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APPARATUS FOR DETECTING VASOSPASM

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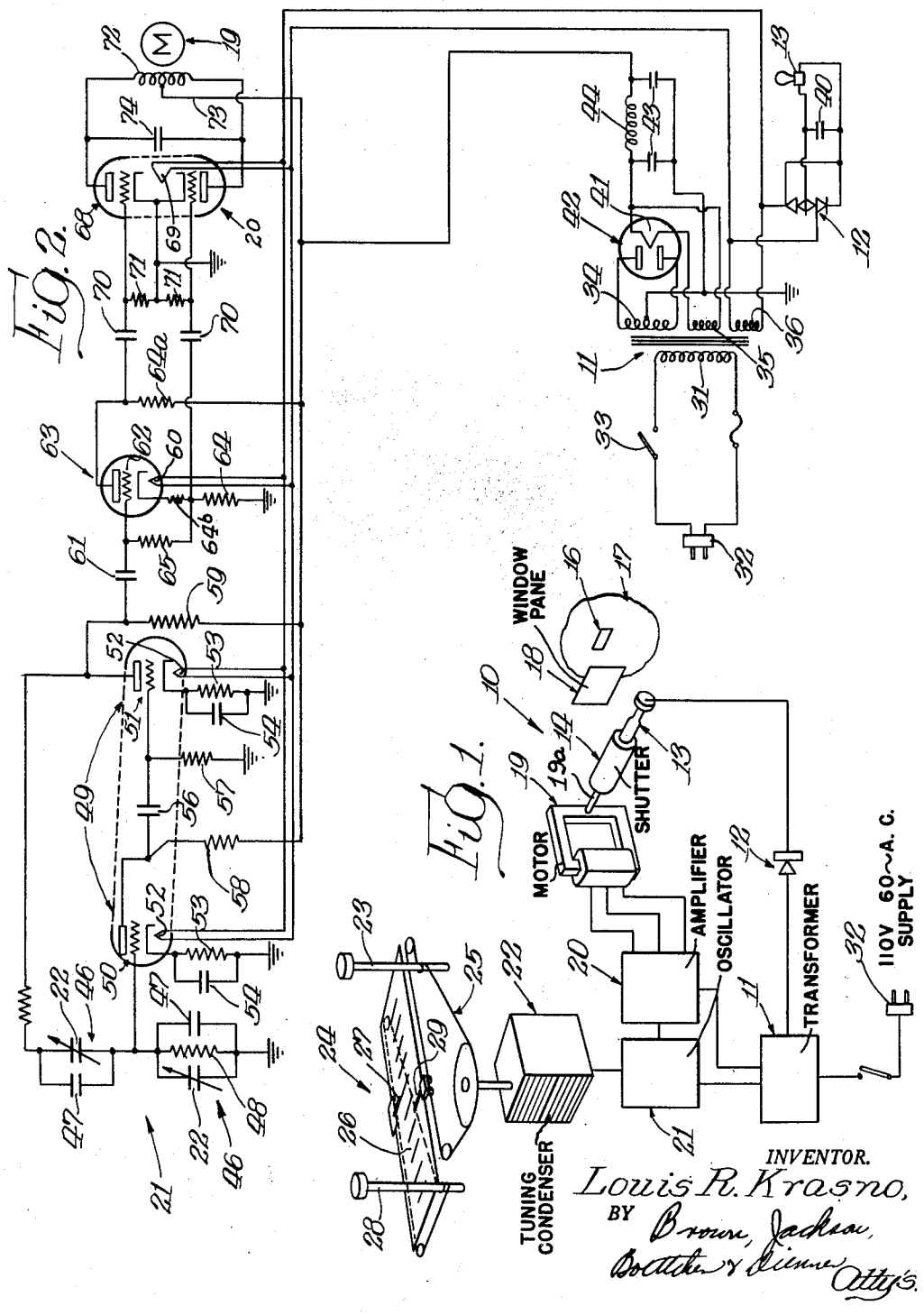

Fig. 1.

Fig. 2.

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APPARATUS FOR DETECTING VASOSPASM

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This invention is directed to a new, improved, and useful method of detecting vasospasm in the human body whereby the presence of subclinical and potential heart disease may be determined.

This invention is also concerned with a new and improved apparatus for the physiological measurement of the flicker fusion threshold of a patient whereby vasospasm may be detected.

In recent years the importance of diseases of the human heart as a threat to a healthy civilization has been realized by more and more members of the medical profession throughout the world. Important discoveries and contributions in the field of cardiovascular medicine have been made in the effort to combat this dreaded enemy of the public. Nevertheless, the majority of these efforts have been directed toward the therapeutic rather than the prophylactic approach. The need for a successful method of detecting the presence of incipient heart disease has been felt by all who have attacked the problem.

The use of the electrocardiograph has admittedly done much to aid in the treatment of heart disease. However, this method is of clinical value primarily only after the disease has made its appearance in the form of fully developed damage to the heart. It is imperative, therefore, that the medical world have some reliable means whereby the abnormal processes leading to a myocardial infarction, hypertension, coronary insufficiency and angina pectoris may be detected before such serious damage to the heart occurs.

I propose to make such an early detection of heart disease by determining the presence of vasospasm which is unphysiological and does not normally exist in the human body, the presence of which is consistently found to be associated with the aforementioned established abnormal cardiovascular conditions.

Other methods of discovering vasospasm have not been very successful due to their dependence on physiological indicia which represent abnormal anatomical changes. One such method is that of taking the skin temperatures of a patient, which method depends on absolute readings of the recording instrument and variations of the skin temperature. All of these methods depend largely on the blood vessels of the extremities which, because of their anatomic structure, are by no means as sensitive and as indicative of what is taking place within the cardiovascular system as are the blood vessels of the brain and retina, which vessels my method employs by use of the flicker fusion test. These methods require equipment and procedures too complicated to make it a practical office procedure. Some methods require attachments of instruments to the skin of the extremities while other procedures involve the injection of radioactive materials into the circulation of the patient. This makes for additional inconvenience to the doctor and the patient and still involves blood vessels of the extremities which are structurally different from those of the retina. These disadvantages are obviated with the present method.

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During World War II extensive experiments were conducted with reference to anoxia and fatigue of the central nervous system. These were concerned with anoxia occurring during high altitude flying by airplane pilots. Such anoxia, or lack of oxygen supply to the tissues of the body, was most successfully detected by the flicker fusion test, which indicated pilot anoxia and fatigue long before any other tests or symptoms made this condition apparent. Such anoxia was termed innocuous, that is, non-apparent anoxia. Under normal atmospheric conditions with a normal supply of oxygen present, a normal person should not suffer from anoxia, providing, of course, that he has a normal cardiovascular system. Therefore, if a normal person develops the findings of anoxia at ground level, it would indicate some abnormality in his circulatory system which supplies the body tissue with needed oxygen. Such an abnormality of impairment of the circulation, and thus an impairment of the supply of oxygen to the body tissues, apparently is associated with vasospasm at a very early stage in the development of abnormal cardiovascular conditions.

The hereinafter described method of detecting heart disease adopts the premise that since hypertensive and coronary cardiovascular disease is ultimately and physiologically expressed by the appearance of tissue anoxia, there exists an "innocuous" anoxia in the early cardiac patient associated with vasospasm. This "innocuous" or non-apparent anoxia may not be detectable by any of the known methods of examination. Further, it may not be associated with any detectable anatomic change of symptoms, and the patient may be entirely unaware of its presence.

It is an object of my invention to describe a method whereby these early physiological changes of cardiovascular disease may be easily and readily detected.

It is a further object of my invention to present a simple and reliable method which can be used in the normal routine of office examinations to

detect an early tendency to hypertensive or coronary heart diseases.

It is a further object of my invention to describe a new and improved method of detecting an early tendency to hypertensive and coronary heart disease by means of a comparison of flicker fusion performance before and after the administration of a drug to the patient which indicates the presence of vasospasm.

It is a still further object of my invention to provide a new and improved electronic device for the physiological measurement of a patient's flicker fusion threshold. These and further objects will appear in the following description.

In order to acquaint those skilled in the art with the hereinafter described method of detecting vasospasm, and with the construction and utilization of a device related to this method, a description of a preferred embodiment of the testing device portions of this invention will be made with reference to the accompanying drawings, wherein:

Figure 1 is a schematic diagram of the main elements of a flicker fusion testing machine made in accordance with this invention;

Figure 2 shows a circuit diagram of the machine displayed schematically in Figure 1.

The flicker fusion test is made by means of a constant light source which is intermittently cut off from the observer by interposing a shield at varying frequency. As a consequence, the light appears to flicker on an off. The frequency rate at which the flickering light flashes appears to the observer as an uninterrupted beam of light is known as the flicker fusion threshold (F. F. T.) for that individual. If anoxia is present, the F. F. T. lessens—that is, the frequency with which the beam of light is being intermittently shielded must be reduced before the patient can detect a flicker. When anoxia is overcome, by various therapeutic methods, the F. F. T. will increase and the patient can detect interruptions in the beam of light at greater frequencies. A probative treatise on the flicker fusion test is to be found in the book entitled Medical Physics by Otto Glasser, volume II, pages 335 to 339, 1950 edition by The Year Book Publishers, of Chicago, Illinois, wherein the prior developments and uses of flicker fusion phenomena are set forth more fully.

Prior to the invention of the herein disclosed testing device, the flicker fusion test has generally been conducted by one of two well-known types of testing machines. One type consists of a standard, direct or alternating current-driven motor, which drives a two or four-bladed fan, so that the fan blades intercept the beam of light produced by a tungsten filament light bulb. The motor speed is generally varied by a variable resistance rheostat and the revolutions per minute are read off a moving tachometer pointer. The fact that the pointer is in motion causes some error in the taking of readings with a machine of this general type. The other type which has been used in the past has an electrically produced flickering light based on a frequency oscillator type of arrangement, similar to that used in neon or gas filled bulbs or tubes. A serious difficulty encountered with this latter type of testing device is the lag in the appearance and disappearance of the light. This results in an indefinite flicker and thus in erroneous readings.

The device shown schematically in Figure 1 overcomes the above objections and combines several mechanical and electrical advantages in a single compact machine.

Referring now to Figures 1 and 2 of the drawings, a flicker fusion testing machine, indicated generally at **10**, comprises generally a power supplying transformer **11** supplying a low voltage rectifier **12** with alternating current, which it rectifies to supply a direct current light source **13** interrupted by a cylindrical shutter **14** which controls the emission of light through a window **15** in an outer casing **17** surrounding the machine. A glass window pane **18** may be provided to evenly diffuse the light beams coming through window **16**. A synchronous motor **19** is provided to rotate the shutter **14** and may be controlled, as shown herein by control means of an amplifier **20** fed by a suitable oscillator **21** whose frequency is varied by a suitable tuning condenser **22** controlled by a tuning control knob **23**. Means for indicating and recording the frequency of interrupting the light source is shown generally at **24**, and comprises an indicating scale **26** having a movable index pointer **27** controlled and moved by turning a suitable ndex knob **28** and a similar control pointer **29** movable along scale **26** in response to the rotating movement of control knob **23**. The control pointer **29** is used for indicating the flicker rate of the light as determined by the patient after the administration of a vasodilating drug, which post drug reading is compared with the initial frequency of the light detectable by the patient before drug administration and recorded on scale **26** by the index pointer **27**.

Coming now to the details of the several electronic circuits involved in this machine, as set forth in diagrammatic form in Figure 2, it will be noted that the transformer **11** may have its primary winding **31** fed by an ordinary household alternating current supply **32** of approximately 117 volts at 60 cycles. Other values of power supply may be used with equal facility, depending on the particular circuit values required. An off and on switch **33** may be provided and may be conveniently mounted in the outer casing **17** of the machine. The transformer has three secondary windings **34**, **35** and **36**; **34** being a high voltage secondary of approximately 600 volts for supplying anode voltages to the various tubes of the machine, as will appear more clearly later herein; **35** being a low voltage winding supplying approximately 5 volts, and **36** another low voltage winding supplying approximately 6 volts.

The low voltage rectifier **12** may be of a common, well known contact type of such materials as copper sulfide, copper oxide or selenium, and is supplied by the transformer winding **36** for rectifying the alternating current supplied thereby into direct current for supplying energy to the light source **13**, which may be as herein shown, a direct current bulb, to insure a steady light. A high frequency alternating current bulb would be equally effective if the frequency were sufficiently high to insure imperceptible flicker of the light. A filter condenser **40** may be placed in circuit between the rectifier **12** and the light source **13** to smooth out the rectified current and is herein of a high capacity, 1000 mf., low voltage, 15 v., type.

The low voltage secondary winding **35** of the transformer energizes a filament **41** of a high vacuum, full wave, thermionic rectifier tube **42** which is shown herein as a conventional 5Y3 tube. The tube **42** supplies pulsating, direct current which is filtered by a pi network comprised herein of a pair of 20–20 mf., 450 v. condensers **43**, and a 20 henry choke **44**, which network serves to smooth out the high voltage D. C. sup-

plied by the 5Y3 rectifier tube for supplying the anodes of further tubes in the circuit and the field windings of the motor 19, as will appear more clearly hereinafter.

The oscillator 21 may be of a standard R.-C. type, as shown herein, having a variable component consisting of a frequency control section composed chiefly of a dual section 20–350 mmf. range control, indicated generally at 46. Each section 46 of the range control may have a condenser 47, herein shown as 150 mmf. A resistor 48, herein of 4.4 megohms, which determines the range of frequency control, is grounded to the chassis. A tuning condenser 22 is also employed with the sections 46 and may be of the ordinary radio gang plate type, adapted to be tuned by turning the control knob 23 associated with the indicating means 24.

The remaining section of the oscillator circuit contains a twin triode tube 49 connected and used as a resistance coupled amplifier and, as shown herein, may be a standard, commercially available, 6SN7 type tube. The two triode members 50 and 51, enclosed in a common tube 49, have a pair of heaters 52 which are connected in parallel interrelation and supplied by the secondary winding 36 of the transformer. The cathode circuit of each triode member comprises a parallel resistor-capacitor network including a resistor 53, in the order of 10,000 ohms, and a by-pass capacitor, in the order of 25 mf., whereby a low impedance A.-C. path is provided therefor. A condenser 56, herein a 0.1 mf., 400 v. condenser, couples the plate or anode of the triode unit 50 to the grid circuit of the triode unit 51, a grid resistor 57 providing a D.-C. return to ground for the grid of triode unit 51. The plates or anodes of the two section oscillator tube 49 are supplied with positive voltage by the 5Y3 rectifier unit and the associated filter circuit comprising condensers 43 and choke 44; connection of the plates thereto being effected over plate load resistances 58 and 59 respectively. Resistance 58 may be in the order of 47,000 ohms and resistance 59 in the order of 680,000 ohms. Of course, it is apparent that the various values given for the elements connected with the above described oscillator circuit may be changed, as desired, to present a variety of control ranges, and that all of the circuits associated with the oscillator 6SN7 tube control the frequency of oscillation to a greater or lesser extent.

The output side of oscillator 21 is coupled to a phase inverter tube 63, which is a medium mu triode tube, such as a conventional 6J5 type having a heater 60 fed by the secondary winding 36. The capacitor 61 is connected between the plate of the second section 51 of tube 49 and the grid of phase inverter tube 63. The cathode circuit of phase inverter tube 63 includes a resistance 64b, in the order of 3900 ohms which connects the cathode to resistor 64; the latter being connected to ground. A grid resistor 65, in the order of 2.2 megohms is connected between the grid 62 and the resistance 64 to provide the normal grid bias for the grid of the tube. The plate or anode of the phase inverter tube 63 is supplied with positive voltage over a plate load resistance 64a which is connected to the D.-C. supply from tube 42 and the associated filtering pi network of choke 44 and condensers 43. Resistors 64 and 64a are normally selected to comprise in combination the required plate load value; resistance 64a being connected in the plate circuit in a normal manner and resistance 64 being connected in the cathode to ground circuit. The resistances are normally of equal values and in the disclosed embodiment herein may be in the order of 47,000 ohms. The plate and cathode of tube 63 are coupled to the succeeding circuit stage by a pair of capacitors 70, 70.

The phase inverter tube 63 supplies voltages to grids 66 and 67 of a low mu twin triode power tube 68, herein, a 6N7 type tube, used as a class C power amplifier having a common heater 69 fed by the secondary winding 36 of the transformer. Connection with tube 63 is made through a pair of condensers 78, 79 which may be of 0.1 mf. capacitance. The two grids of the tube 68 are arranged to act 180° out of phase with one another in push-pull relation, thereby using the tube property in which the cathode and plate voltages are 180° out of phase with one another. A pair of resistors 71, 71, herein each having a 47,000 ohm value, are connected between the grids and cathodes of the two sections of the 6N7 tube 68 to furnish the proper operating bias for the tube sections. The output of the first and second sections of tube 68 is supplied to field winding 72 of the synchronous motor 19, as each section is alternatively rendered conductive; the output circuits of these sections being shunted by a 0.5 mf. capacitor 74. A supply conductor 73, extending to the output side of the D.-C. voltage supply circuit, is connected to the field winding 72 of the synchronous motor 19 in center tapped relation whereby the anodes of the two sections of tube 68 are constantly supplied with the necessary B+ voltage.

The motor 19 may be a common, well known hysteresis synchronous type having an armature of a suitable magnetic material, with a 220 v. field coil provided with a center tap. This type of motor is very similar to that used in present day self-starting electric clocks. As employed hrein, the field coil has 8100 turns with a center tap therefrom to bring the motor in proper synchronous relation with the driving amplifier and other electronic controls of the circuit; that number of col turns in combination with the 0.5 mf. condenser 74 presenting a proper load value for the 6N7 tube. Other turn values may, of course, be employed, depending on the circuit values required.

The shutter 14 is attached directly to one end of the armature shaft 19a associated with the motor 19 so that the shutter and armature shaft rotate about a common cylindrical axis. The light bulb 13 is adapted to fit within the hollow interior of the shutter built as a cylindrical tube. The shutter is preferably made of a transparent material such as Lucite, glass or like material. A shutter effect easily is gained by painting one half of the transparent shutter, along its cylindrical length, with some opaque material, such as black paint. Since the shutter's rotational speed is equal to that of the motor, varying the rotational speed of the motor serves to vary the speed of the shutter. The aforedescribed electronic system serves to vary the motor's speed, the direct control being by manual rotation of the control knob 23 which serves to tune the variable condenser 22 for varying the frequency of the oscillator stage 21 and thus the speed of the shutter rotation is varied as well. It will be noted that shuttering of the light beams prior to their emission through window 16 of flashed opal glass or the like adjacent the shutter, is accomplished by alternately presenting first the transparent and then the opaque portions of the cylindrical shutter to the

window as the shutter rotates with the horizontally disposed armature shaft 19a.

Any suitable metal case 17 may surround the various above described parts to afford a pleasing exterior to the machine and protect the various parts assembled therein.

The indicating scale 26 may be calibrated in rotational cycles per second of the motor or shutter, the frequency of interrupting the light source, or any other suitable units. The index pointer 27 is normally set at the initial average flicker fusion threshold (F. F. T.) of the patient before the administration of nitro glycerin and the control pointer registers the F. F. T. after the nitroglycerin administration, whereby a comparative study between the before and after readings may be made for purposes which will appear more clearly later herein.

The control knob 23 may be connected by a suitable pulley and belt arrangement 25 with the tuning condenser 22 for regulating the frequency of rotation of the shutter. The index control knob 28 may be likewise mounted at the top of the machine case and connected through pulleys and belting to control the movement of the index pointer which acts merely as a recording pointer for a patient's normal F. F. T. reading and in no way is connected to the tuning condenser or other electronic units of the machine.

Having thus described a new and improved device for determining the flicker fusion point or threshold of a patient, the purpose and utilization of such a test in determining the presence of vasospasm may appropriately be described.

It is well known in the medical world that vasospasm is an important element in hypertensive and coronary heart disease and that blood circulation is impaired by vasospasm with varying degrees of resultant anoxia. It is an additional fact that nitroglycerin or a like vasodilating drug has a vasodilative effect on the blood vessels of the body and consequently the vasospastic components of hypertensive and coronary heart disease may be temporarily overcome with the administration of a vasodilator, such as nitroglycerin.

It has also been established that the central nervous system is most sensitive to anoxia. As pointed out above, insensible degrees of anoxia of the central nervous system as a result of high altitudes have been detected by giving a flicker fusion test to pilots in whom the anoxia was apparently asymptomatic.

Under the influence of a vasodilator, such as nitroglycerin, the flicker fusion threshold of a person with a vasospastic condition will have a characteristic increase due to the improved blood circulation and a temporary decreased anoxia of the central nervous system. A normal individual with no hypertensive or coronary heart disease will have no vasospasm or anoxia. Accordingly, the central nervous system of such a person will not exhibit an increased efficiency after the introduction of nitroglycerin, since the central nervous system is already operating at optimum efficiency as far as the vasospastic component is concerned. In the normal person, the F. F. T. is characteristically decreased because of over dilation by such a vasodilator as nitroglycerin.

The resultant effect of these facts is such as to indicate that the flicker fusion threshold of a patient following the administration of nitroglycerin, will indicate the presence or absence of vasospasm. The presence of vasospasm may be the forerunner of a serious heart disease to appear in the future since it has been found to be associated in over 98% of known cases with hypertensive and/or coronary heart disease.

Based on the above recited facts, then, a method of indicating vasospasm as a forerunner to coronary and hypertensive diseases has been evolved using the flicker fusion threshold of a patient before and after the introduction of approximately $\frac{1}{150}$ grains of nitroglycerin or equivalent amounts of a like vasodilating drug to the patient. If an increase in the flicker fusion threshold of a patient occurs after the nitroglycerin therapy, vasospasm is indicated. Normally the optimum detectable difference observable by a patient will occur around four minutes after administration of the nitroglycerin. For assurance, readings may be taken at two minute intervals for approximately eight minutes, thus insuring an accurate reading. Clinical results have proven this method to be extremely accurate and valuable in diagnosing potential heart disease; in fact I have discovered vasospasm as measured by my invention to be present in over 98% of persons tested having a known or established hypertensive and/or coronary heart disease.

Thus it is seen that a simple and effective means of discovering the presence of vasospasm is provided under this method. This, when coupled with the new and improved testing device described heretofore will make it possible for a doctor to detect vasospasm in a normal routine office examination, with little effort and no specialized skill.

Use and operation

In detecting vasospasm by means of this device and determining the importance of the findings so far as heart disease is concerned, the following procedure may be followed:

A patient is given a flicker fusion test by placing him looking at the flickering light rays emitted from the testing machine. A distance of from three to four feet between the patient and the machine has been found to be the most satisfactory. The doctor or operator first turns the proper control knob 23 to a frequency of interrupted light flashes which is so rapid that it appears to the patient to be a steady beam. The patient is then instructed to tell the operator when the light first appears to flicker, the operator meanwhile gradually decreasing the flickering frequency of the light beam by turning the control knob 23 in an opposite direction.

It has been discovered that starting with a steady light and reducing the frequency until the light appears to the patient to flicker is operatively more successful than the reverse procedure because of the absence of "after image" which occurs if the F. F. T. is established by going from the flickering to the steady light.

The frequency at which the patient detects a flickering light is readable directly from the scale of the machine in cycles per second, cycles per minute, or other suitable units. The procedure of reducing the frequency is done several times to enable the patient to become familiar with the change in the appearance of the light and to secure an accurate reading. When three identical and consecutive readings are obtained, this is taken as the flicker fusion threshold for that patient and may be recorded for later reference by turning the index control knob 28 to move the index pointer 27 to the appropriate position for recording the reading on the index scale 26.

The patient is next given a suitable vasodilat-

ing drug, such as nitroglycerin, which may be administered in the form of a sublingual tablet of approximately 1/150 grain or its equivalent of a like vasodilating drug. If desired, the nitroglycerin or other vasodilating drug may be administered hypodermically or by other known means, although the sublingual tablet is preferred for the sake of convenience to the doctor. After the administration of the vasodilating drug, the flicker fusion test is repeated and values of the patient's F. F. T. are established at approximately two minute intervals for the next eight minutes. If the frequency at which the light appears to be interrupted to the patient increases, vasospasm is indicated, even though electrocardiograph readings indicate the patient to be normal and discounting such readily detectable causes as anemia and hypothyroidism or the like, with a resultant warning that heart disease is present in an incipient form, or may follow. The presence of vasospasm does not necessarily conclusively indicate that there will eventually be a disease of the heart, but it does serve as a warning, since a patient with vasospasm is more likely to have heart disease than one without it. This warning permits the doctor to initiate measures which can readily dissolve vasospasm and follow the patient more closely.

Nitroglycerin relaxes the smooth musculature, especially the muscles of the finer blood vessels, but has no direct effect on the myocardium. If coronary vessel impairment has caused anoxia of the myocardium, the dilation of the coronary vessels will result in increased efficiency of the myocardium. The retinal blood vessels are dilated by nitroglycerin, and the improved F. F. T. of some patients with hypertensive or coronary disease after the administration of nitroglycerin may be due to this effect. Nitroglycerin also affects the finer blood vessels of the skin splanchnic area, meninges, and coronary vascular tree as well. Consequently, it may properly be said that the characteristic improved F. F. T. of vasospastic individuals is due to a combined and generalized peripheral and central vasodilation involving blood vessels of retina, brain and heart. However, the important thing gained from the detection of vasospasm, whether peripheral, central, or both, is the warning of possible present or future hypertensive and coronary heart disease.

Having thus described a method and device in which my invention may be embodied it will be readily understood that many changes, substitution of equivalents and modifications may be employed without departing from the spirit and scope of my invention and, therefore, I do not wish to be limited to the specific embodiment disclosed herein except as may appear in the following appended claims.

I claim:

1. A flicker fusion testing machine of the class described, comprising, a power transformer having three secondary windings, one of said secondary winding developing a low voltage arranged to supply power to a steady light producing unit, a second of said three winding developing suitable voltage for supplying driving power to a variable speed motor, an electronic control circuit associated with said motor and supplied by the third of secondary windings, said control circuit including an electronic oscillator stage, the frequency output of which is variable according to the tuning of a variable condenser whereby said motor is rotatable at varying speeds in accordance with the adjustment of said condenser, a cylindrical shutter mounted coaxially with the armature of said motor and in surrounding relation with said light producing unit, one half of said shutter's cylindrical length being opaque and the remaining half thereof being transparent whereby the visibility of said light producing unit is interrupted by rotating said shutter therearound, and indicating means including a moveable pointer and a stationary scale, said pointer being operatively moveable with adjustment of said condenser whereby the frequency of shuttering said light producing unit may be visibly indicated on said scale simultaneously and directly with the speed variation of said motor.

2. A flicker fusion testing machine of the class described comprising in combination, a transformer supplied by alternating current, a first electronic circuit supplied by said transformer and having a rectifier therein for powering a direct current light producing unit, a second electronic circuit supplied with alternating current by said transformer and comprising a frequency oscillator, a tuning condenser arranged to control the output frequency range of said oscillator, a phase invertor supplied by said oscillator, a twin triode driving amplifier tube in circuit with said oscillator and having its grids in push-pull relation, a synchronous motor in circuit with said driving amplifier tube and having a center tap from its field windings for supplying plate current to said amplifier tube, a cylindrical shutter rotatably driven by said motor and arranged concentrically about said lighting unit, said shutter comprising a tubular member having longitudinal portions thereof opaque and the remainder thereof transparent whereby rotational driving of the shutter causes interruption of said light's visibility; the rotational speed of said motor and shutter and thus the frequency of interrupting said light's visibility being controlled by adjustment of said tuning condenser; and indicating pointer means operated synchronously with and by the tuning of said condenser, and arranged for movement over a suitable scale to indicate the frequency of interrupting the visibility of said light producing unit.

3. A flicker fusion testing apparatus comprising, a source of steady light, viewing means for presenting said light in even diffusion to an observer, shutter means surrounding said light source and disposed intermediate the same and said viewing means, a motor connected directly to said shutter means in a manner to rotatably drive the same for interrupting said light's visibility to the observer, control means for adjusting the rotational speed of said motor and shutter means, a pointer means driven by adjustment of said control means, and a scale means related to said pointer means for indicating the rotating frequency of said shutter means corresponding to the indexing of said pointer means thereon.

4. A flicker fusion testing apparatus comprising, a source of steady light, viewing means arranged to present such light to an observer, shutter means disposed intermediate said source of light and said viewing means, a motor arranged to drive said shutter means thereby to interrupt periodically the visibility of said light to said observer, control means constructed and arranged to adjust the rotational speed of said motor, a first pointer means operatively adjustable with said control means, a scale means related with said pointer means in a manner for indicating the rotational frequency of said shutter means in conjunction with the positioning of said pointer

means, and a second pointer means adjustable relative to said scale means independently of said control means and arranged for position matching the scale index of said first pointer means thereby to keep a visible record of said first pointer's scale indication when the first pointer means is moved to a subsequent position by readjustment of said control means.

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