(No Model.)

4 Sheets—Sheet 1.

H. CONANT.

ASTRONOMICAL CLOCK.

No. 371,306. Patented Oct. 11, 1887.

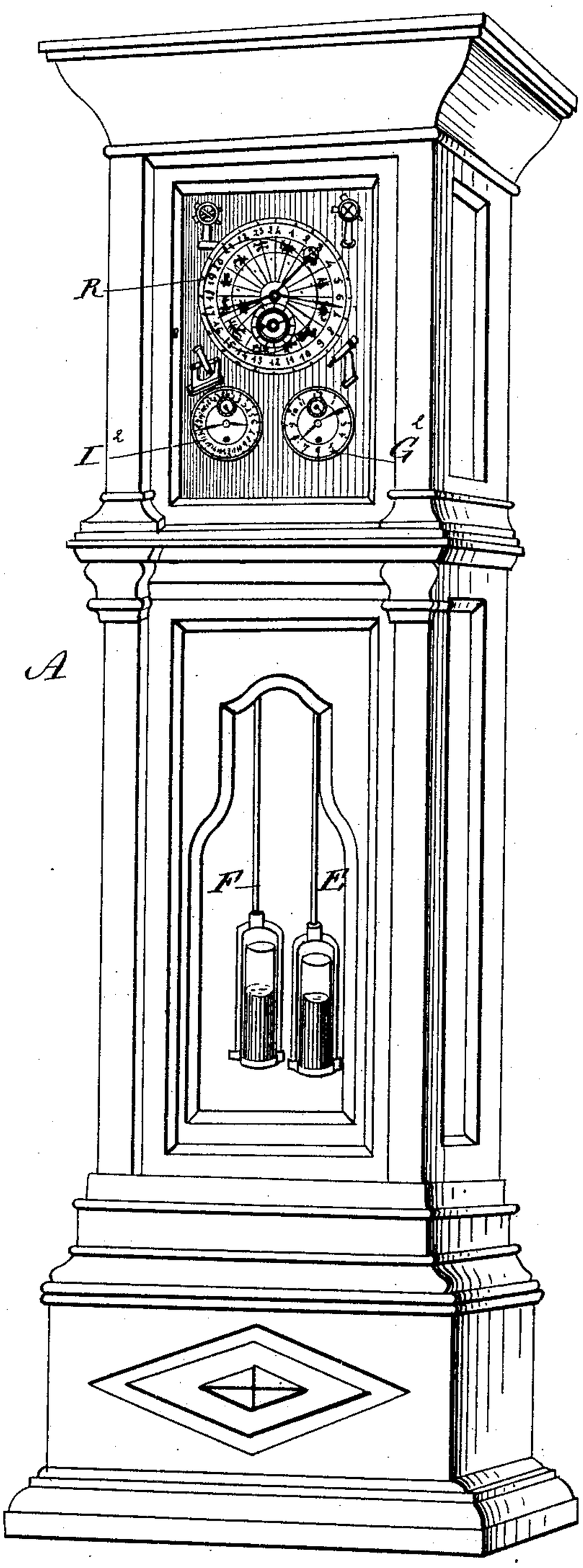

Fig. 1

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ATTORNEYS.

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Fig. 2.

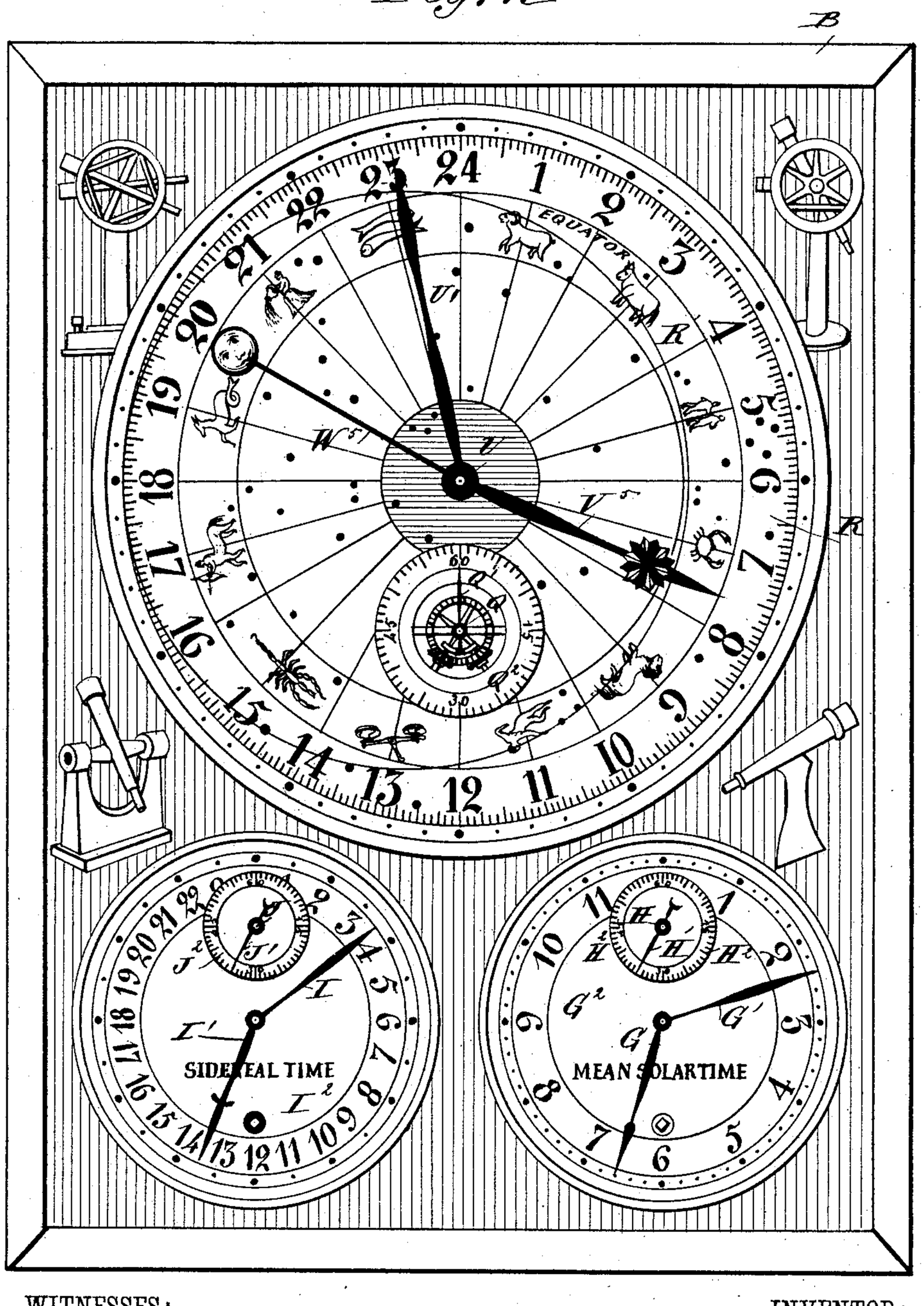

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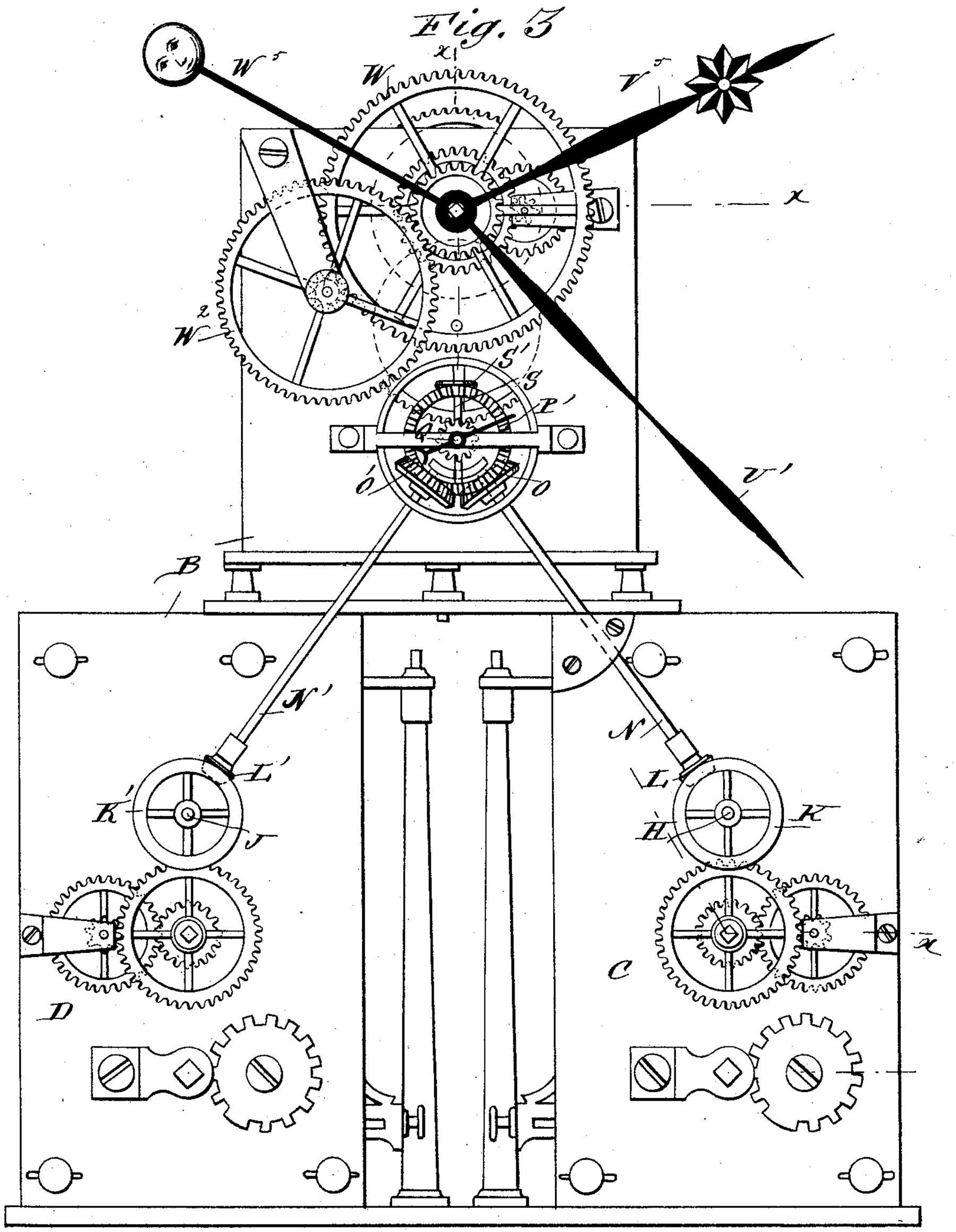
Fig. 3



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4 Sheets—Sheet 4.

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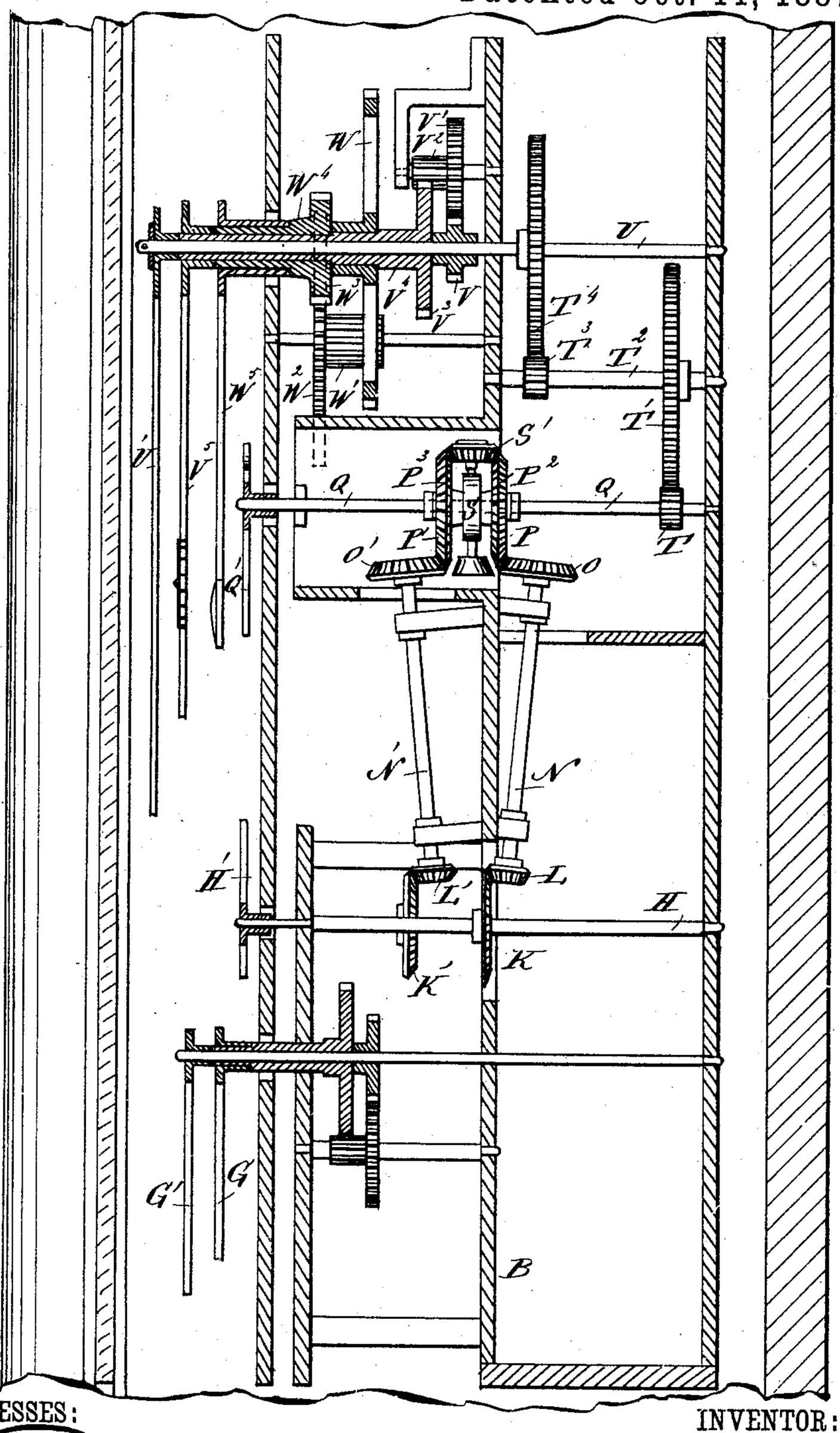
Fig. 4



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UNITED STATES PATENT OFFICE.

HEZEKIAH CONANT, OF PAWTUCKET, RHODE ISLAND.

ASTRONOMICAL CLOCK.

SPECIFICATION forming part of Letters Patent No. 371,306, dated October 11, 1887.

Application filed March 9, 1887. Serial No. 230,241. (No model.)

To all whom it may concern:

Be it known that I, HEZEKIAH CONANT, of Pawtucket, in the county of Providence and State of Rhode Island, have invented a new and Improved Astronomical Clock, of which the following is a full, clear, and exact description.

The object of my invention is to provide a new and improved astronomical time-keeping instrument indicating the correct solar and sidereal time, and also at the same time the right ascension of the mean sun.

The invention consists of two independent regulators or clocks, of which one is regulated to mark mean solar time and the other sidereal time, the difference of the two movements being indicated by a third movement on a dial, indicating right ascension of the mean sun.

The invention also consists of various parts and details and combinations of the same, as will be fully described hereinafter, and then pointed out in the claims.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar letters of reference indicate corresponding parts in all the figures.

Figure 1 is a perspective view of my improvement. Fig. 2 is an enlarged view of the dials. Fig. 3 is a front elevation of the clock mechanism, the dials being removed; and Fig. 4 is a vertical cross-section of the same on the line *x x* of Fig. 3.

My invention, presently to be described, is based on the principle that the difference between mean solar time and sidereal time is the mean right ascension of the sun.

My improved clock is mounted in the casing A, in which is secured the clock-frame B, in the lower part of which are mounted the regulators or clocks C and D, of any approved construction. Preferably, each of the regulators or clocks C and D has a one-second pendulum, E F, respectively, of which the pendulum E is regulated to mean solar time, and actuates by the usual connections the hour and minute hands G and G′, indicating mean time on the dial G^2, which is divided into twelve hours and subdivisions. The escape-wheel shaft H of the pendulum E carries the second-hand H′, indicating on the seconds-dial H^2, formed on the front of the dial G^2.

The pendulum F of the regulator or clock D is set to sidereal time, and actuates, by the usual connections, the hour and minute hands I and I′, indicating sidereal time on the dial I^2, divided into twenty-four hours and subdivisions. The escape-wheel shaft J of the pendulum F carries the second-hand J′, indicating on the seconds-dial J^2, formed on the face of the dial I^2. The hands on the dials G^2 and I^2 thus indicate mean solar time and sidereal time, respectively, in hours, minutes, and seconds. Each of the escape-wheel shafts H and J may be provided (instead of pendulum-escapements) with an escapement of any approved construction.

On each of the escape-wheel shafts H and J of the regulators or clocks C and D is secured a bevel gear-wheel, K or K′, respectively, meshing into the pinions L and L′, respectively, secured to the lower ends of the shafts N and N′, respectively, carrying on their upper ends the bevel gear-wheels O and O′, respectively, meshing into the bevel gear-wheels P and P′, both loosely mounted on the shaft Q, which carries on its outer end the hand Q′, indicating seconds on the seconds-dial Q^2, formed on the main dial R. On the shaft Q is also secured the cross-piece S, carrying on one outer end the bevel planetary gear-wheel S′, which meshes on one side into the bevel gear-wheel P^2, formed on the inside of the bevel gear-wheel P, and the said bevel planetary gear-wheel S′ also meshes on its other side into the bevel gear-wheel P^3, formed on the inside of the bevel gear-wheel P′. The corresponding gear-wheels of the two mechanisms above described, connecting the two regulators with the planetary wheel S′, are alike in number of their teeth.

The gear-wheels K and K′ make a revolution once in every minute, and the train of gear-wheels connected with the said wheels K K′ is such as to impart a rotary motion to the gear-wheels P and P′ at double the speed of the said gear-wheels K and K′. This is necessary to indicate on the shaft Q, by means of the planetary gear-wheel S′, any existing difference between the gear-wheels K and K′, and to indicate this difference on the dial Q^2 by the hand Q′, so that when the second-hand J′ on the shaft J, carrying the said gear-wheel K′, has, for instance, gained one second on the other hand, H′, secured to the shaft H, carrying the said gear-wheel K, then the second-

hand Q' will move forward one second, thereby showing the difference which has occurred between the two hands J' and H' or the two gear-wheels K and K'.

On the shaft Q is secured the pinion T, meshing into the gear-wheel T', secured on the shaft T^2, carrying the pinion T^3, meshing into the gear-wheel T^4, fastened on the shaft U, carrying on its outer end the minute-hand U', indicating minutes on the main dial R. On the shaft U is also secured the pinion V, meshing into the gear-wheel V', having a pinion, V^2, meshing into the gear-wheel V^3, formed on the sleeve V^4, held loosely on the shaft U, and carrying on its outer end the hour-hand V^5, indicating hours on the main dial R.

On the sleeve V^4 is secured the gear-wheel W, meshing into the pinion W', held on the gear-wheel W^2, meshing into the gear-wheel W^3, formed on the sleeve W^4, held loosely on the sleeve V^4, and carrying on its outer end the moon-hand W^5, indicating position of the moon on the dial R. The latter is divided into twenty-four hours, each hour of which is indicated by the hour-hand V^5, the hours being subdivided into minutes, indicated by the minute-hand U', and on the dial is also formed the zodiac R', by which the moon's place is indicated by the moon-hand W^5, giving the respective position of the moon in right ascension.

The operation is as follows: The two regulators or clocks C and D are connected with the differential-motion mechanism on the shaft Q by the gear-wheels O and O', which revolve in opposite directions at a different rate of speed, according to the mean solar time and the sidereal time indicated by the said regulators or clocks C and D. The gear-wheels O and O' impart their motion and speed to the bevel gear-wheels P' P^3 and P P^2, and as both bevel gear-wheels act on the planetary gear-wheel S', but in opposite directions and at a differential rate of speed, the gear-wheel S' will consequently turn with its cross-piece S in the direction of the bevel gear-wheel, P' P^3 or P P^2, which travels the fastest; but the wheel S' travels at a differential rate of speed in relation to the said double gear-wheels P' P^3 and P P^2. The planetary gear-wheel S' and its cross-piece S thus cause the shaft Q to travel at a differential rate of speed between the regulator or clock C and the regulator or clock D, and as the shaft Q operates by its direct connections the hands U', V^5, and W^5 on the main dial R it necessarily follows that the time indicated by these hands is the time of the mean right ascension of the sun.

To illustrate the action of the instrument more clearly it is supposed that the hands of all these dials are set exactly at noon—that is, the solar clock points exactly at mean solar noon, the sidereal clock to sidereal noon, and the upper or right ascension dial to the vernal equinox or twenty-four hours. This, it will be understood, is zero position, and both clocks are properly adjusted and regulated to mean solar and sidereal time, respectively, as indicated. Now let the sidereal clock be started and run exactly one hour, while the mean solar remains stationary. The hands on right-ascension dial R will move forward exactly at the same rate, because it must record the difference between the time by the sidereal and mean solar clocks, so that at the end of one hour the second and minute hands of the sidereal and right-ascension dials will point to zero, and the hour-hands at one hour, showing that the sidereal clock has gained one hour over the mean solar clock exactly. Now suppose the sidereal clock to be stopped at this point and the solar clock started and run exactly one hour. Now, if the hands of the right-ascension dial always show the difference in time of the two clocks, it is evident that they must move backward, as every second that the solar clock makes reduces the recorded difference. This it does so faithfully that at the end of the hour the hands of the right-ascension dial are all moved back to the hour of 24 and zero, as at first. This shows that there is no difference in the time of the mean solar or sidereal clocks. It will be evident from this that whatever the sidereal clock gains over the solar clock will be the measure of the movement of the hands on the right ascension on the large dial R, and it is evident also that the daily gain of the sidereal over solar time is the daily progress of those hands, and also the mean sun in right ascension, so that the time indicated at any instant by the hands of that dial is the record in hours, minutes, and seconds of the sun's progress and his position at that instant, and the time required for these hands to perform the complete record of twenty-four hours, and which is the time required for the sidereal clock to gain twenty-four hours or one whole day and again overtake the solar clock, is exactly the measure of a tropical year, and the instant that the sidereal time is exactly with mean solar time and its pendulums tick simultaneously, that is the instant of the vernal equinox, and in whatever longitude the mean sun crosses the equator on that meridian the vernal equinox takes place and sidereal and solar noon occur simultaneously, and this instrument, if there, would take the exact position first given to all dials indicating noon and zero.

The moon-hand W^5 is to represent approximately the position of that planet in right ascension, and as its motions will be regular it will be a mean moon just as the hour-hand of this dial represents the mean and not the true sun. This hand W^5 makes in its cycle of nineteen years two hundred and fifty-four revolutions about the earth, and will make two hundred and thirty-five conjunctions with the sun, each representing a new moon, and its apposition a full moon, so that the dial will always show approximately the moon's position in the heavens, the center of the dial representing the north pole and also the earth's axis.

It will be seen that the clock is differential, as the hands on the main dial R are indebted for their motion to the difference between the two regulators or clocks C and D, the mean right ascension of the sun being always the difference between mean solar and sidereal time.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The combination, in one instrument, of two clock or time-measuring movements or mechanisms regulated to sidereal and solar time, respectively, and a third train or mechanism which is actuated by the difference in speed of said clocks or time-measuring mechanisms, and indicates said difference by means of moving hands over the face of a third dial, substantially as set forth and described.

2. The combination of a solar and sidereal clock or time-keeping movement or mechanism with a differential device or mechanism, substantially as described, by means of which the progress of the mean sun in right ascension, and other heavenly bodies as well, may be indicated on a third dial, in the manner substantially as set forth.

3. The combination, in one instrument, of a solar and sidereal clock and a third train connected therewith by a differential motion, the whole forming an astronomical clock, showing at a glance mean solar time, sidereal time, and the right ascension of the mean sun in hours, minutes, and seconds, and approximately the positions of other heavenly bodies—as the moon or fixed stars, as may be desired—in the manner substantially as described.

4. In an astronomical time-keeping instrument, the combination, with two regulators or clocks set, respectively, to mean solar time and sidereal time, of means, substantially as described, for indicating the absolute difference between the movements of the two regulators or clocks on a separate dial by hour and minute hands, as set forth.

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Witnesses:
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