

PATENT SPECIFICATION

(11) 1213617

DRAWINGS ATTACHED

- (21) Application No. 4584/69 (22) Filed 28 Jan. 1969
 (31) Convention Application No. P 16 22 323.7
 (32) Filed 1 Feb. 1968 in
 (33) Germany (DT)
 (31) Convention Application No. P 16 22 325.9
 (32) Filed 7 Feb. 1968 in
 (33) Germany (DT)
 (45) Complete Specification published 25 Nov. 1970
 (51) International Classification G 03 b 15/05
 (52) Index at acceptance
 G2A 1H 1K1 1KY
 H2H 14 2B7



(54) DISCHARGE FLASH TUBE ARRANGEMENT

- (71) We, FRANKE & HEIDECKE, G.m.b.H., a German Body Corporate, trading as ROLLEI-WERKE FRANKE & HEIDECKE, of 196 Salzdahlumerstrasse, Braunschweig, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—
- 10 The present invention relates to a discharge flash-tube arrangement, particularly for taking photographs and for adapting the light output to the requirements arising in each case.
- 15 This has hitherto been done by means of apparatus in which the light output could be adjusted. This enabled it to be adjusted to the prospective requirements and a waste of energy to be to some extent avoided, but this system did not enable the light to be regulated automatically.
- 20 It has therefore been suggested that the discharge of a flash tube be controlled by short-circuiting the flash tube at the required moment, this being done by igniting a second flash tube which is connected in parallel with the said tube and which, when ignited, has a far lower resistance than that of said tube in its ignited state. This short
- 30 circuiting can be brought about by an electronic time switch or by measuring, by photo-electric means, the light reflected from the subject, during the discharge of the flash tube. As the said discharge generates alternating light, this proves an easy means of ensuring that the measurement takes place independently of the other surrounding light, i.e. is insensitive to daylight.
- 35 The full power for which the apparatus is designed, however, is then consumed on each flash operation, as that part of the power which is not required is destroyed on each "take". According to the present invention there is provided a discharge flash tube arrangement, particularly for photographic purposes, comprising a plurality of flash units with their own ignition circuits and an ignition impulse generator for continuous successive ignition of the flash units in accordance with a periodically repeated impulse programme, wherein the impulse programme is controlled by an intrinsically known integrating photo-electric luminous-density measuring system for the flashlight reflected from the subject, this measuring system interrupting the ignition impulse sequence when a certain preselected threshold value is reached.
- 45 Preferably the arrangement is used in connection with an intrinsically known integrating photo-electric light-density measuring system for the light reflected from the subject, this system interrupting the ignition impulse sequence when a certain selectable threshold value is reached.
- 50 Two flash units of the same power or a number of flash units of equal or graduated power may be combined together, either as individual units or in one and the same apparatus.
- 55 The advantage of this system may be that the number of flashes obtainable with a battery charge is increased to that extent to which the proportion of close-ups predominates numerically. Or for one and the same performance (number of flashes) the apparatus can be used in conjunction with smaller and lighter batteries; alternatively, the maximum light performance of the apparatus can be considerably increased, maintaining the present dimensions. The extra expenditure involved, for the switching components required, on the other hand, is reduced.
- 60 Constructional embodiments of the present invention will now be described, by way of example with reference to the accompanying drawings, wherein:—
- 65 70 75 80 85
- [Price 5s. 0d. (25p)]

Fig. 1 shows an arrangement with two flash units operating alternately;

Fig. 2 shows another type of circuit with two flash units operating alternately;

5 Fig. 3 shows a diagram of the ignition sequence;

Fig. 4 shows a circuit of the ignition apparatus which is part of the flash unit shown in Fig. 1 or 2;

10 Fig. 5 shows another version of the circuit of the ignition apparatus which is part of the flash unit shown in Fig. 1 or 2;

Fig. 6 shows a flash tube arrangement with three flash units with a continuous ignition cycle;

15 Fig. 7 shows an arrangement similar to fig. 6, with a fixed ignition sequence and with a photo-electric limiting system;

20 Fig. 8 shows an arrangement similar to Fig. 7, but with separate transformers for the respective flash tube;

Fig. 9 shows a version of a four-unit flash apparatus; and

25 Fig. 10 shows an arrangement based on Fig. 8.

In Fig. 1, the main capacitor 1, with a capacity of a few hundred μF , is connected, via the diode 2, in the customary manner, with the main voltage supply, usually a direct-voltage converter. The capacitor 3, of a few μF , is connected with the capacitor 1 via the flash tube 4. The second flash tube 5 is connected with the capacitor 3. When the current supply is switched on, the capacitor 1, is charged up, the capacitor 3 is without charge. The ignition of the tubes 4 and 5 is effected by ignition impulses of the ignition circuits 6 and 7, which are described farther on. The process is such that the main storage capacitor 1 discharges when the flash tube 4 ignites, the capacitor 3 charging up in the process, until equality of voltage is obtained between the charging of the capacitor 1 and that of the capacitor 3. As the voltage of the two capacitors, at the end of this process, has been reduced to half the original charging voltage of the storage capacitor 1, the two capacitors 1 and 3, at the end of this process, will each contain only a quarter of the original charge, since $A = U^2 \times C$ in this formula, A is stored work, U the voltage and C the capacity of the capacitor. Half the stored energy has thus been converted into light in the flash tube 4. When the flash tube 5 is then ignited the capacitor 3 will be discharged and the fourth part which it contains of the original accumulation energy will be converted into light.

Even if the capacity of the capacitor 3 is just as great as that of the capacitor 1, therefore, the flash performance will continually decrease as the succession of the flashes continues. The number of flashes can only continue as long as the remaining voltage in the capacitor 1 exceeds the ignition voltage of

the flash tubes. If the capacity of the capacitor 3 is appreciably lower than that of the capacitor 1, it is easy to understand that the reduction of energy in the individual stages takes place more slowly, resulting in a discharge curve similar to that shown in Fig. 3.

It is obvious that the system can be used in conjunction with an impulse generator with facilities for disconnecting the impulses, for the control of the flash tube output; in conjunction with an impulse pick-up of which the impulse sequence is adjustable, it is possible to obtain a stroboscopic effect.

That part of the charge of the capacitor 1 which is left unused in each case is preserved and is thus again available the next time the apparatus is used.

In Fig. 2, another version is illustrated, with two flash tubes ignited alternatively. In this case, a capacitor 13, 18, is connected in parallel with each flash tube, 14 and 15 respectively; each flash tube, 14 and 15, has its own ignition circuit, 16 and 17 respectively. The storage capacitor 11, which is connected, via the diode 12, with the high-tension transformer is in parallel with the flash tubes. On the ignition of the tube 14 the capacitor 18 discharges, the capacitor 13 being at the same time charged up by the storage capacitor 11. On the ignition of the tube 15 the capacitor 13 discharges, and at the same time the storage capacitor 11 charges up the capacitor 18. In this system, therefore, the loading of both tubes is effected symmetrically.

If the impulse sequence is to be concentrated in a period, of the same order of magnitude as the normal discharge of the storage capacitor, difficulties arise owing to the fact that the ignition capacitors have to be charged up within very short periods from a few micro-seconds, which periods are extended by drop resistors and the efficiency of the current source. Use is therefore made of ignition circuits associated with the flash tubes which are adapted to the purposes in view and which are free of the disadvantages described.

One constructional version is shown in Fig. 4. A storage capacitor 21 is charged up via the diode 22. Its capacity can be made great enough to ensure that it will be sufficient for the total ignition impulse sequence. The charging is effected before the commencement of the flash, so that sufficient time is available to completely charge the storage capacitor. The actual ignition capacitor 23 can be charged up in a very short time via the thyristor 24 and the ignition transformer 25. In this process a high-tension impulse occurs on the high-tension side of the transformer 25. When the ignition capacitor 23 is fully charged up, the thyristor 24 is extinguished. The ignition capacitor 23 can now be discharged via the thyristor 26 and the transformer 27, in which process a high-tension

impulse occurs on the secondary side of this transformer 27. This process can be repeated continuously, if a generator causing the thyristors 24 and 26 to be switched on at the desired intervals is used for controlling them. This generator 28 may consist, for instance, of a multi-vibrator (a-stable flip flop), which can be caused to oscillate by relating a blocking device. By a control apparatus 29 preceding it e.g. a timer, or the intrinsically known integrating photo-electric luminous-density measuring device mentioned at the beginning, the number of high-tension ignition impulses given off can be limited.

Fig. 5 shows a second version, in which two ignition capacitors 30, 33 are provided, in a symmetrical circuit structure, analogous to the flash tube circuit in Fig. 2. Apart from the second ignition capacitor 30, all parts have the same numbers in the units position as in Fig. 4.

Arrangements with more than two flash units are shown in Figs. 6—9 of the drawings.

A number of equivalent flash units are provided, having their own flash tubes, flash capacitors and ignition circuits, the flash tubes 41, 42, 43 the flash capacitors 44, 45, 46 and the ignition circuits, 47, 48, 49. The capacitors 44, 45, 46 are charged up by the battery 50, via the direct-voltage transformers 51 and the diodes 52, 53, 54. The ignition circuits 47, 48, 49, are controlled through the thyristors 55, 56, 57, which are connected with the ignition impulse distributor 58, which consists of a ring selector circuit of a kind already known in itself. By each contact produced by the synchro-contact 59 the ignition impulse is passed on to the next flash unit, so that the flash units are individually ignited in turn and continuously. By short-circuiting the ignition impulse distributor 58 it is also possible for all the flash tubes, if necessary, to be ignited simultaneously.

While in the case of the two-tube arrangement shown in Figs. 1 and 2 the sum of the separate flashes is obtained from the capacity of the capacitor 1, 11, the version shown in Fig. 6 leads to the addition of the full individual flash outputs, in accordance with the sum of the capacities of the capacitors 44, 45, 46. As the cycle can occur a number of times in succession, a multiple of this output is available, if the direct-voltage converter is of the required efficiency, and if the time sequence of the flashes is appropriately adapted. It may be advisable to provide each flash tube part with its own converter, as in the version shown in Fig. 8.

To produce an impulse sequence, the contact 59 can be replaced by an impulse generator 60, with an operating contact 61. This impulse generator 60 may consist, for example, of a number of univibrators, which are connected in such a way that the rear flank of

a univibrator impulse in each case actuates the following univibrator, so that the flash units are ignited in succession. The sequence can thus be either compressed or extended in time, as desired.

In Fig. 7 the arrangement described in the foregoing has been modified in accordance with the requirements of the automatic photo-electric illumination-control system. For the sake of clarity, the respective parts have been given the same reference number, each increased by 100. The ignition impulse distributor 58 has been eliminated. The impulse generator 160, when the contact 161 is actuated, always ignites the tubes 141, 142 and 143 in the same order, starting with the tube 141. In a particularly advantageous version the outputs of the individual flash appliances are graduated in a quadratic series, i.e. 1, 2, 4, 8, 16, if 5 flash tubes are used, for example. If one common transformer is employed, this would be the graduation of the capacities of the capacitors, while in the case of separate transformers for the respective flash tube circuits a graduation of the voltage is likewise possible. The quadratic graduation enables the illumination to be advantageously adapted to the various different distances of subject, as the higher powers are only required in the case of greater distances and increase with the square of the distance. By slightly advancing the ignition of the respective stages, by comparison with the number of stages required according to measurement, it is possible to ensure that the ignition will not be inadequate at any point over the entire range. The ignition circuits 147, 148, 149 of the flash tubes 141, 142, 143 can be actuated by the thyristors 155, 156, 157. When the contact 161 is actuated, the impulse generator 160 is set in operation, and this emits a sequence of (in the present case) three positive impulses, which, in succession and via the capacitors 162, 163, 164 control the thyristors 155, 156 and 157 and thus the relevant ignition circuits 147, 148, 149. The impulse generator may consist, for example, of three univibrators, in which case the first univibrator in the known manner, actuates the next univibrator by the rear flank of the resultant impulse, after it has been set in operation, and so forth. The retardation can be individually adapted to the duration of the flash, particularly, when different flash units are employed. The thyristors 155, 156, 157 however, can only be set in operation if the transistor 165 is blocked, which is the case as long as the exposure has not yet reached the preselected level. For this purpose, a photo-electric light-transformer 166 is provided, which measures the light of the flash tubes 141, 142, 143, which is reflected from the subject. This measurement is integrated over time by an integrating device 167, and is conveyed, after being amplified by an ampli-

fier 168, to a diode 169, as threshold indicator. As soon as the threshold value has been reached, the transistor 165 is supplied with a positive impulse, and is thus rendered conductive. The control grids of the thyristors 155, 156 and 157 thus receive a negative bias voltage; the thyristors which up to that moment have not yet been ignited can then no longer be influenced by the impulse generator 160. The necessary negative potential is generated by an additional battery 175 or branched off the transformer 151. A potentiometer 170 connected between the amplifier 168 and the diode 169 is used for adjusting the sensitivity and for taking into account the film speed and fixed camera data, such as the lens diaphragm.

The further version, shown in Fig. 8 differs from that described in the foregoing, owing to the fact that for each flash unit a special transformer is provided, 171, 172 and 173 respectively; in addition, the photo-electric measuring- and integrating-device 166, 167 and 168 has been combined to form one single unit, the sensor 174.

Fig. 9 shows a flash gun consisting of four flash units. In this case, the flash units are constructed in the same manner, each being provided with a reflector of its own. As the flash output of the individual unit need not only amount to a fraction of that of a normal flashlamp, they can be accommodated in a gun of which the dimensions need not exceed those of a normal individual flash gun; this applies in particular to the version shown in Fig. 6, where the total performance may be subdivided among several complete cycles.

The flash intervals can be kept so short, with photographic flash apparatus, that they are imperceptible as such, the individual flashes appearing as one single flash.

The power of the individual flash units can be as great as desired; for the purpose of more satisfactory adaptation to the power and requirements of the individual "takes" it can be graduated in a quadratic or geometric series. To ensure that no under-exposure occurs at any point throughout the range, over-exposure up to one stage has to be accepted.

Further according to the invention the exposure is to be accurately adapted to the individual light requirements, in that when the required total flash output is reached the discharge of the particular flash unit which has been ignited is terminated by short-circuiting the flash unit concerned. In this process, it is true that the remaining energy, not required, is lost, but the total energy consumption is no greater than in the embodiments hereinbefore described. In addition, accurate adaptation to the actual light requirement of the individual "take" is ensured.

The further embodiment of the invention is illustrated in conjunction with a version based on the system illustrated in Fig. 8. Any parts

identical with those in Fig. 8 have been given the same reference numbers.

As shown in Figure 10 the impulse generator 160 ignites the flash tubes 141, 142, 163, when the contact 161 is actuated, and always in the same order, starting with the tube 141. In a particularly advantageous version, the outputs of the individual items of flash apparatus are graduated in a quadratic series, i.e. 1, 2, 4, 8, 16, if use is made for instance of 5 flash tubes.

The quadratic graduation results in advantageous adaptation of the illumination to the various different distances of subject, since the higher outputs are only required in the case of greater distances and increase with the square of the distance. The ignition circuits, 147, 148, 149 of the flash tubes 141, 142, 143, can be actuated by the thyristors 155, 156, 157. When the release contact 161 is set in operation, the impulse generator 160 is switched on, and emits a sequence of (in the present case) three positive impulses, which actuate the capacitors 162, 163, 164, the thyristors 155, 156, 157 and thus the relevant ignition circuits 147, 148, 149 in succession. The thyristors 155, 156, 157 cannot be actuated as long as the transistor 165 is blocked and the exposure has not yet reached the pre-selected level. In Fig. 10, the photo-electric transformer 166, the integrating device 167 and the amplifier 168 have been combined, as in Fig. 8, and are shown as one single unit, the sensor 174. A photo-electric light transformer 166 measures the light reflected from the subject. This measurement is conveyed, as a threshold indicator, to the diode 169, via an integrating device 167 and an amplifier 168. As soon as the threshold value is reached, the transistor 165 receives a positive impulse and thus becomes conductive. The control grids of the thyristors 155, 156, 157, are thus supplied with a negative bias voltage; those thyristors which have up to that moment not yet been ignited can then no longer be influenced by the impulse generator 160. A potentiometer 170 connected between the amplifier 168 and the diode 169 serves to set the film speed.

Parallel to each flash tube 141, 142, 143 are the tubes 181, 182 and 183 respectively, which can be ignited by the ignition circuits 184, 185 and 186 respectively. These ignition circuits are actuated by the thyristors 187, 188, 189.

To ensure that only that switch tube 181, 182 or 183 can still be ignited which is associated with the main tube flashing at the moment, the positive impulse occurring when the threshold value is reached is conveyed by the diode 169 to the thyristors 187, 188, 189. This is prevented by the normally conductive transistors 190, 191, 192 which are coupled to the impulse generator in such a way that the bases normally have positive

voltage. The control signal is thus short-circuited and becomes inoperative. When the generator 160 supplies positive signals in succession to the thyristor, the grid transistors 190, 191 and 192 can at the same time be blocked in succession, in that the voltage, from the point of view of the impulses, drops at the base to zero or to a negative value. The transistor in question is thus blocked, and the thyristor associated with it can be ignited by the control signal of the diode 169.

WHAT WE CLAIM IS:—

1. A discharge flash tube arrangement, particularly for photographic purposes, comprising a plurality of flash units with their own ignition circuits and an ignition impulse generator for continuous successive ignition of the flash units in accordance with a periodically repeated impulse programme, wherein the impulse programme is controlled by an intrinsically known integrating photo-electric luminous-density measuring system for the flashlight reflected from the subject, this measuring system interrupting the ignition impulse sequence when a certain preselectable threshold value is reached.

2. A discharge flash tube arrangement as claimed in claim 1, wherein each flash unit is provided with two flash tubes which are connected in series and are connected in parallel with a first storage capacitor, and of which tubes at least one is connected parallel with a first further capacitor of which the capacity corresponds to the individual flash output.

3. A discharge flash tube arrangement as claimed in claim 2, wherein a second further capacitor in series with said first further capacitor is provided and these capacitors are arranged whereby each one is in parallel with a different one of said two flash tubes.

4. A discharge flash tube arrangement as claimed in claim 3, wherein the capacity ratio of the first storage capacitor to the first and/or second further capacitors is dependent upon the number of desired separate flashes per storage capacitor charge.

5. A discharge flash tube arrangement as claimed in any one of claims 1 to 4, wherein each ignition circuit comprises transformers with two thyristors connected in series to form two transformer-thyristor series with a second storage capacitor and wherein an ignition capacitor is provided and connected in parallel to each transformer-thyristor series and an impulse pick-up is provided for alternately controlling the thyristors.

6. A discharge flash tube arrangement as claimed in claim 5, wherein an ignition capacitor is connected in parallel with each transformer-thyristor series.

7. A discharge flash tube arrangement as claimed in claim 1, having a plurality of complete flash units, consisting of flash tubes and said ignition circuits provided with storage

capacitors, and wherein thyristors are provided and arranged to control the ignition circuits, which are continuously ignited in turn by an ignition impulse distributor in a ring selector circuit system known in itself.

8. A discharge flash tube arrangement as claimed in claim 7, having an impulse generator connected in series in front of the ignition impulse distributor.

9. A discharge flash tube arrangement as claimed in claim 8, wherein the thyristors are connected, without the use of an ignition impulse distributor, to said impulse generator by which the said thyristors are ignited in succession and in a pre-determined sequence when it is actuated.

10. A discharge flash tube arrangement as claimed in claim 8 or 9, wherein impulse conductors between the impulse generator and the thyristors are connected to a common transistor which, when the threshold value is reached, is rendered conductive by a threshold indicator, and which supplies the control grids of the thyristors with a negative bias voltage, prevented the impulse from being passed through.

11. A discharge flash tube arrangement as claimed in claim 1, having a photo-electric light transformer, for measuring the light reflected from the subject.

12. A discharge flash tube arrangement as claimed in any one of claims 7 to 11, wherein a special direct-voltage transformer is provided for each flash unit.

13. A discharge flash tube arrangement as claimed in any one of claims 7 to 12, wherein the performance of the flash tubes and their capacitors considered in respect of their ignition sequence, is graduated in a geometrical series, preferably quadratic.

14. A discharge flash tube arrangement as claimed in any one of claims 1 to 13, wherein the flash tubes are constructed in the same manner, each being provided with its own reflector, and are accommodated in one common flash-gun.

15. A discharge flash tube arrangement as claimed in claim 1, wherein the threshold impulse generated by an integrating photo-electric luminous-density meter is conveyed to the generator for interrupting the ignition impulse sequence and to quenching tubes connected in parallel with the ignition circuits of the flash tubes.

16. A discharge flash tube arrangement as claimed in claim 15 wherein the control transistors for the ignition of the quenching tubes are connected in front of a threshold impulse pick-up and the impulse generator, by means of transistors in such a way that the switching impulse is only conveyed to the ignition circuit of the quenching tube of the particular flash tube as the case may be which is ignited at the time.

17. A discharge flash tube arrangement sub-

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voltage. The control signal is thus short-circuited and becomes inoperative. When the generator 160 supplies positive signals in succession to the thyristor, the grid transistors 190, 191 and 192 can at the same time be blocked in succession, in that the voltage, from the point of view of the impulses, drops at the base to zero or to a negative value. The transistor in question is thus blocked, and the thyristor associated with it can be ignited by the control signal of the diode 169.

WHAT WE CLAIM IS:—

1. A discharge flash tube arrangement, particularly for photographic purposes, comprising a plurality of flash units with their own ignition circuits and an ignition impulse generator for continuous successive ignition of the flash units in accordance with a periodically repeated impulse programme, wherein the impulse programme is controlled by an intrinsically known integrating photo-electric luminous-density measuring system for the flashlight reflected from the subject, this measuring system interrupting the ignition impulse sequence when a certain preselectable threshold value is reached.

2. A discharge flash tube arrangement as claimed in claim 1, wherein each flash unit is provided with two flash tubes which are connected in series and are connected in parallel with a first storage capacitor, and of which tubes at least one is connected parallel with a first further capacitor of which the capacity corresponds to the individual flash output.

3. A discharge flash tube arrangement as claimed in claim 2, wherein a second further capacitor in series with said first further capacitor is provided and these capacitors are arranged whereby each one is in parallel with a different one of said two flash tubes.

4. A discharge flash tube arrangement as claimed in claim 3, wherein the capacity ratio of the first storage capacitor to the first and/or second further capacitors is dependent upon the number of desired separate flashes per storage capacitor charge.

5. A discharge flash tube arrangement as claimed in any one of claims 1 to 4, wherein each ignition circuit comprises transformers with two thyristors connected in series to form two transformer-thyristor series with a second storage capacitor and wherein an ignition capacitor is provided and connected in parallel to each transformer-thyristor series and an impulse pick-up is provided for alternately controlling the thyristors.

6. A discharge flash tube arrangement as claimed in claim 5, wherein an ignition capacitor is connected in parallel with each transformer-thyristor series.

7. A discharge flash tube arrangement as claimed in claim 1, having a plurality of complete flash units, consisting of flash tubes and said ignition circuits provided with storage

capacitors, and wherein thyristors are provided and arranged to control the ignition circuits, which are continuously ignited in turn by an ignition impulse distributor in a ring selector circuit system known in itself.

8. A discharge flash tube arrangement as claimed in claim 7, having an impulse generator connected in series in front of the ignition impulse distributor.

9. A discharge flash tube arrangement as claimed in claim 8, wherein the thyristors are connected, without the use of an ignition impulse distributor, to said impulse generator by which the said thyristors are ignited in succession and in a pre-determined sequence when it is actuated.

10. A discharge flash tube arrangement as claimed in claim 8 or 9, wherein impulse conductors between the impulse generator and the thyristors are connected to a common transistor which, when the threshold value is reached, is rendered conductive by a threshold indicator, and which supplies the control grids of the thyristors with a negative bias voltage, prevented the impulse from being passed through.

11. A discharge flash tube arrangement as claimed in claim 1, having a photo-electric light transformer, for measuring the light reflected from the subject.

12. A discharge flash tube arrangement as claimed in any one of claims 7 to 11, wherein a special direct-voltage transformer is provided for each flash unit.

13. A discharge flash tube arrangement as claimed in any one of claims 7 to 12, wherein the performance of the flash tubes and their capacitors considered in respect of their ignition sequence, is graduated in a geometrical series, preferably quadratic.

14. A discharge flash tube arrangement as claimed in any one of claims 1 to 13, wherein the flash tubes are constructed in the same manner, each being provided with its own reflector, and are accommodated in one common flash-gun.

15. A discharge flash tube arrangement as claimed in claim 1, wherein the threshold impulse generated by an integrating photo-electric luminous-density meter is conveyed to the generator for interrupting the ignition impulse sequence and to quenching tubes connected in parallel with the ignition circuits of the flash tubes.

16. A discharge flash tube arrangement as claimed in claim 15 wherein the control transistors for the ignition of the quenching tubes are connected in front of a threshold impulse pick-up and the impulse generator, by means of transistors in such a way that the switching impulse is only conveyed to the ignition circuit of the quenching tube of the particular flash tube as the case may be which is ignited at the time.

17. A discharge flash tube arrangement sub-

stantially as described herein with reference to any one of the embodiments shown in the accompanying drawings.

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Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1970.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from
which copies may be obtained.

