the production rate until at **520** the factory is completely destroyed. Because of inventory, emergency procurement and the like the combined output **502** will fall at a slower rate than production. The failure of replacements and the like will reduce the offensive potential as indicated at **504**. Since the reduction is indirect and consequential the response is roughly second order as compared to the first order response caused by destruction of the offensive forces. If a time scale is assumed such that one second represents one day and bombing the actual target will reduce the effectiveness of the enemy forces in being by one-half in six months. Then time to the half point is about 180 seconds when the simulated target is charged at a rate of six times per minute.

Inasmuch as this is a game intended for the entertainment of the players, means for displaying the progress of the contest are important. The neon bulbs at the target capacitors glow when the target is charged to the destroyed condition.

Neon bulb **260** flashes at a high rate when the offense is at a high level, and barely flashes when the striking force is low. Bulb **324** serves to indicate by its brightness the level of the defensive potential. Bulb **254** in the discharge circuit glows with an arc-type discharge each time that a launched strike penetrates the enemy defense. In addition, meters **326** and **326'** are provided to indicate to each side the level of its own offensive potential.

Because of the long time constants, resetting of initial conditions would be lengthy but for the resetting relay arrangement shown in Fig. 5. These relays were made up from four multicontact relays **330** with 30-volt coils **332**. Connecting the four in series across the 117-volt line **334** gives adequate voltage to actuate the relays. The grounding contacts are used to ground target capacitors and the grids of discharge devices controlling the potentials of each side. The remaining pairs of contacts short integrating resistors **102** and **166** and their corresponding numbers on the other side.

Assuming that adjustment and calibration have been completed, find a prospective opponent, and start learning the game together. First, try the following three contests, resetting after each:

(1) Red attacks taget **54**, and Blue attacks target **68'**;

(2) Red attacks target **54** ninety percent of the time and target **68** ten percent, while Blue attacks target **68'**;

(3) Red attacks target **54** ninety percent of the time and target **68** ten percent, while Blue attacks target **170'** fifty percent and target **176'** fifty percent.

These plans of attack should illustrate that in this game the primary target to attack is the enemy offensive potential and the primary object to defend is your own offensive potential. By stretching the imagination, target **54** can be strategic bomber or missile bases; target **68** some element of basic industry, say aluminum or steel plant; target **74** bomber or missile assembly plants; targets **170** and **176** some assential commodity common to both offense and defense, such as gasoline and oil; target **136** more basic industry; and target **110** interceptor or defensive missile bases.

Since some of the games may be long drawn out, it is useful to establish a criterion of winning. When one side is below 10 percent of its offensive potential and the other is twice as great and increasing the contest can be declared at an end, the winner being the one with the greater offensive potential. Another criterion might be to declare as winner the side that can keep the opponent's strike and defense neon bulbs from flashing.

The game as laid out in this design is meant to produce, with a minimum of parts, a device that will entertain players and illustrate a few basic principles in the employment of air power. The values chosen have little relation to the specifics of any engagement with a possible enemy of the United States. No attempt is made to simulate combat loss effects except to say that each side suffers losses in proportion to the amount of its force in being, the loss rate being the same on each side. Transportion, power, and many other types of targets are not represented in the industrial complex. The important principles of war—offensive, concentration, mass and security—are illustrated and emphasized by the dynamics of an engagement speeded up many fold.

The problem of achieving balance between the two sides of the game is complicated by the lack of uniformity between the neon bulbs which are used to convert potential to rate. One solution to this problem is careful selection and aging of the bulbs to be used in the critical circuits. Another solution is apparent

when one analyzes the problem and realizes that the only components which have to be unique and separate are the memory or integrating circuits; and, of course, the manual controls. The solution is to provide common circuits for the conversion of potential to rate, and rate to strike strength; i. e., the voltage pulse that is generated at a rate determined by the offensive potential can be converted to a charge delivered in the form of a current pulse by a conversion unit common to both sides. Circuits designed to accomplish this are shown in Figure 6.

A four pole double throw relay 400 is arranged to sample alternately the two sides. The first switch 402 of the relay 400 alternately connects the grid 404 of a multi-vibrator 406 to a positive terminal 408 and a negative terminal 410. The relay 400 being driven by a coil 412 connected between the positive terminal 38 and an anode 414 of the multi-vibrator 406.

The contacts 408—410 of the relay 400 are used to cause the relay 400 to shift from one side to the other at about ½ cycle per second. Relay 400 when closed moves switch 402 against negative contact 408 to apply negative potential to grid 404 to terminate current flow in coil 412 and allow relay 400 to open to engage switch 402 with contact 410 to apply positive potential to grid 404 and restore current flow in coil 412.

The second switch 416 and a set of contacts 418 and 420 samples alternately the Red and the Blue offensive potentials, connecting them to a neon bulb 422. The positive pulse generated across the series resistor 424 is imposed on the grid 426 of a thyratron tube 428. The thyratron 428 will fire if the cathode 430 is not driven positive by a blanking pulse from the defense circuits. When it fires, the pulse is transmitted to the proper target selector switch 240 or 240′ by the fourth switch 432 and a set of contacts 434 and 436 and neon tube 438. The defensive potentials of the belligerents are supplied to contacts 440 and 442 and are alternately sampled by switch 444. The defensive potentials are converted to rate by common neon tube 446 and series resistor 448, as depicted in Figure 6, and the pulses are furnished to a "one shot" multi-vibrator 450 constituted by first and second triodes. This is not a free running multi-vibrator, the dwell time of the state of the output plate being controlled by the defensive potential. In this circuit, Figure 6, the normal state of the multi-vibrator 450 is such that the voltage transferred to the cathode 430 of the thyratron 428 would allow a positive pulse on the grid 426 to fire the thyratron 428. A positive pulse generated by neon tube 446 firing through the series resistor 448 causes the "one shot" multi-vibrator 450 to transmit a positive square pulse to the cathode 430 of the thyratron 428, blanking any firing pulse from the offensive circuit. The dwell time of the multivibrator 450 is constant, determined by an RC time constant in the grid drive of the second triode. This "dwell time" is chosen so that it is 50% of the time between pulses generated by 446 at maximum defensive potential. As the defensive potential falls, the time between actuating pulses increases and the ratio between the time duration of the blanking pulse and the time duration of the normal condition decreases. When the defensive potential falls below the point at which the neon bulb 446 will fire all offensive pulses delivered to the grid 426 of the thyratron 428 will cause it to fire.

The sampling rate of the relay must be chosen with due regard to the other rates characteristic of the game. In this game, the maximum rate of launching strikes is one cycle per second. As the offensive potentials decrease, the time between strikes increases. Therefore, the sampling rate was chosen faster than the maximum launching rate, or one-half cycle per second. The pulse rate derived from the defensive potentials was chosen to be about twenty times the sampling rate, at maximum defensive potential, in order to remove the multi-vibrator from the influence of any coupling with the relay.

For purpose of exemplification particular embodiments of the invention have been shown and described according to the best present understanding thereof. However, it will be apparent that many changes and modifications in the arrangement and construction of the parts thereof may be resorted to without departing from the true spirit and scope of the invention.

What I claim is:

1. An air war game comprising a game assembly divided into a plurality of symmetrical sections, each of said sections including a plurality of electric storage devices, a selector switch operable to be connected to any storage device of an opposed section, a charge forming device, an electric discharge device operable to control flow of a charge from said charge forming device to said selector switch, a first and second control means for said discharge device, said storage devices being connected into a first and a second group, a first circuit means deriving a first potential dependent on the electrical condition of the storage devices of said first group, a first control circuit means responsive to said first potential for impressing control potential on said first control means, a second circuit means deriving a second potential responsive to the electrical condition of the storage devices of said second group, a second control circuit means responsive to said second potential for impressing control potential on said second control means of the opposed section.

2. An air war game comprising a game assembly divided into a plurality of symmetrical sections, each of said sections including a plurality of electric storage devices, said storage devices being connected into a first group and a second group, a source of electric energy, a first circuit means energized from said source and operative to derive a first potential dependent on the electrical condition of the storage devices of said first group, a second circuit means energized from said source and operative to derive a second potential dependent on the electrical condition of the storage devices of said second group, a charge receiving means charged from said source, a selector switch operable to connect said charge receiving means to any storage device of an opposed section, an electric discharge device controlling current flow from said charge receiving means to said selector switch, a first and a second control means for said discharge device, a first control circuit means responsive to said first potential for impressing control potential on said first control means and a second control circuit means responsive to said second potential for impressing control potential on said second control means of the discharge device of the opposed section.

3. An air war game comprising a game assembly divided into a plurality of symmetrical sections, each of said sections including a plurality of electric storage devices, said storage devices being connected into a first group and a second group, a source of electric energy, a first circuit means energized from said source and operative to derive a first potential dependent on the electrical condition of the storage devices of said first group, a second circuit means energized from said source and operative to derive a second potential dependent on the electrical condition of the storage devices of said second group, a capacitor, means for charging said capacitor from said source, a selector switch operable to connect said capacitor to any storage device of an opposed section, an electric discharge device controlling current flow from said capacitor to said selector switch, a first and a second control means for said discharge device, a first control circuit including a saw tooth wave generator energized by said first potential for impressing control impulses on said first control means and a second control circuit including a multivibrator for applying control impulses proportional to said second potential of the opposed section on the second control means of the discharge device.

4. An air war game comprising a game assembly arranged in opposed equal sections, each section including a plurality of electric storage devices, said storage devices being connected into a first and a second group, a source of electric energy, a first circuit means including a controlled electric discharge means energized from said source, said first circuit means being operative to derive a first potential, a control element for said first circuit means, circuit means responsive to the electrical condition of the storage devices of said first group for impressing control potential on the control element of said first circuit means, a second circuit means including a second controlled electric discharge means energized from said source, said second circuit means being opertive to derive a second potential, a control element for said second circuit means, circuit means responsive to the electrical condition of the storage devices of said second group for impressing control potential on said control element for said second circuit means, a capacitor, connections for charging said capacitor from said source, a selector switch operable to connect said capacitor to any storage device of an opposed section, and electric discharge device controlling current flow from said capacitor to said selector switch, a first and a second control means for said discharge device, a first control circuit means responsive to said first potential for impressing control pulses on said first control means and a second control circuit means responsive to said second potential from the opposed section for impressing intermittent control potential on said second control means.

5. An air war game comprising a game assembly divided into a plurality of symmetrical opposed sections, each of said sections including a plurality of electric storage devices, said storage devices being connected into a first group and a second group, a source of electric energy, a first circuit means including a first discharge path energized from said source and operative to derive a first potential, a control electrode in said discharge path, circuit means responsive to the electrical condition of the storage devices of said first group for impressing a control potential on said electrode, a second circuit means including a second discharge path energized from said source and operative to derive a second potential, a control electrode in said second discharge path, circuit means responsive to the electrical condition of the storage devices of said second group for impressing a control potential on said second mentioned control electrode, a charge receiving means, connections for charging said charge receiving means, from said source, a selector switch operable to connect said charge receiving means to any storage device of an opposed section, an electric discharge device controlling current flow from said charge receiving means to said selector switch, said discharge device including an anode, a cathode and a control electrode, a first control circuit means responsive to said first potential for impressing control potential on said cathode and a second control circuit means responsive to said second potential of the opposed section for impressing intermittent control potential on said control electrode of said discharge device.

6. An air war game comprising a game assembly divided into a plurality of symmetrical opposed sections, each of said sections including a plurality of electric storage devices, said storage devices being connected into a first group and a second group, a source of electric energy, a first circuit means including a first controlled discharge path energized from said source and operative to derive a first potential, said path including an electronic tube having a grid in controlling relation to said path, circuit means responsive to the electrical condition of the storage devices of said first group for impressing a control potential on said grid, a second circuit means including a second controlled discharge path energized from said source and operative to derive a second potential, said path including an electronic tube having a second grid in controlling relation to said second discharge path, circuit means responsive to the electrical condition of the storage devices of said second group for impressing a control potential on said second mentioned grid, a charge receiving means connected to be charged from said source, a selector switch operable to connect said charge receiving means to any storage device of an opposed section, an electric discharge device controlling current flow from said charge receiving means to said selector switch, a first and a second control means for said discharge device, a first control circuit means responsive to said first potential for impressing control potential on said first control means and a second control circuit means responsive to said second potential of the opposed section for impressing control potential on said second control means of the discharge device.

7. An air war game comprising a game assembly divided into a plurality of symmetrical sections, each of said sections including a plurality of electric storage devices, said storage devices being connected into a first group and a second group, a source of electric energy, a first circuit means energized from said source and operative to derive a first potential dependent on the electrical condition of the storage devices of said first group, a second circuit means energized from said source and operative to derive a second potential dependent on the electrical condition of the storage devices of said second group, a capacitor, means for charging said capacitor from said source, a selector switch operable to connect said capacitor to any storage device of an opposed section, a controlled electric discharge device interposed between said capacitor and said selector switch, a first and a second control means for said discharge device, a first control circuit means responsive to said first potential for impressing control potential on said first control means and a second control circuit means responsive to the second potential of an opposed section for impressing control potential on said second control means of said discharge device.

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