F. W. SPRINGER.

IGNITING SYSTEM FOR EXPLOSIVE ENGINES.

APPLICATION FILED NOV. 5, 1906.

960,598.

Patented June 7, 1910.

2 SHEETS—SHEET 1.

Fig. 1.

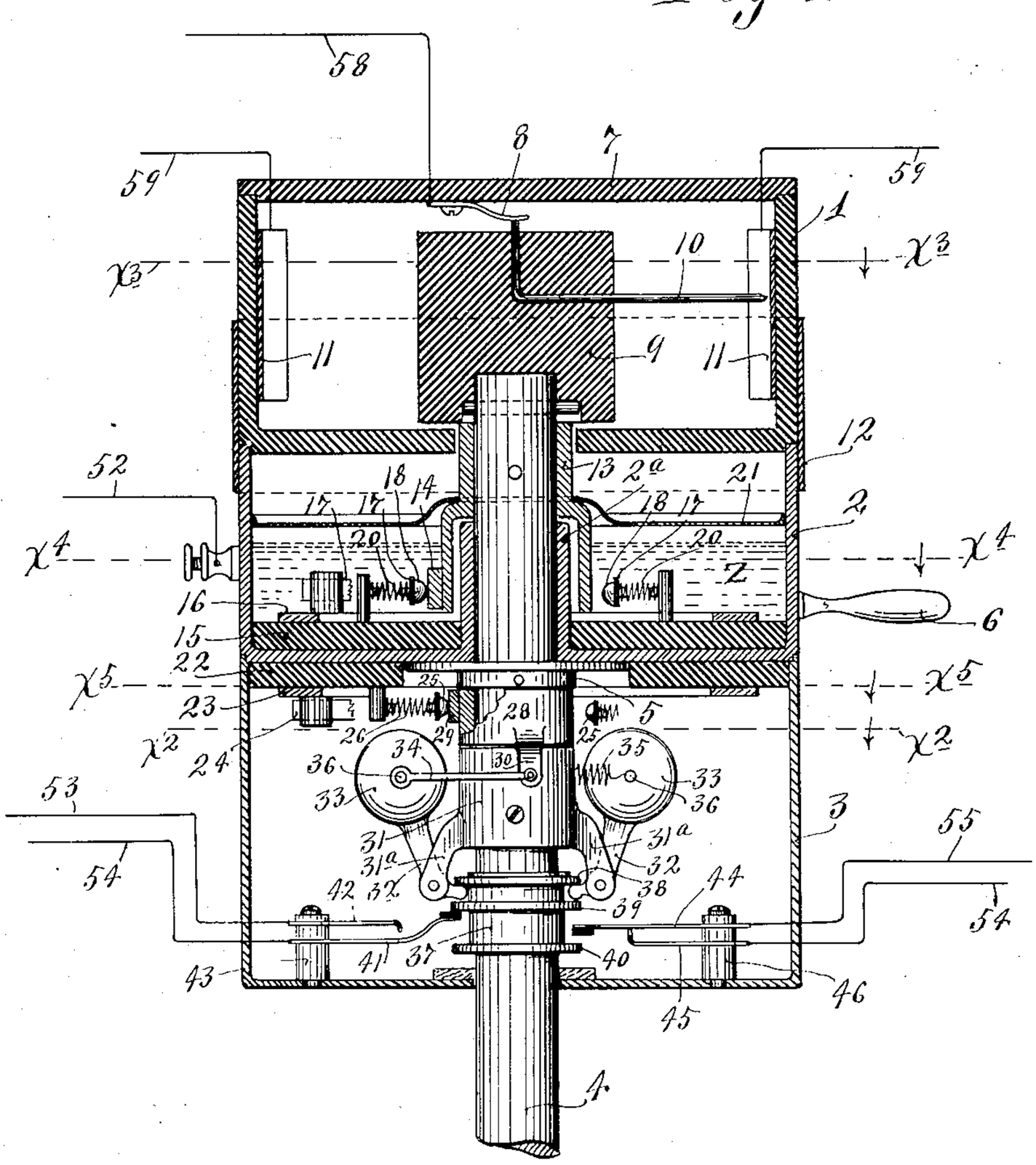

Fig. 2

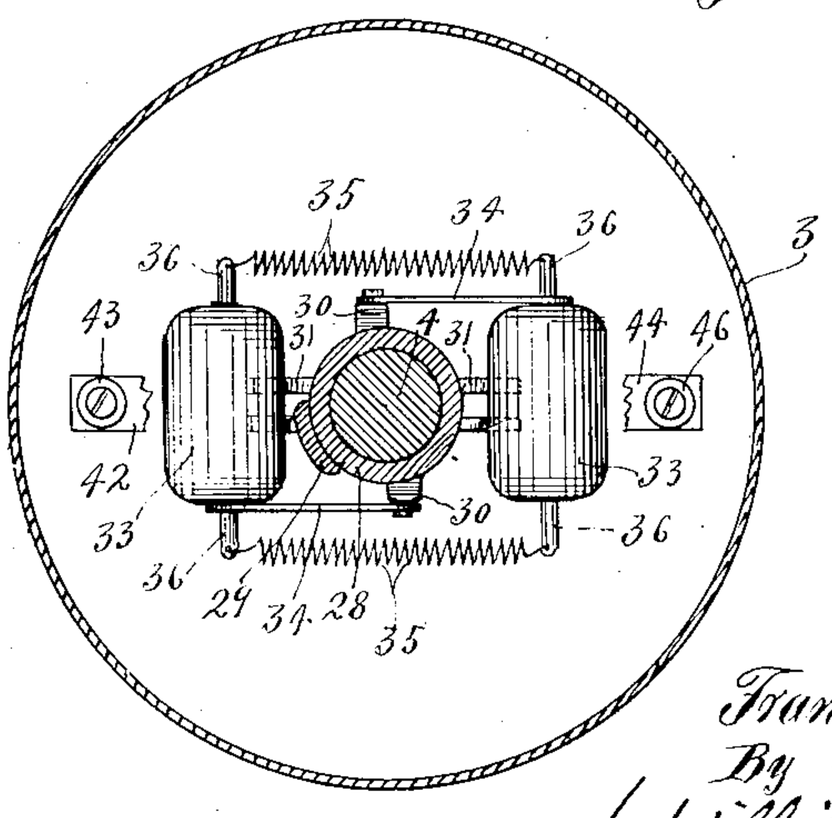

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Fig. 3.

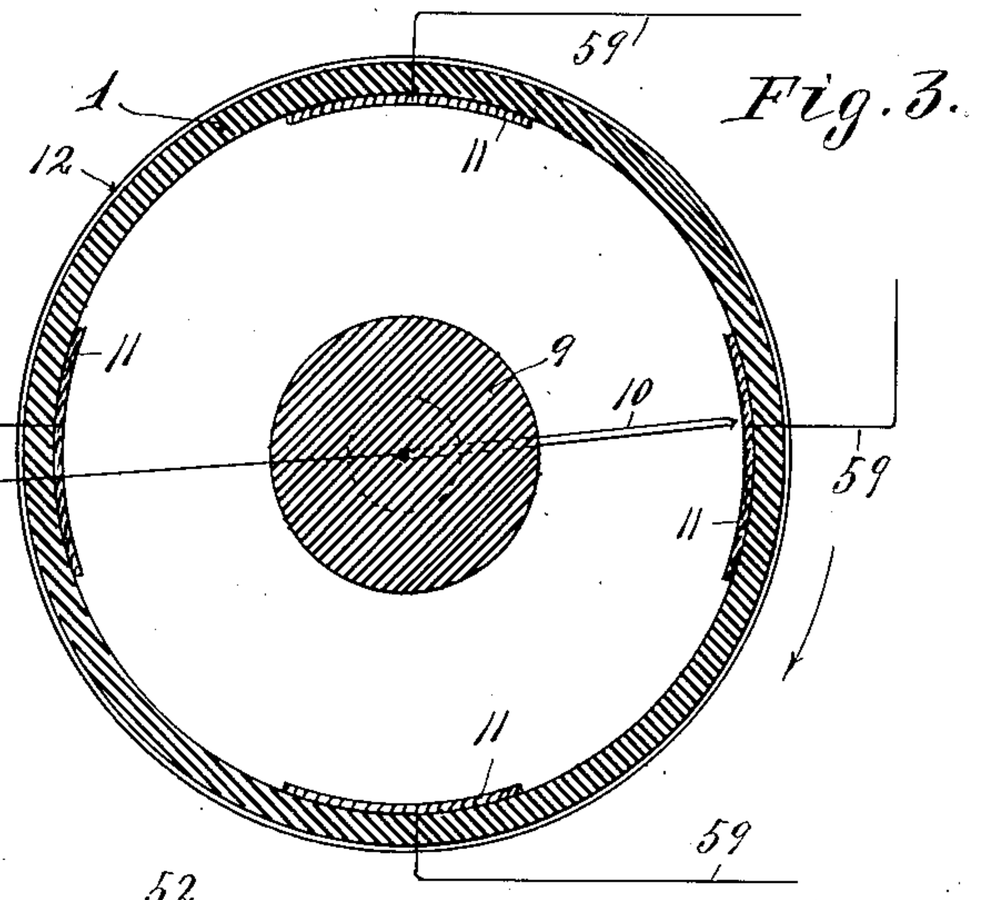

Fig. 4.

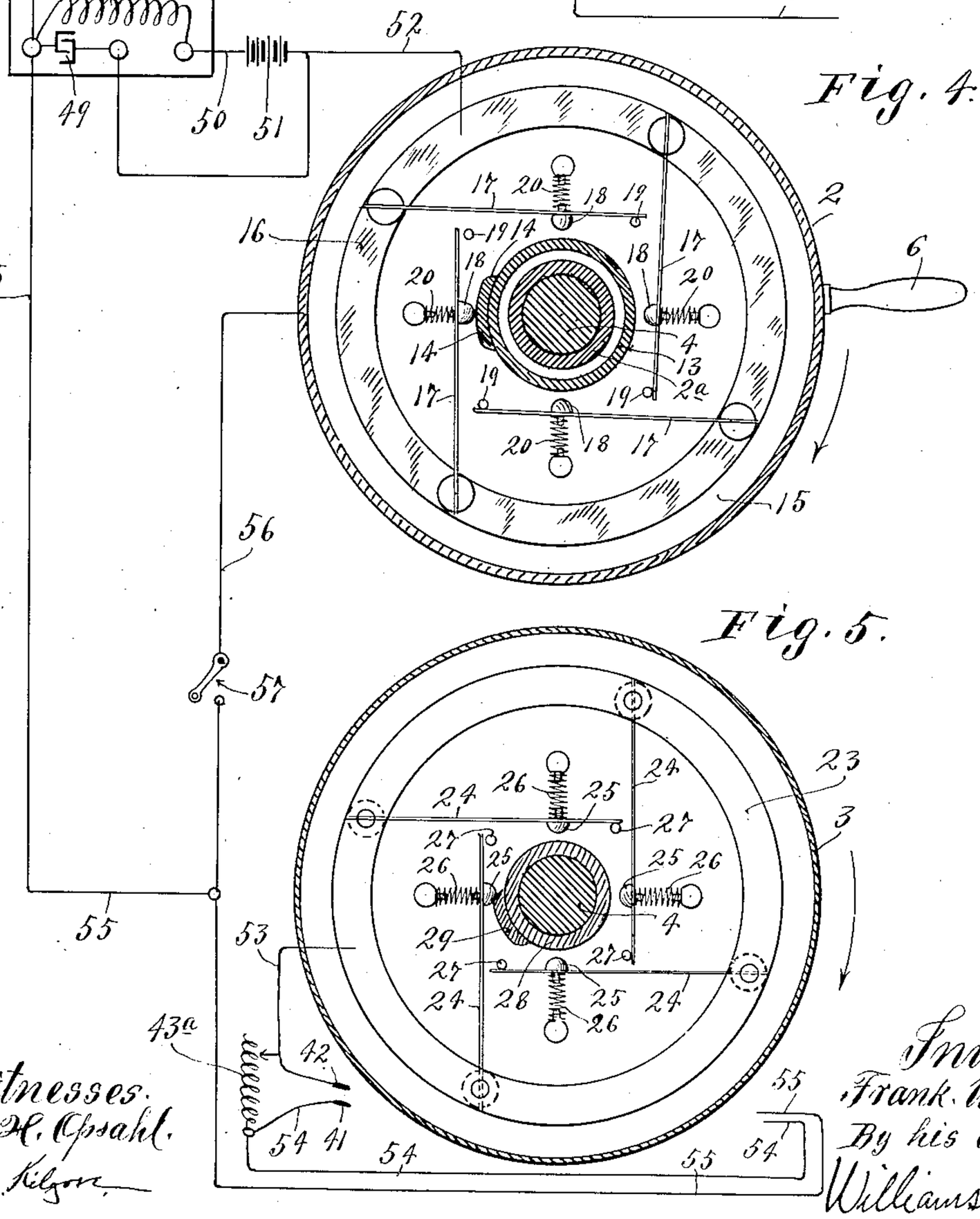

Fig. 5.

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UNITED STATES PATENT OFFICE.

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IGNITING SYSTEM FOR EXPLOSIVE-ENGINES.

960,598. Specification of Letters Patent. Patented June 7, 1910.

Application filed November 5, 1906. Serial No. 341,971.

To all whom it may concern:

Be it known that I, FRANK W. SPRINGER, a citizen of the United States, residing at Minneapolis, in the county of Hennepin and State of Minnesota, have invented certain new and useful Improvements in Igniting systems for Explosive-Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention has for its object to improve the construction and increase the efficiency of ignition systems for explosive engines, and is particularly directed to the improvement of igniting systems for multi-cylinder engines wherein a "distributer" and a non-vibrating sparking coil are employed.

The invention consists of the novel devices and combinations of devices hereinafter described and defined in the claims.

In starting an explosive engine and before it has acquired any considerable speed, a large igniting spark is desirable because of unfavorable conditions, such as low temperature and imperfect explosive mixture. A constant voltage source, such as a battery, working with a non-vibrating jump spark coil or ordinary touch spark coil gives this result under the ordinary or commonly used arrangement, but with such arrangement, under increasing speeds of the engine, the spark continues to become smaller and smaller, because of the decreasing interval of time of contact between the circuit closing members in the igniting system. Under high engine speeds, a large spark is desirable to insure quick ignition, because, as is obvious, at such high speeds, the intervals of time between sparks and the time consumed by each working stroke of the piston becomes very short. In practice, I have found that the best results can be obtained by the production of sparks that decrease in size when the engine speed is increased from zero to a predetermined low or moderate running speed, and which begin to increase in size before the engine speed has increased to the maximum or normal speed. When a battery or constant potential dynamo is used to supply current to the agitation system, sparks of increased size, under increasing engine speeds, can be produced only by increasing the duration or actual interval of time of contact between the circuit closing contacts of the ignition system. This result can not, of course, be obtained by maintaining a constant interval of time of contact. This gradual increasing interval of contact I obtain in my improved ignition system by a device which is arranged to increase the arc of contact between the said contact members at a greater speed than the increase in speed of the engine above a certain desired speed.

My improved sparking apparatus, as illustrated in the drawings and hereinafter described in its preferred form, involves a distributer (for a multi-cylinder engine); a main timer; an auxiliary timer, a governor for adjusting the contact controlling element of the auxiliary timer with respect to the contact controlling element of the main timer; a non-vibrating sparking coil; and a constant source of electrical energy, such as a battery, or a constant potential dynamo, or a battery and dynamo working conjointly. Also the governor is preferably arranged to cut in resistance at very slow speeds, so that the battery will not be seriously depleted while starting the engine, owing to the long time of contact. A condenser is also preferably placed in the distributer for the purpose of increasing the intensity of the spark. This I believe to be a novel arrangement.

The invention is illustrated in the accompanying drawings, wherein like characters indicate like parts throughout the several views.

Referring to the drawings, Figure 1 is a vertical section taken through the combined distributer, timer and governor, some parts being left in full. Fig. 2 is a horizontal section taken approximately on the line x^2 x^2 of Fig. 1. Fig. 3 is a horizontal section taken on the line x^3 x^3 of Fig. 1. Fig. 4 is a horizontal section taken on the line x^4 x^4 of Fig. 1, and Fig. 5 is a horizontal section taken on the line x^5 x^5 of Fig. 1.

In connection with Figs. 3, 4 and 5, the non-vibrating jump spark coil is shown diagrammatically, and the proper connections between same and the various parts of the distributer, timer and governor, shown in the said three views, are illustrated. The combination distributer, timer and governor, in this preferred arrangement, comprise three cup-like sections 1, 2 and 3 that are set one on top of the other and rigidly secured together by bolts, or other suitable means, not shown. Section 1 is constructed of suit-

able insulating material, while the sections 2 and 3 are preferably constructed of metal.

Extending axially upward through the bottoms of the three sections 1, 2 and 3, is an engine driven shaft 4, which, for a two stroke cycle engine, would be driven at the same speed as the engine drive shaft, and for a four stroke cycle engine would be given one rotation for each two rotations of the engine crank shaft. On the shaft 4 is a collar 5 that engages the bottom of the case section 2 and supports the entire case, made up of three sections 1, 2 and 3. The said case, however, does not rotate with the shaft 4, but is, in practice, arranged to be secured against rotation in any one of several positions. This feature of adjustment, however, does not relate to my present invention, and may be the usual arrangement, including a hand piece 6 shown as secured to the case section 2. The case section 1 is shown as provided with a cover 7 of insulating material, to the under central portion of which is secured a spring contact 8. A head 9 of insulating material is secured to the upper end of the shaft 4, and rotates with said shaft, within the case section 1. A metallic distributing arm or finger 10 is secured to and projects radially from the insulating head 9, the inner end thereof being extended upward in line with the axis of the shaft 4 and having constant engagement with the spring contact 8.

The distributer, as shown, is designed for a four cylinder engine, and hence four segmental metallic terminals 11 that are secured to the inner surface of the insulating case section 1, are spaced on quarters. The outer extremity of the distributing arm 10, is arranged to pass nearly or quite into contact with the said terminal plates 11 under the rotary movement of the shaft 4. To provide the condenser above referred to, a metallic conducting plate, preferably in the form of a ring or band 12, is placed around the insulating case section 1. This band 12 is grounded through the case 3, shaft 4 and metallic parts (not shown) of the engine, and is preferably made adjustable up and down upon the case section 1, so as to locate more or less of the said band opposite to the several terminal plates 11, and thereby vary the electrostatic capacity of the condenser.

The bottom of the case section 2 is extended upward in the form of a sleeve 2^a that surrounds and forms a bearing for the upper end of the shaft 4. Rigidly secured to the shaft 4, above the sleeve 2^a, is a sleeve 13, the lower portion of which is enlarged so that it extends over but out of contact with the sleeve 2^a. At its lower extremity, the sleeve 13 carries a segmental rotary contact 14, hereinafter designated as the main contact.

Resting upon and secured to the bottom of the case section 2, is a disk-like supporting plate 15 of insulating material, on the upper surface of which is rigidly secured a metallic conducting ring 16. Contact brushes, as shown, in the form of leaf springs 17, are secured and electrically connected at their outer ends to the metallic ring 16. In the present instance, there are four of these brushes, and each is provided with an inwardly projecting contact piece 18. The contact pieces 18 are located on quarters, and normally stand in positions to be engaged by the main contact 14. As shown, the inward movements of the free ends of the brushes 17 are limited by stop pins 19 on the insulating plate 15, and the said brushes are yieldingly pressed inward by springs 20, this construction being best shown in Figs. 1 and 4. The brushes 17 are hereinafter designated as the main brushes. The main contact 14 and main brushes 17 constitute the controlling elements of the so-called main timer.

Within the case section 2 is a body of liquid oil, indicated by the character *z*. The main contact 14 and the main brushes 17 are submerged in this body of oil. To prevent splashing of the oil, it is preferably covered by a reinforced disk 21 of felt or other suitable material, which, as shown, rests upon and is supported by the shoulder of the sleeve 13.

Located in the upper portion of the case section 3, and secured, as shown, to the bottom of the case section 2, is a ring 22 of insulating material. To the under surface of this ring 22 is secured a metallic conducting ring 23, and to said conducting ring is attached four brushes 24, which, as shown, are duplicates of the main brushes 17 above described, and, like the said brushes 17, are provided with contact pieces 25, and by springs 26 are pressed outward against stops 27, which latter are applied to the insulating ring 22. The brushes 24 are hereinafter designated as the auxiliary brushes.

Mounted to rotate on the shaft 4, just below the collar 5 thereof, is a sleeve 28 that carries a segmental contact 29, corresponding in dimensions and shape closely to the main contact 14, and hereinafter designated as the auxiliary contact. This contact 29 is adapted to be thrown into engagement in succession with the contact pieces 25 of the auxiliary brushes 24. The rotary sleeve 28 is provided with depending ears 30 at diametrically opposite points. The auxiliary contact 29 and auxiliary brushes 24 constitute the controlling elements of the so-called auxiliary timer.

The parts of the governor proper will now be described. The numeral 31 indicates a sleeve which is rigidly secured to the shaft 4, and is provided at diametrically op-

posite points with depending lugs 31ª, to which the arms 32 of the governor balls 33 are pivoted. These governor balls 33 are connected by light links 34, one to each of the depending ears 30 of the rotatively adjustable sleeve 28. Also the two governor balls 33 are yieldingly connected, preferably by a pair of coiled springs 35, shown as attached to pin-like projections 36 thereof, as best shown in Fig. 2. Mounted to slide on the shaft 4 below the sleeve 30, is a circuit maker and breaker in the form of a collar 37, which has three peripheral flanges 38, 39 and 40. The short inwardly extended portions of the governor arms 32 work in the groove between the flanges 38 and 39, and when the governor balls move outward, cause the collar 37 to rise, and when they move inward, they cause the said collar to again lower.

The numerals 41 and 42 indicate a pair of spring contacts, shown as secured to insulating post 43 located within the case section 3. The free end of the spring contact 41 is engaged by a flange 39 of the collar 37, and in the normal positions of the parts shown in Fig. 1, is held out of engagement with the contact 42. These contacts 41 and 42, as will hereinafter appear, afford means for cutting in and out of the primary circuit of the ignition system, a resistance coil 43ª, shown only in Fig. 5.

The numerals 44 and 45 indicate a pair of spring contacts shown as secured to a post 46 located within the case section 3. These contacts 44 and 45 normally are in engagement, as shown in Fig. 1, but they are adapted to be separated by the engagement of the collar flange 40 with the free end of the contact 44, when the collar 37 is moved upward to an extreme position, under an excessive engine speed. As will hereinafter appear, these contacts 44 and 45, when separated, open the primary circuit of the ignition system, and render the system, for the time being, ineffective to produce igniting sparks.

A non-vibrating jump spark coil of standard construction may be employed. Such a jump spark coil is illustrated diagrammatically in connection with Figs. 3, 4 and 5, wherein the number 47 indicates the primary coil, the numeral 48 the secondary coil, and the numeral 49 the condenser. One terminal of the primary coil 47 is connected, by a wire 50, to one pole of a battery or other source of electrical energy. The other pole of the battery is connected by a wire 52 to the conducting ring 16. (Fig. 4).

The conducting ring 23 is connected by wire 53 to the contact 42 (Figs. 1 and 5). The contact 41 is connected by wire 54 to the contact 45, and the contact 44 is connected by wire 55 to the other terminal of the primary coil 47. The resistance coil 43ª, already noted (see Fig. 5), is constantly connected to the two wires 53 and 54. The resistance coil 43ª is preferably adjustable.

A wire 56, having a switch 57, connects the wire 55 (when the said switch is closed) with the ground, through the case section 2 and shaft 4. Normally the switch 57 is open, but is adapted to be closed, in case of damage to the auxiliary timer, shown in Fig. 5, to thereby short circuit the same and to permit the main timer, shown in Fig. 4, to be used as the ordinary timer.

One terminal of the secondary coil 48 is connected to one terminal of the primary coil 47, and hence to ground, while the other terminal of said second coil is connected by wire 58 to the contact 8 (Fig. 1), and hence to the distributing arm 10.

The terminal plates 11 of the distributer (Figs. 1 and 2), are connected by wires 59 in the usual way, to the insulated electrodes of the corresponding spark plugs of the respective cylinders not shown.

Operation: For the purposes of illustration, we will assume that the shaft 4 and parts carried thereby, to-wit, the distributing arm 10, the main and auxiliary timers, and the governor are rotated in the direction of the arrows marked adjacent to Figs. 3, 4 and 5. We must also, of course, assume that the switch 57 is open. We will further assume that the battery or source 51 is a constant potential source of electrical energy. By reference to Figs. 4 and 5, it will be noted that the main contact 14 in respect to the main brushes 17, is set ahead of the auxiliary contact 29 in respect to the auxiliary brushes 24. The position shown in Figs. 4 and 5 may be assumed to illustrate a condition under medium engine speed with the auxiliary contact 29 just brought into an engagement with the contact piece 25 of an auxiliary brush 24, at which time the central portion of the main contact 14 is in an engagement with the contact piece 18 of the corresponding main brush 17. The distributing finger 10 (Fig. 3) at such time moves over or across the corresponding terminal plate 11. As is evident, the primary circuit will be closed and magnetic energy will be stored up in the primary coil 47 only while both the main and auxiliary contacts 14 and 29 are in contact with their respective brushes. It will also be understood that with the main contact set ahead of the auxiliary contact, the primary circuit will be broken and the igniting spark produced, when the main contact 14 passes out of engagement with the contact piece 18 of the respective main brush 17. Otherwise stated, the time of closing the primary circuit is controlled by the auxiliary contact 29, and the time of break or opening of the primary circuit is controlled by the main contact 14. Also it follows that

the length of arc of contact, during which the primary circuit is closed, is controlled by the time during which both the main and auxiliary contacts have coincident engagement with their respective brushes. This coincident contact, and hence the so-called arc of the circuit closing contact, is determined by the relative positions of the said main and auxiliary contacts with respect to the coöperating brushes. To illustrate, if the said two contacts be so set that they simultaneously engage and simultaneously disengage their respective brushes, the maximum arc of circuit closing contact would be accomplished. The minimum arc of circuit closing contact is accomplished when the auxiliary contact 29 is set backward with respect to the direction of its rotation so that it engages a second brush 24 when the main contact 14 is about to leave contact with the corresponding main brush. The governor is so constructed and set that the balls 33 will commence to move outward, against the tension of the springs 35, when the engine has acquired a desired low running speed. When the governor balls 33 move outward, they cause the sleeve 28 to rotate slightly on the shaft 4, thereby causing the auxiliary contact 29 to advance in the direction of its rotation, thus increasing the arc of coincident contact in the two contacts, and thus, of course, increasing the arc through which the primary circuit is closed. This relative advancing movement or adjustment of the auxiliary contact, and the resulting increasing arc of coincident contact compensates, to an extent depending on the amount of said adjustment, for the decreasing duration of contact which would result from increasing engine speed. When a constant source of electrical energy is employed, in order to obtain a spark of increasing size, as the engine speed increases, the auxiliary contact 29 must be advanced fast enough to give a coincident arc of contact in the two contacts that increases faster than the said engine speed, and so that there will be an actual increase in the duration of time during which the primary circuit will be closed under increasing engine speed. This result is accomplished by the action of the governor, and in the particular construction described is due to the arrangement of the governor balls, their levers and coöperating connections. It is evident that the governor balls will tend to move outward or distant from the axis of the shaft 4 with a force directly proportional to the square of the speed of the governor balls or weights and directly as the distance of the governor weights from the shaft, which distance increases with the engine speed. Inasmuch as the spring force increases only as the distance that the governor balls move outward from their initial position while the centrifugal force of the governor balls increases as the square of the engine speed, or even at a greater rate, as above shown, it is evident that the arc of contact will increase at a faster rate than the increase of the engine speed above that predetermined speed at which the centrifugal force just balances the spring tension of the governor. Further, the stiffer the adjustment of the springs, the higher will be the speed at which the arc of contact begins to increase. The initial outward movements of the governor balls 33 raises the collar 37, and permits the spring contact 41 to engage the contacts 42, and thus short circuits the resistance coil 43. By this arrangement, the resistance coil 43 is thrown into the primary circuit, when the engine is stopped and when the engine is running at slow speed, as in starting. When the resistance coil 43 is short-circuited the size of the spark will be instantly increased to a considerable extent. When the engine speed has been increased to a predetermined maximum, the lower flange 40 of the collar 37 will engage the spring contact 44 and thus separate the same from the contact 45, thereby opening the primary circuit and preventing the further production of igniting sparks, until the engine speed is again decreased.

The purpose of the oil *z* in the case section 2, is to smother the spark which is produced when the main contact 14 moves out of engagement with the contact 18 of a main brush 17. The said oil also gives good lubrication.

The above illustrations have assumed the source of electrical energy to be of constant potential. When a variable potential dynamo, which gives a constant increase of voltage as the engine speed increases, is employed, this constantly increasing voltage, to some extent compensates for the increasing engine speed, so that the advance of the auxiliary contact 29 should be less than that above described. In fact, in this latter noted arrangement, the auxiliary contact 29 should be then advanced so as to give an increasing coincident arc of circuit closing contact, less than sufficient to maintain a constant duration of time of circuit closing contact, but sufficient, nevertheless, to give sparks of the desired increasing size, under increasing engine speeds, above a low or predetermined running speed.

In applying the invention to a touch spark ignition system, neither the distributer nor the parts designated as the main timer would be employed. The sparking electrodes in the cylinder or cylinders would be operated in point of time of contact and separation to correspond approximately to the time action of the said main timer, and the auxiliary timer and governor would cooperate therewith to produce sparks of increasing size under increasing engine speeds.

What I claim is:

1. In an igniting system for explosive engines, the combination with a main timer and an auxiliary timer coöperating to produce a coincident circuit closing arc of contact, each of said timers comprising a rotary circuit closing contact, of a governor operative to adjust the said contact of said auxiliary timer with respect to the circuit closing contact of said main timer, to thereby vary the circuit closing arc of contact under varying engine speeds, substantially as described.

2. In an igniting system for multi-cylinder explosive engines having primary and secondary circuits, the combination with a distributer in the secondary circuit of said system having a rotatively adjustable case, of a circuit controlling timer in the primary circuit of said system, and an electrical condenser applied to said adjustable case of said distributer and coöperating with the terminals thereof, substantially as described.

3. In an igniting system for multi-cylinder explosive engines having primary and secondary circuits, the combination with a circuit controlling timer in the primary circuit of said system and a distributer in the secondary circuit, of an adjustable electrical condenser applied to said distributer and cooperating with the terminals thereof, substantially as described.

4. In an igniting system for explosive engines, the combination with a casing and an engine driven shaft extending into said casing, of main and auxiliary circuit controlling timers arranged to produce a coincident circuit closing arc of contact, the said two timers having circuit closing contacts driven by said shaft, and a centrifugal governor driven by said shaft, and operative to adjust the contact of said auxiliary timer with respect to the contact of said main timer, all the said parts being located within said casing, substantially as described.

5. In an igniting system for explosive engines, the combination with a receptacle adapted to contain oil, of a circuit controlling timer comprising a contact brush, a rotary shaft, a sleeve carried by said shaft and having an outwardly spaced depending portion, and a contact carried by the lower portion thereof, the said brush and contact and the lower portion of said sleeve being submerged in the liquid oil contained in the said receptacle, substantially as described.

6. In an igniting system for explosive engines, the combination with a receptacle adapted to contain oil, of a circuit controlling timer comprising a contact brush, a rotary shaft, a sleeve carried by said shaft and having an outwardly spaced depending portion provided with a contact for coöperation with said brush, said brush and contact and the lower portion of said sleeves being submerged in the liquid oil contained in said receptacle, and a disk-like shield overlying the liquid oil contained in said receptacle, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

FRANK W. SPRINGER.

Witnesses:
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F. D. MERCHANT.