These are photocopies of original lecture notes made by HE Jones for a lecture given in March 1972 to the UK Antiquarian Horological Society Electrical Horology Group at a meeting in Uffington, where he was joined by colleague at Synchronome WE Richardson and his son EH Jones, then Chief Engineer and a Director of Synchronome. Unfortunately the quality is not very high, but we are lucky the document has survived.

The lecture contains personal reminiscences of the early days of the Synchronome company including early development, a few asides on the horophone, WH Shortt, his railway speed indicator and free pendulum clocks. There is information on best setup for the standard one second master clock and its regulation, uses for grid metering, telegraphic time transmission and some notes on various installations at British Rail, the United Kingdom Atomic Energy Authority, the Shell centre on the Embankment, turret clocks and time recorders, the evolution of the Shortt free pendulum clock with some measurements and details of the suspension and impulse carriage and changes in the design over the years. There are details on free pendulum installations with variations. The lecture finishes with information on carillons. Hopefully you can read the parts of interest to you.

EW Odell

Mr. Hope-Jones was born in 1868 and was the founder of the Synchronome Company in 1895. He started by introducing the half-minute impulse system; for some years he was up against many people who condemned electric clocks, many being the makers of the ordinary keywound clocks. His enthusiasm for his Master Clock system made him carry on, even though he got little encouragement, and at times the firm was in a bad way financially.
It has been told that in his young days, he wore a top hat, as was usual in those days, and pushed a costers barrow through the London streets with his clocks on.

The early Synchronome systems consisted of a Master clock of what is known as the escapement type, together with secondary dials of the BUC make, i.e. a movement looking like an alarm clock movement with its pair of stamped frames, the centre wheel had 120 epicycloidal teeth and the usual click lever, backstop and coil.

The Master Clock movement was a dead beat escapement driven by a gravity lever resting on a ratchet on the third wheel arbor. The gravity lever was slowly let into contact by the pendulum beating with an armature contact which completed an electrical circuit through its own reset coils and the secondary dials connected in series in the circuit. The battery was usually the Leclanche type and in some cases the clock system was run from the D.C.110 volt mains via a carbon filament lamp of suitable candle power; a carbon filament lamp has a high resistance when cold and lessens as it warms up. This was ideal as it enabled the current to rise in the clock circuit until it was sufficient for the armature in the Master Clock to re-set the gravity lever onto the next tooth up on the ratchet.

This impulse system was so good that soon many were installed, mainly in London. Attempts were made to make a Master movement without the dead beat escapement and after various efforts the movement with its detached gravity escapement as used to this present day was invented; this was in 1907

After the inception of the Daylight Saving Act, as each time change was due, Mr. Hope-Jones would broadcast from the BBC a short talk about putting the clocks to the new time.

His enthusiasm for the Synchronome clock system never lagged, he was always full of it and even when he retired in 1938 he continued writing articles for various journals. He died about 1949.

In these early days we were making a wireless set called the 'Horophone'. This was a one valve set fitted with what was called pancake coils - 2 of them - to react on each other to give a strong time signal from the Eiffel Tower - the Onogo signal. These sets were made up by Mr. Richardson.

MR SHORTT NOTES RE THE ORIGIN OF THE 'SHORTT CLOCKS'

Mr. W.H. Shortt's interest in precision timekeeping can be traced back to 1906 when a serious accident occurred at Salisbury on the London and South Western Railway, as it was then known.

Following this accident Mr. Shortt, who then was a junior assistant in the Civil Engineering Department of that line, was called upon to design a portable speed recorder that would record the speed of a passing train in a manner that could not be disputed.

The instrument he produced embodied a tuning fork with a period of 50 per second, and to check and adjust this fork Mr. Shortt had to arrange a seconds pendulum to produce electrical contacts every second with accuracy. From then onwards he became interested in precision time-keeping, in this he was encouraged by Mr. Hope-Jones and Prof. Sampson, the then Astronomer Royal for Scotland.

In 1912 he delivered a lecture before the British Horological Institute entitled 'Precision Timekeeping' and finished with a description of a clock designed by himself and made by the Synchronome Co. embodying what was then called the 'Inertia Escapement'. (See English Patent No. 12328 of 1911).

In actual tests however, the timekeeping of this clock did not come up to expectations and Mr. Shortt spent much time in endeavouring to reduce the admittedly large amount of energy needed to unlock the escapement. However, the Synchronome Company encouraged him and granted him a Directorship in 1913 and in 1915 he filed another patent No. 9527 of 1915 detailing a further advance, namely the replacement of the single lever hitherto used for impulsing the pendulum and making a reliable electric contact by two levers, a light one for impulsing the pendulum and a heavy one for making contact, the final movement of the light one releasing the heavy one which in its turn reset the light lever by a slow cam action.

In the meantime Mr. Hope-Jones had taken Mr. Shortt to see the Free Pendulum clock which Mr. R.J. Rudd had produced, and had pointed out that the adoption of this principle, i.e. the utilisation of a synchronised slave to dothe work that the time keeping pendulum had previously been called upon to do, was the solution of his problem.

This was the position when in 1916 Mr. Shortt went to France to serve as a R.E. Field Company officer. When he was demobilised with the rank of Captain R.E. after the war had ended he took up Mr. Hope-Jones' challenge and started looking for a reliable means of keeping one pendulum in accurate step with another. This he found (see English patent No. 137614) and in 1921 the precursor of the Shortt Free Pendulum Clocks, later number 0 by Prof. Sampson, came into being.

When seeing this in London in 1921, Prof. Sampson was sufficiantly impressed to say that he must forthwith test its going at his Observatory in Edinburgh. The clock was actually set up in the Observatory early in 1922, and its performance in 1922 and 1923 was so favourably reported upon by Prof. Sampson that the Synchronome Company had to produce duplicates, and they called upon Mr. Shortt for a suitable design to work to. Although the impulse in Shortt 0 was delivered to the master pendulum below the bob he decided that in future it would be better to deliver it to the Master Pendulum some 6 inches below its point of suspension. The required drawings were prepared accordingly and all future clocks were made in accordance therewith.

Shortly after Mr. Shortt returned to the London & South Western Railway on the ending of the first world war he was appointed Divisional Engineer in charge of the maintenance of the Western Division and became a full member of the Institution of Civil Engineers.

In 1931 the Worshipful Company of Clockmakers of London made him a liveryman 'honoris Causea' Later he was invited to join the Court of Assistants and he served as Master in 1950.

In 1931 the British Horological Institute presented him with a Gold Medal on which is engraved 'OB HOROLOGIAM EXERCI TATIONE PROMOTAM DOCTRINAQUE ERUDITAM' and the Franklin Institute awarded him one of their John Price Wetherill Medals for discovery invention of development in physical science.

When in 1954 the Clockmakers Company decided to commemorate Outstanding Achievements in Horology by anyone British or otherwise by the award of a Gold medal to be known as the 'Tompion Medal' they resolved that the first medal should go to Mr. Shortt.

Mr. Shortt was in touch with Mr. Richardson and myself for many years by personal visits and correspondence. It was left to us to carry on, with the help of two or three bench hands, with making the railway speed recorders and the Shortt clocks and slaves and the other apparatus that goes with them.

For some time Mr. Shortt did all the mathematical calculations for each Shortt clock, he also made the free pendulum suspension springs but somewhere around 1930 he left us to do it all. We made a special grinding machine for the making of the suspension springs. (Show suspension spring)

Mr. Shortt was in retirement for some years and died on 4th February 1971.

THE STANDARD MASTER CLOCK.

A few words about the standard half-minute impulse Master Clock - the controlling pendulum, the basis from which we have done so much. It is worth mentioning some of the rules which should be observed to get the best service from it.

When set up correctly and set going the arc of the pendulum should settle down to 35 + 35 to 40 + 40 on the beat scale. The beat scale is set out in millimetres

centimetres and 20 millimetres equals 1° of arc. The various adjustments are probably known to you all but a brief mention of them may be helpful. When the pendulum is at zero and the gravity lever roller is allowed to rest on the curve of the impulse pallet, the pivot of the roller should be in a horizontal line with the top corner of the curve of the pallet.

Contact gaps. With gravity lever on its catch and the armature left hand stop adjusted so that the armature has a 1/100 inch between it and the top magnet pole. The closed gap should be 1.8 millimetres (.071"). Adjust the contact screw suitably. The open gap, i.e. when the armature is resting against the right hand stop, should be 5.4 millimetres (.212").

Adjust right hand armature stop suitably. The return spring on the catch should not be too strong.

The current values. It is quite important that the current adjustments should be correct as the whole system, Master Clock and dials depend on it for correct working. An ammeter should be placed in series with circuit and an adjustable resistance of a few ohms together with a suitable battery. The battery should be about 4 volts or a little more.

Hold the contact closed and adjust the resistance so that you have a current reading of .26 amp. - Explain BN and adjustment of armature tailspring. Explain dying kick and working current.

Now if the spring tensions onthe dials in circuit are adjusted so that the movements will just respond at .22 amp. then the dials will all work correctly even when battery warning is indicated, and the battery can be attended to without the circuit getting out of order.

Regulation. By means of the rating nut, 30 secs. per day for one revolution.

Weights on tray. When tray is midway between suspension spring and centre of bob .63 gramme put on the tray will make clock gain one second a day.

If there is no tray then put weights on top of the bob - 2 grammes will make clock gain one second a day.

Weight of roller of GA on pallet=24 grammes. Only 8 grammes required to maintain the arc.

PENDULUM COMPENSATION

The Standard Master Clock called Controlling Pendulum fitted with seconds switch and used for making records on Seismograph apparatus 2 secs. every minute, 4 secs. every hour or other periods of recording.

USES IN POWER STATIONS Grid metering for checking loads at every 30 minutes. Set up on station panel centre secs. impulse dial, mains impulse dial, differential dial of 30 secs. 60 secs. 120 secs. 180 secs. 300 secs. 15 minutes, 20 minutes.

Other forms of frequency checking, twin seconds hands, revolving centre dial and pointer as Everett Edgcumbe showing difference between mains and impulse. A system (Dwg. No. 13683) which uses a differential dial with a dial calibrated for 15 minutes +- as shown on Dwg. 11520, this dial is fitted with adjustable contacts which operate two interlocking relays, one closes its contacts as soon as the frequency is a set number of seconds fast, and the other when frequency slow; when the frequency takes the differential points back to zero both relays become on open circuit. The idea of being interlocking is so that if one relay is operating, the other cannot be. The output from the relays operates other devices which cause the generator to slow down or speed up until the necessary correction is made.

The Master Clock through these devices automatically controls the speed of the station generators to put out a frequency of 50 cycles within very close limits. Dwg. MC/C035/8 shows a typical circuit for a power station.

Uses by Cables & Wireless, Eastern Telegraph, Western Telegraph, etc.

started in 1923. The Telegraph companies have been supplied with over 150 special Master Clocks in teak cases, made airtight with rubber gaskets and special clamps. The usual half-minute impulse movement and an Observatory type seconds switch and other fittings. Each clock has had to pass a rigid test by a visiting Company Inspector with regard to all mechanical and electrical details.

The half-minute circuit is sometimes used for operating a few dials, the seconds circuit is used for synchronising or correcting a powerful reed which vibrates at 30 per second and in turn supplies impulses to a phonic motor; each second the phonic motor is checked for speed from the seconds swith and if found wandering fast or slow by a few milliseconds, the clock impulse makes a slight alteration to the speed of the reed, which in turn alters the speed of the phonic motor.

The phonic motor winds a coded paper tape through a transmitter at high speed sending its message to a receiver in another part of the world. The receiver also consits of a phonic motor which is kept synchronised by seconds impulses from the sending end.

The method of transmitting over long distances is quite complicated in order to overcome lag and strangulation on the lines running under the sea.

The Master Clocks are stationed all over the world; some in quite remote places like the ~~Arizona~~ AZORES, Batavia, Ascension, St. Helena, Pernambuco, Monte Video, Rio, Rodriquez and Penang.

British Railways have many installations including Euston House and Station, Crewe, Rugby and places where remote control in required, operating dials up to 20 miles away from the Master Clock. & FT$_{DA}$ S/S DIAL

An installation was supplied to an Indian University where the dials were set out in Viparlas, Parlas, and Ghati, our equivelent of seconds, minutes and hours, but at different speeds; the difference being 60 viparlas = 1 parla, and 60 parlas one Ghatie, and a day was about 20 hours.

Our Master Clocks are used extensively by London Passenger Transport Board on the underground railways; each Master Clock fitted at various points along the railway system and each Master Clock is fitted with a heart shaped synchroniser cam on the 15 toothed wheel and a daily signal is sent out to them all to keep all Master Clocks to correct time.

Apart from the above type of synchroniser and the hit and miss type, there is the rocker synchroniser.

The United Kingdom Atomic Energy Authority of Winfrith have a large installation of clocks installed consisting of 2 Master Clocks with Observatory Seconds Swithes, one Master Clock synchronised by the hit and miss by the other. They have an alarm system made by us to sound if the Master Clocks vary from one another in seconds or half-minutes, or if the mains failed or the battery voltage dropped or a line disconnection, or AC mains failed. They also have some 25 special time panels, about 150 triple relay units, a large number of half-minute dials and seconds dials; the seconds impulses were also used for many other purposes.

A change over switchsystem we supplied enabled one Master Clock to take the load whilst the other was kept going ready to take over.

Shell Centre on the Embankment.

This installation had 2 Master Clocks, one synchronised to the other, had seconds switches and 4 - 16 way Distribution Boards making 64 loops of clocks. Over 3000 dials installed with an ultimate of 4000. All the dials in each loop are connected in parallel to each other.

50V. Battery special Charger.

40 amps. on impulse. Each dial requires 10 milliamps, Change over Switch box, one Master Clock on duty, the other kept in step and ready to take over.

The Synchronome Company has many hundreds of clock installations out all over England, Scotland, Ireland and Wales and throughout the world, as far away as Australia and New Zealand.

In London, just to mention a few out of many hundreds - Libertys of Regent Street with George and Dragon and quarter chimes. Other well known buildings are Selfridges, Harrods, Gamages, Prudential, Swan and Edgers, Cadby Hall (J. Lyons) Many Marks and Spencer stores have Synchronome clocks. Outside the store, these double faced clocks are built specially to a design for Marks and Spencers.

Synchronome House in Clerkenwell Road - Master clock in ontrance.
Later a 3 ft. Centre Seconds double faced clock was erected on the front of the building and was fitted with a loud speaker from which was given the 6 pips every hour.

London Airport Airport Dwg. No. 1C5/6/2.

Over 400 dials, cyclometers. Two Master Clocks.

Distribution Boards
Typical Charger
} Dwg. W 9033/4 way.

Dial Movements

Sizes No. 1, 2, 3, 4, 5 ½ min. impulse.

Centre seconds impulse.

London Hospital Type.

Swing Armature.

Rotary type movements.

Impulse and Mains Timers, Flyback, remote operation and front reset.

With these movements, dial sizes range from 3½" dia. to 9 ft. dia.

Screw collars, backstop lock, magnetic lock, Bridge Motion.

Bulova clock in Piccadilly Circus is a 10 ft. (ten ft.) dia. centre seconds clock, the seconds hand is mains driven, the hour and minutes are half-minute impulse driven by a size 10 movement. Dwg. 14552/1 Actual size.

Seconds hand corrected to Master Clock time every minute.

Turret Clocks

Control of existing turret clocks by hit and miss synchroniser on the pendulum.

Release by doing away with the pendulum. Mains motor driving large dials Master clock controlled every half minute and memory device.

Huygens endless chain drive on weight driven turret clocks.

Striking and Quarter chime gears with Master Clock Control. Striking gear for 4 ton bell. Turret clocks with removable centres.

Bensons & Gillett & Johnson were joined up with us for some years during which time we worked with them, they making the clocks and we supplying the equipment to put them under the control of the Master Clock.

Programme Controller (See Dwg. M 9037)

This instrument is operated by half-minute impulses from the Master Clock or can be made to operate from the AC Mains.

It is arranged to sound or show signals at any 5 minutes during the 24 hour day. The signals can be pre-set to repeat daily and times may be altered quite easily; the number of signals per day increased or decreased as desired. Normally the soundings are from bells which ring for 8 or 10 seconds.

The signals normally repeated at the same times daily can be silenced for any day or week-ends or part of any day.

Signals may be in the form of a number of bells throughout a building or to light lamps, sound klaxons or hooters, close circuits for multiples of five minutes; often used for switching on and off 'Music while you Work'; lighting street lamps in factories spread over a large area such as Austin Motors.

Relay, latching relays, timer relays can be fitted in Programme Controllers to handle very heavy loads such as 60 amps. at 250 volts.

The Programme Controller can be made for from one to six sets of daily signals and can be used in a variety of ways; a change of programme on 6 days of the week, or six output circuits, each circuit having different signal times, or any combination desired from 2 to 6 circuits.

Another type of Programme Controller can have a selectivity of one minute, making 1,440 selections per day but this is restricted to one output circuit.

Time Recorders and Time Stamps

Various makes of Time Recorders have been adapted to come under the control of the Master Clock such as the National, International, Gledhill Brooks, Radial Machines etc.

The control is by the release method in which case the clock is wound as usual and the escapement modified or done away with to allow the half-minute impulse to let the train run the space of half a minute in a second or so.

Another method is by fitting a Synchronome impulse movement in place of the keywound movement.

Marine Master Clocks

Several types have been made, the early ones just as one Master movement with pilot dial, press button for advancing and a brake lever to stop the escapement for retarding.

All Marine Master clocks are fitted with a fully jewelled robust lever escapement with a 25 millimetre (1 inch) dia. balance wheel and the movement is similar to the escapement type Master Clock excepting that the gravity lever is made in the form of an inertia bar to prevent it jumping about due to the violent pitching of the boat.

Another type contained 2 master movements with a change over switch so that if the one on duty breaks down the other can be switched in.

This Master Clock had a special device with a slip tooth wheel for retarding and a press button for advancing. The type shown here, as you can see, has automatic advance and retard. The most modern type is shown in the photograph.

Page 248 Electrical Timekeeping.

A number of marine installations are in use.

The Shortt clocks and Slaves

The first Shortt Clock No. 0, was built by Mr. Shortt in 1921. We were able to help in the finishing of this clock; the movement was underneath the bottom of the pendulum. Prof. Sampson of the Royal Observatory, Scotland, tested this clock out and was so impressed by its timekeeping performance he decided to make it his chief clock and gave Mr. Shortt a very encouraging report on it.

Mr. Shortt in co-operation with Mr. Hope-Jones, who had been most enthusiastic with Mr. Shortt's efforts for some years, decided to make more of these clocks, but the movement below the pendulum was abandoned owing to the awkardness of fitting up in an airtight case and the quick action of the impulse.

The clock was re-designed so that its movement gave an impulse to the pendulum 6½ in. below the centre of suspension. This brought the movement above the top flange of the copper cylinder case and under a glass bell jar.

The production of the Shortt clock was then given to the Synchronome Company to produce under the guidance of Mr. Shortt who did the preliminary drawings and all the calculations necessary for each one. A standard half-minute impulse Master Clock was used as the slave clock and it was by Mr. Shortt's brilliant invention of the hit and miss synchroniser that enabled very close coupling between the Shortt clock and slave, to within 1/1000 of a second, thus enabling the Shortt clock to become such a perfect timekeeper, being freed from all work and its pendulum being given such a perfectly timed half-minute impulse. Everything was done to make the Shortt clock perfect. A fully jewelled movement with a very light balanced gravity lever with a small weight fitted to it for the impulse so that the pressure on the impulse wheel, fitted on the pendulum, by the gravity lever was 1.2 grammes when the clock is working in atmosphere and only .32 grammes when working at an air pressure of 20 millimetres. The travel of the gravity lever at its engaging tip with the wheel is 2½ millimetres before they part company.

Resetting of the gravity lever. Page 162 Practical Horology, Pechman Rees

The pendulum rod is of a special high quality stabilised invar of a very low temperature co-efficient.

The suspension spring ground from a solid piece of elinvar 10 Millimetres wide by 1½ millimetres (.005") thick for an area of 10 millimetres by 6 millimetres; the thick ends being suitably finished so that drag could not occur.

the centre part of this blank was ground away until the centre part was .125 millimetres

The compensating collar which is pinned to the rod and supports the bob is made of brass, steel or invar of a length suitable for compensating purposes.

The bob, weighing 14 lbs. made of typemetal is counterbored from below so that it rests on the compensating collar at about its centre, and therefore the bob does not come into the compensation calculations.

The impulse carriage fitted on the pendulum carries the impulse wheel which is 6 millimetres dia. spoked and fitted on a staff or arbor with pivots .125 millimetres dia. (.005") running in jewel holes with endstones.

After Shortt No. 37 an invar bob was used as being a firmer material than typemetal. The pendulum is suspended on a heavy 4 legged casting resting on the top ring of the case and facilities are fitted on this headcasting for enabling the pendulum to be traversed in all directions for correct centering.

The movement is also fitted to the headcasting so that it too can be adjusted for height and right to left position.

Gauges are fitted inside the case to show temperature and air pressure and an oil gauge as a vernier (?) pressure gauge.

The copper cylinder is 9 inches dia. by $\frac{1}{8}$" thick and originally was fitted in heavy gunmetal end castings, the copper tubing finishing half was through the end casting. This joint gave us quite a bit of trouble with air leaks and we spent much time in water testing, locating the leak and stopping it up.

This went on until Shortt No. 28 in 1929.

A new design was madd where the copper tube went right through the gunmetal casting and was flanged over the top and the copper ends precision surfaced to take the bell jar at the top and the $\frac{3}{4}$" thick plate glass circle at the bottom. This proved very successful and very little trouble was experienced afterwards.

I would mention that when the internal air pressure of the case was reducedfrom about 760 millimetres to 20 millimetres the crushing pressure on the case, bell jar and plate glass is 9 tons.

The first Shortt clock made after No. 0 was kept by the Synchronome Co. It was built up in a glass cylinder 43 inches long by 10 inches dia. with special end castings and unsuitable for use at a reduced air pressure. After some time it was given to Dr. Ward at the Science Museum, South Kensington where it still is. It had no number.

In 1924 production really started on the Shortt clocks and slaves. No. 1 going to Helwan in Egypt as a sidereal clock. No. 2 going to Tokio, Mean Solar Time; and No. 3 to the Royal Observatory, Greenwich as a Sidereal clock.

Throughout the years business was pretty brisk with Shortt clocks until No. 98 in 1956 when it slowed up owing to rising prices and the growing popularity of Quartz crystal clocks.

However, since 1924 up until the present day, the Shortt clock has held the world record for accurate timekeeping for pendulum type clocks; this being of the order of within one second a year.

The total arc of the Shortt clock pendulum is a little over 100 minutes, this is rather small but was considered by Mr. Shortt to be most suitable. Reading of the arc is by means of a fine scale engraved on an ivory plate swinging on the bottom of the pendulum against a very fine fixed wire line at zero.

Another method is by means of a reflecting microscope fitted with prism lenses for sighting through two angles; the eye piece is fitted with a vernier scale and the pendulum fitted witha diamond engraved stainless steel scale enabling the arc to be read to within 2 seconds; that is within 1/1000 inch. This is at a radius of 45 inches, a few seconds of arc means a change of rate so it is very important to keep a close check on the arc in order to forecast the rate. Usually no change of arc is noticeable unless through some outside disturbance such as earth tremors.

In most cases where Observatories have Shortt Clocks they have, owing to their extreme accuracy, become the Director clocks. They are usually the Sidereal clocks, more than half of the Shortt clocks supplied are for Sidereal timekeeping.

Most of the slave clocks have been of the Regulator or B type and many of them of the Mean Solar type have had time signal duties to do for transmission over the wireless services.

In 1927 we installed a Rugby Rhythmic transmitter with a half-seconds pendulum, controlled from the Shortt Clock. This was the first transmission of this type of signal sent out from Rugby.

Some time later we installed a one seconds pendulum B type slave fitted with the Rugby Rhythmic signal which took over from the half-seconds one.

Greenwich Observatory have 6 Shortt Clocks and associated apparatus and the Sidereal clocks were the Director clocks for many years.

Over the years we have been much in contact with Prof. Sampson of Edinburgh, the late Sir Frank Dyson, Astronomer Royal for England, the late Mr. Bowyer, Chief Time Assistant, Dr. Jackson, Mr. Humphrey Smith at that time in charge of Abinger Magnetic Observatory, the late Sir Harold Spencer Jones, Astronomer Royal for England, Mr. Rickett in charge of the clock and watch section at Hurstmonceaux and Mr. Gould of the National Physical Laboratory.

The Shortt clocks are stationed all over the world -

15	installations	in	Russia
9	"	"	China
9	"	"	America
7	"	"	Poland
6	"	"	Greenwich
3	"	"	Helwan
3	"	"	Rio de Janeiro
4	"	"	Australia

Many of them, particularly those in China have been fitted with various extra time signals such as the 6 dot seconds, the Rhythmic Signal, Mean Time Signal, Gong Signal, American Time Signal.

The Magn[illegible] Creed Relay. Gerryck Vacuum Pump.

Time Ball and Shepperd clock at Greenwich.

Reiflir (?) from Adelaide.

Buckfast Abbey 9 ft. dial.

Emanuel Southampton

Loomis, Admiral Fountaine, Mr. Uitermarck (Barometric Compensation)

Mr. Fry, Dr. Shone,

Mean Time - Sidereal Clocks. Synchronome
Vinos
Comrie 137 153 20 S/D
Mk 45 71 257

W.T.T.

Time Elapse Clocks. B.I.F. Reverse Polarity Master Clock.

Carrillones

The Carillone was an idea thought up by our Mr. Burgess about 1950. He was then our Managing Director having succeeded Mr. Hope-Jones in 1938.

We contacted a Mr. Leslie Bourn, Chief Electronics Engineer of the Compton Organ Co. of Acton, who readily took to the idea. He had already invented the Electronic organ which was being used in churches, cinemas and Working Mens' Clubs.

Mr. Bourn designed an instrument to sound bell notes on a 25 note keyboard and to sound any sort of chime; strike, and tune automatically; provided, that we designed and made all the clock control mechanism operated from the standard Master clock. This was done and an instrument was produced which was in a metal case standing 6 ft. high 2 ft. wide and about 15 ins. deep. It weighed over 2 cwt.

It consisted of a complicated clock mechanism (as here) a pilot dial, over 40 relays, 3 or 4 uniselectors, 12 note generators (as here) driven by a motor, a multitude of resistors and capacitors mostly to control the dying away of each note after the initial percussion blow. A 90 watt amplifier, a loudspeaker, power supply transformer, rectifiers and smoothing devices and various control switches and output plugs for

the external loudspeakers. Instruments were made up to the customers requirements, which consisted of the Westminster chimes and bells; the Whittington chime and strike, traditional tunes like Come back to Erin or Scotland the Brave; Hymn tunes e.g. the 23rd Psalm; the Angelus at the times required. Come to Church bells and toll for the dead.

The external loudspeakers were 4 in number of the straight horn type, 6 ft. long or re-entrant type; each loudspeaker being fitted with twin loudspeaker or pressure units. Usually fitted up on a special frame on the roof or in the church tower. When in action they could be heard up to 1 mile away.

The 12 note generators, each give out several pure notes by means of capacitance off metalised discs engraved to give the required note frequency. The generators all revolve at speed, each one at a different speed so some 50 frequencies are made. These are all on open circuit until a uniselector being impulsed by a beat relay closes a relay to initiate a note. This relay ~~xxxxxxxxxxxx~~ is fitted with 6 contacts which is wired to as many pure notes to make up the required bell note which starts as a sharp blow and slowly fades due to the discharge of capacitors through resistences.

This is fed into the Amplifier which produces a near perfect bell note.

The Carillone can be and is usually, installed in a remote position from the loudspeakers. The complete range of notes from a Carillone is equal to 10 tons of bells.

Some Campanologists do not approve of the Carillone; in fact one gentlemen I know usually shudders when he hears one, particularly if he sees I am watching him!

Over 20 Carillones were made and sent to various places, each one being under the control of the Master Clock and often comprising circuits of dials.. .... Father Myers, Phillipines; West Drayton Council Offices; Annistymon Church, County Clare; Meath Street Catholic Church, Dublin; Moneymore Catholic Church, N. Ireland; St. Patrick's Catholic Church College, Maynooth, Nr. Dublin;

(Jamison, Jeweller, O'Connell St., Dublin
(with 3 faced clock on face of building having 3 - 3 ft. dials, Jamie,
(Prince and Princess striking the hall of St. Patrick
(Holy Trinity Church, Glasgow.
St. Pauls " "
St. Johns " "
St. Stephens " "
Kirkintilloch " "
St. Charles " "
St. Aloysius " "
St. Christopher, Speke.
T. Aroka, New Zealand.

House of Fraser, Binns, Edinburgh with a large outside clock with the pipers as shown in photograph. Complete with Carillons playing quarter chimes, tunes i.e. Scotland the Brave and Caller Herrin and other.