SIMPLE CALIBRATED PHONOCARDIOGRAPHY

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Vol. I.

INTRODUCTION.

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The history of graphic recording of the heart sounds already spreads over nearly a century, but, even yet, this valuable adjunct to cardiovascular investigation is in the experimental stage. As late as 1940, experienced investigators in this field, such as Boyers, Eckstein and Wiggers (4), wrote "The day has not yet arrived when heart sounds can be recorded routinely through simple manoeuvres as in the case of making electro-cardiograms"; and also, "In view of the astounding changes in the configurations and vibrations of sounds which are produced by even slight changes in technique, it is improbable that the repeated records from patients will prove to be of much diagnostic or prognostic importance for the clinicians or practitioners of medicine". It is the purpose of this thesis to describe and discuss a method which, though not so simple as an electro-cardiogram, yet has been, and can be, of clinical value for routine use where doubt exists or extra information is desired with regard to the vibrations produced by the heart, and to discuss certain aspects which have arisen during the investigation.

CHAPTER 1:

HISTORICAL:

CHAPTER 1.

The earliest recorded attempt at a graphic registration of the heart sounds was by Donders (11) in 1856. His method was revised by Martius (31) in 1888, and consisted essentially of beating the time of the sounds on a receiving tambour and recording the movements by means of a lever. Hurthle (24), in 1893, was the first investigator to succeed in registering the actual vibrations produced. His method was elaborate and clumsy. A stethoscope carried the sounds to a resonance apparatus amplifying the vibrations, the enlarged vibrations acted on the handle of a wooden tuning fork which in turn excited a microphone, which set in motion an electro-magnetic signal apparatus, and the movements were transferred to the pantograph of Marey and registered. The following year, 1894, Einthoven and Geluk (13) experimented with a much simplified apparatus. A stethoscope on the chest transferred the vibrations by means of rubber tubing, to a microphone which excited a capillary electrometer, the movements of which were recorded on a moving photographic plate. In 1895, Holowinski (23) employed a similar apparatus, but used as a recording medium the "optical telephone", which depended on the interference rings of Newton, the changes in which were photographed. Einthoven (14), in 1903, introduced the string galvanometer, and in 1907 reported its use in phonocardiography. This method, in essentials, has been the pattern of all succeeding electrical methods.

At this time there was an increase of interest in heart sound recording and, in view of difficulties with electrical devices attempts were made to produce a "direct" method. Marbe (32) in 1907, and Roos (40) in 1908, transferred the oscillations of a tambour activated by heart sounds to a gas flame of great sensitivity and, by passing a paper through the sooty flame, recorded the sounds on the paper. During the same years Frank and Hess (19) were experimenting along somewhat similar lines and devised the Frank's capsule, which has been the predecessor of all the direct methods since that date.

The apparatus devised by Einthoven was used virtually unchanged for almost two decades by many prominent investigators in studying various aspects of heart sounds and their changes. Among them were Khan (26), Eyster (16), Fahr (17) and Lewis (28). Improvement in electrical methods developed concurrently with the advance in the knowledge of electronics. In 1916, S.G. Brown (6) introduced a telephone stethoscope which amplified the heart sounds sixty times by passing the currents through a telephone relay, from which he made gramophone records. In 1921, H.B. Williams (47) devised an electromagnetic transmitter and two stages of electrical amplification to record a cardiac murmur. At the same time Squier (42) amplified the sounds and reproduced them on a loud speaker. Two years later Myres (34) drew attention to the newly developed vacuum or audion tube, and announced it as the beginning of a microscope for the ear; and in 1923 R.C. Cabot (9) announced the development of the electrical amplifying stethoscope designed by the Western Electric Company in New York.

In 1924, Gamble and Replogle (20), and Jacobson (25), separately introduced the electric filter in modifying heart sounds, but did not pursue this aspect to any great extent, but Mannheimer (33) in Sweden has studied extensively the variation in selective recording. The instrument of this nature which has been most extensively employed has been the Electro- stethograph designed and built by M.L. Lockhart (29) in 1938. He used three acoustic filters and varying sizes of chest pieces to vary the frequency band recorded. This instrument has the advantage of being portable. Among others it has been used by Bierring, Bone and Lockhart (2), and McKee (35). An important work employing electrical methods was published by Rappaport and Sprague (39) in 1941. Evans (15) reverted to the original Einthoven method. Luisada (30) has contributed widely to the literature. The recording device with all methods has been a moving photographic plate, but some investigators have discussed the use of the Argon or Kathode ray tube as first described by Asher (1) in 1932 and later by Colvin and Steinbach (10), Boone (3), and Kountz, Gibson and Smith (27).

The direct method has also been extensively used and developed. The basis of all the instruments has been Frank's capsule, with modifications in the capsule and membrane, refinements in the recording mechanism, the attempted elimination of extraneous sounds, and the introduction of devices for the amplification of the vibrations. Weiss (45), Weiss and Joachim (46), Hofbauer and Weiss (22), Gerhartz (21), Bull (7), Van Zwaluenberg and Agnew (44), and Ohm (36), were early workers with this type of apparatus and published results between 1908 and 1912. These results, however, were only with selected cases and were variable and confusing.

The theory and practice of direct methods was studied by Wiggers and Dean (48), in 1917. They improved Frank's capsule by devising a membrane of rubber cement, and, by using a very small mirror attached to its surface, rendered it much more sensitive. They also enclosed the entire capsule in a housing with a glass window, thus diminishing the effect of external sounds, and adopted the Einthoven method of eliminating chest movements of respiration and apex beat by means of an adjustable valve, opening in the collecting tube. The results produced by these modifications compared favourably with those of the electrical methods available at that date, and the apparatus was in routine use by the same authors for twenty years, but even with those improvements it was still unsatisfactory in that adventitious sounds prevented clear recording. The workers with this apparatus have been principally South American, and published results between 1935 and 1937. They were:- Taquini and Braun Menéndez (43), Braun Menéndez and Solari (5), and Caeiro and Orias (8). Sacks, Marquis and Blumenthal (41) combined electrical and direct methods by using a crystal microphone, a three stage amplifier, and an output receiver connected to a Wiggers - Dean type of segment capsule, but proceeded no further with a very complicated apparatus. Orias (37), increased the sensitivity of the capsule by means of slacker membranes and larger receivers, but markedly reduced the frequency response. Eckstein (12), eliminated adventitious sounds by increasing the frequency of the membrane to 350 or more cycles per second, either by vulcanising the membrane or enlarging the side tube opening to the air. He made even thinner mirrors to increase sensitivity, and a slightly different reflecting recording mechanism. In 1939, Orias and Braun Menéndez (38), published an extensive monograph on various aspects of heart sounds and murmurs using direct methods. At the same time Boyer, Eckstein and Wiggers (4), studied the changes in the records produced by capsules of varying frequency response, showing pictures comparable with those of the filtered electrical methods.

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CHAPTER 2.

THE APPARATUS.

CHAPTER 2.

During early attempts to establish the clinical value, apart from experimental value and limitations of various machines, it became apparent that recordings by different types of instruments presented varying pictures, not only due to imperfections, but also due to the intrinsic frequency response of each individual instrument, a factor which early investigators have tended to disregard. It became obvious that if comparable results were to be obtained by different workers, either some standard of comparison must be laid down and the present confusion of individually influenced recordings and interpretations eliminated, or an instrument devised which produces different pictures of a series of frequency response ranges reducing this error to a practical minimum. It should then be possible to build up a widely acknowledged series of patterns associated with distinct lesions.

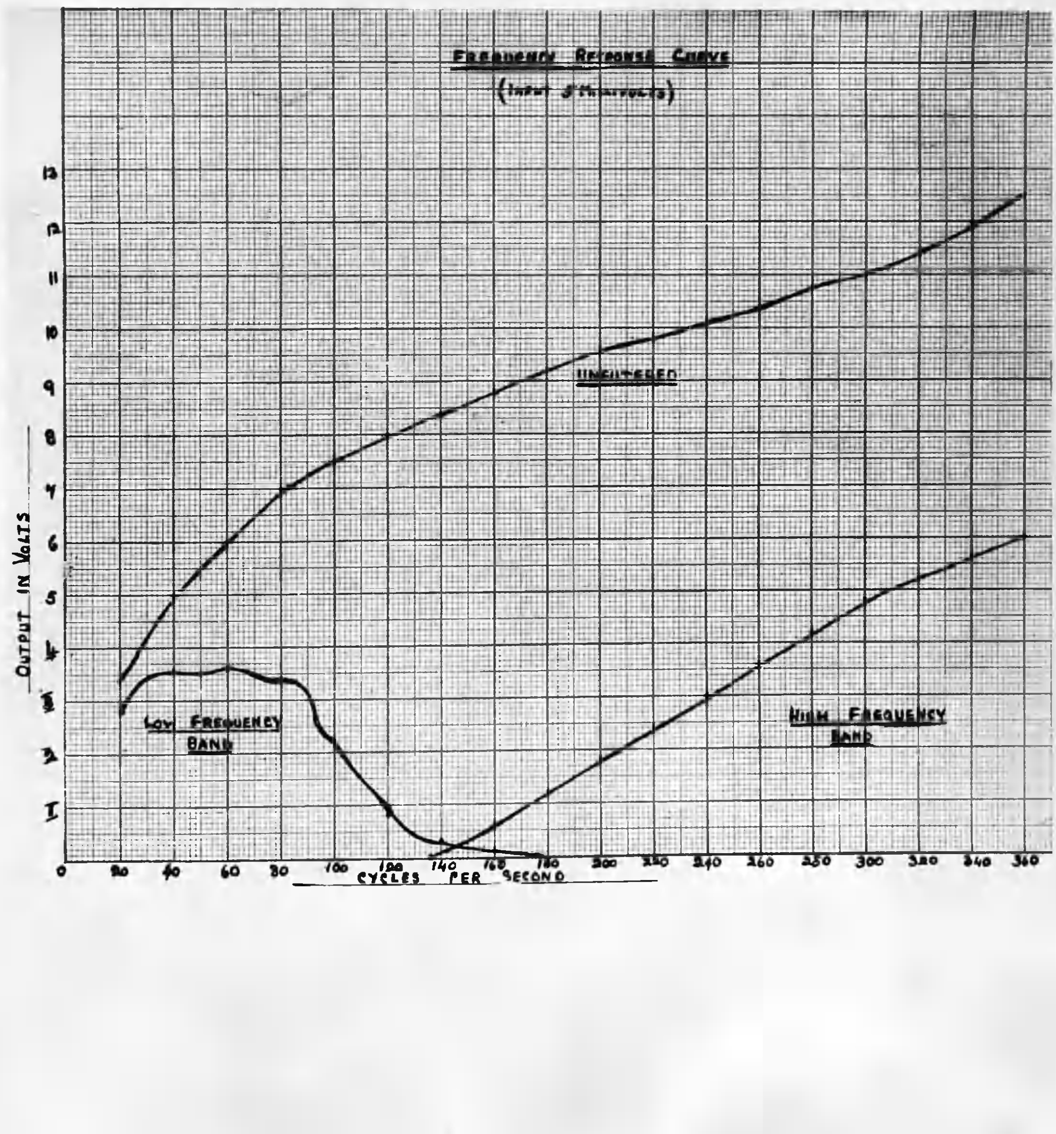
The purpose of the present work was to devise and test the efficiency of such an instrument.

The advantages and disadvantages of the direct and electrical methods were considered. From experimental work, and from the records of previous workers, it was decided that the electrical methods offered the greater efficiency for routine use. All direct methods have certain fundamental disadvantages. With regard to the capsule, considerable experience is required for their

efficient manufacture. Each membrane has a very limited life, although recently Arrhigi (1), introduced a new membrane composed of elastic collodion, wrinkled to make it more sensitive, and said to last for some years. Each has a varying frequency response of its own, and in addition the frequency response of each individual membrane is a variable as it grows older.
Amplification of the vibrations is limited by the distance through which light beams can be satisfactorily concentrated, and in many cases is not sufficient. This difficulty led to the elaborate apparatus devised by Sacks, Marquis and Blumenthal (6). Even with improvement, the impact of extraneous sounds easily influences the membrane and relatively soundproof surroundings are necessary. The elimination of chest wall and apex impulse vibrations is an added and troublesome adjustment for each individual case, and finally, the recording mechanism is intricate in its application. Thus, though valuable as an experimental laboratory method, direct recording is considered to be inferior to the electrical for routine use.

Rappaport and Sprague (5), have discussed the properties of the various component parts of an electric recording system. The piezoelectric crystal microphone is the most efficient and robust type available. It is inherently free from noise, is small and light, the output level high, and the fundamental frequency of the crystal approximately 10,000 cycles per second. It is superior to the carbon granule microphone of Einthoven, the electromagnetic microphone, Williams (10), that of Sell (7), and the condenser microphone, Trendelenberg (9).

Varying types of filters were then considered. There was no difference in their efficiency as filters, but the use of acoustic filters necessitated several microphones or detachable bells, and the comparison of this inconvenience with the simple turning of a switch of an electrical filter system made the latter desirable. The amplifier visualised was a standard audion tube amplifier of a similar basic design to that used by Rappaport and Sprague, Lockhart and others, with a series of two or more electrical filters inserted in the circuit. It was fortunate that, at this time, a suitable apparatus became easily available in the form of a standard type of amplifying stethoscope. Incorporated in the amplifier are two electrical filters, one a high pass filter and the other a low pass filter. A third recording can be made when no filter is in use, giving an unfiltered phonocardiogram. The frequency response and output are summarised in the following graph:-



FREQUENCY RESPONSE CURVE
OUTPUT IN VOLTS
CYCLES PER SECOND
UNFILTERED
LOW FREQUENCY BAND
HIGH FREQUENCY BAND

The problem of a recording mechanism was solved by connecting the output lead from the amplifier to the terminals of the string galvanometer of the standard static model Cambridge electrocardiograph, and taking records with a taut and therefore aperiodic fibre.

Recent developments in the microphone have evolved three main types of instrument, and it is necessary to review briefly the properties of the phonocardiographs produced by these microphones.

Linear Phonocardiographs:

These record cardiac vibrations as they exist at the surface of the chest, without selective amplification or attenuation, from a frequency approaching zero to that approaching the upper limit of audibility (0 - 10,000 cycles per second). The recorded amplitude of any vibration is directly proportional to its intensity at the chest wall. The frequency response characteristics can be graphically represented as a horizontal line with an abcissa of frequency range and with an ordinate of % response. Briefly, it is a record of the intensity of sounds produced at the chest wall over a fixed frequency range.

In Linear Phonocardiograms the large amplitude very low frequency, inaudible, or barely audible vibrations so dominate the picture that the much less intense high frequency vibrations are very poorly recorded or not recorded at all. The records thus obtained are equivalent to an apical sphygmogram, the cardiogram of Rappaport and Sprague (5), or approximately to the vibriocardiogram of Kountz and his co-workers (2).

The lack of the selective high frequency amplification characteristic of human hearing, makes the linear phonocardiograph impracticable for general clinical use. It is occasionally of value in distinguishing the "opening snap of the mitral valve" from a third heart sound as was shown by Taquini, Massell and Walsh (8).

The Logarithmic Phonocardiogram:

This instrument, designed by Rappaport and Sprague, greatly attenuates low frequency components and intensifies the higher range. They noted that the normal human audiogram approximated to a logarithmic curve, or, more simply, that the human hearing mechanism distorts the sounds which are transmitted to the tympanum of the ear by the stethoscope in such a way that with rising pitch there is a great increase in the ease with which the sounds are appreciated. Briefly, this method records the sounds as they are perceived by the average observer of normal hearing.

Thus the relatively high frequency components of cardiac murmurs are well recorded, but often at a loss of low frequency components of heart sounds and murmurs which provide valuable information. For example, auricular vibrations, the third sound, and mitral diastolic murmurs from which high frequency components are absent, may not be visualised. In order to make possible a minute analysis of heart sounds, the registration of all vibrations is necessary, and it would appear illogical to impose on such a registration the limitations of human hearing.

If the phonocardiograph is to be considered as something more than an instrument for timing audible cardiac murmurs, then the logarithmic phonocardiograph is not, by itself, a satisfactory instrument.

The Stethoscopic Phonocardiograph:

In an instrument of this description the graph of the frequency response characteristics is a curve, the recorded amplitude of vibrations of the same intensity rising with frequency. The tracing obtained approximates to a record of the cardiac vibrations as they are presented to the observer by the average acoustic stethoscope.

In recordings there is, thus, some attenuation of the low frequency elements, but they remain prominent and in many cases to a degree which does not permit the recording of the softer high pitched murmurs at an amplitude adequate for recognition. Nevertheless, the stethoscopic phonocardiograph is probably the least unsatisfactory of those providing a single recording, in that the tracing does show fairly well both the lower frequency elements of the cardiac sounds and the higher vibrations of the murmurs.

The Value of Simple Calibrated Phonocardiography:

Apart from the difficulties already discussed with regard to the variable frequencies of individual instruments, the interference of extraneous sounds, and the interference of chest wall movements, there are other factors involved. The degree of low frequency attenuation can be made to vary with alteration in the microphone housings and aperture, as was well demonstrated by Lockhart (3), in his description of the Stethograph in which different microphone housings served as acoustic filters. Variation in the size of stethoscope bell can alter records by changes in the natural period of the contained skin diaphragm, Rappaport and Sprague (5), and in the same way, differing pressures of the microphone on the chest wall can produce considerable change. It would appear, therefore, that any single tracing cannot satisfactorily record all possible cardiac vibrations of clinical interest, and that any series of records cannot be compared with these taken elsewhere, unless by an instrument of identical characteristics.

Rappaport and Sprague (5), suggest the recording of linear, stethoscopic and logarithmic phonocardiograms from each case. Apart from the tedious nature of the examination, by this method differences in frequency characteristics of the instruments again would make comparisons difficult - e.g., in the proportion of cases in which the third sound is visible and in the timing of the moment of murmurs, and is still liable to the variables discussed above. The solution would appear to be the utilising of various "wave bands"; calibrated phonocardiography, first adequately discussed by Mannheimer (4). He selected a series of six overlapping frequency bands covering the range from twenty six cycles per second to one thousand cycles per second. His instrument and methods are too complicated for general use and are likely to remain in the hands of the research worker.

Returning to the instrument used in this present work, the exact frequency characteristics of the instrument itself are not important, since by the use of low pass and high pass electrical filters two further records can be obtained. One is of a low frequency band virtually eliminating all vibrations above one hundred and twenty cycles per second, the other a high frequency band eliminating all vibrations below one hundred and forty cycles per second.

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CHAPTER 3.

FREQUENCY RANGES OF HEART SOUNDS,

CORRELATING TIMING DEVICES.

CHAPTER 3.

There have been varying results reached by different authors in the matter of values for the frequencies of heart sounds and murmurs. The explanation for the difference of opinion is probably the fact stressed before, that the varying frequency response characteristics of their instruments have registered but a part, not the whole, of the frequency range within which the sound phenomena of the heart extend.

Williams and Dodge (38), found that practically all the energy in the normal heart sounds is distributed throughout frequencies below 110 cycles per second. Cabot and Dodge (4) noted that while presystolic murmurs contain components up to 400 cycles per second, their frequency, for the most part, lies below 140 cycles per second, and McKee (21) states that the frequency of the vibrations of the diastolic and presystolic murmurs of mitral stenosis are mainly less than 120 cycles per second. Cabot and Dodge (4) have also shown that while some murmurs have important components below 120 cycles per second, and others are composed of relatively high frequency components, as a class systolic and diastolic murmurs possess frequencies within the range 120 - 660 cycles per second.

The frequency bands chosen introduce a convenient separation of components of the cardiac vibrations into "low" and "high" frequencies, making interpretation of the phonocardiogram less difficult, and indicating the presence or absence of important low frequency components of murmurs. Whatever the likely degree of attenuation of the low frequency components of murmurs, heart sounds, or auricular vibrations in the unfiltered phonocardiogram, they are easily recorded at suitable amplitude in the low frequency band, in the absence of all high frequency vibrations. Similarly, in the band embracing frequencies greater than 140 cycles per second, the predominantly higher frequency of most systolic murmurs and diastolic murmurs not of mitral origin, allow them to be recorded at suitable amplitude uninfluenced by the high intensity, low frequency heart sounds, or by extraneous low frequency vibrations.

No attempt was made to assess quantitatively the intensity of the various recorded vibrations. This has been done by Mannheimer (19), but his method, employing tube oscillators, is too complicated for general use. In any case it is very doubtful if the various sound vibrations perceptible at the chest wall bear any constant relationship, even in the individual, to the same vibrations at their source in the heart.

A correlating timing device was considered to be necessary. In the past, various features of cardio-vascular dynamics have been utilised. The correlation of cardiac sounds with the electrocardiograph has been most extensively pursued, among many workers being Kahn (14), Bull (3), Fahr (8), Sands (31), Lewis (15), Wiggers (37), Duchosal (6), Routier and Tavecchi (29), Orias (23), Orias and Braun Menéndez (24), Evans (7), and Luisada (17).

The Phlebogram was described early and again extensively investigated, and incorporated as a simultaneous record in many routine studies.

A peripheral pulse tracing - particularly of the carotid artery, the apex cardiogram, the internal pneumocardiogram, and the oesophagogram have all been used.

The methods of recording these events, on the whole, resemble the instruments devised for phonocardiography, with both direct and electrical recordings being produced. Between 1865 and 1902, the early workers with venous pulse tracings devised systems of tambours and levers, Freidreich (12), Potain (26), Wenckebach (34), and MacKenzie (20), Later the Frank's capsule proved of value, Frank (9), Wiggers and Dean (37), Caeiro and Orias (5), Orias and Braun Menéndez (24). A direct method was evolved by Parkinson (25), in 1915, by placing the patient between a light source and the recording medium. A recent and efficient type of apparatus utilises a suction chamber applicator fastened to the patient's skin and records the changes of pressure in the chamber by means of a linear microphone, and by using a galvanometer, registers photographically after passing through an amplifier in the usual way, Miller and White (22).

The carotid pulse tracing was investigated by means of systems of levers and tambours by Marey (18), in 1881, by Frey (11), and Jaquet (13). Frank's capsule and photographic recording rendered these methods obsolescent, Frank and Petter (10), Wiggers (36), Orias and Braun Menéndez (24). The most recent device is a combination of pneumatic cuff, differential capsule, and crystal microphone, Rappaport and Luisada (28), Luisada (17).

The apex cardiogram has been recorded by methods exactly similar to those used for the Phlebogram, by tambours, Marey (18), by spring and button, Jaquet (13), and by Frank's capsule, Weitz (35), and Weber (33). Later the crystal microphone and the apparatus described above was utilised, Rappaport and Sprague (27), Miller and White (22), and Luisada (17.)

In 1936 the internal pneumogram was investigated by Braun Menéndez and Veyoda (2). Luisada (16), devised a modern electrical method. He curtailed the intensity of the respiratory sounds by means of an electrical filter. The linear microphone was connected to a tube inserted into the patient's nostril, and the changes in intrathoracic pressure caused by cardiac action were recorded.

The oesophagogram was recorded with direct methods by Braun Menéndez and Orias (1), in 1935, and Taquini (32).

The carotid pulse, venous pulse, apex cardiogram, pneumocardiogram and oesophagocardiogram tracings have certain disadvantages in common. An apparatus which is difficult to acquire and often expensive is necessary. The technical operation of the apparatus is not a simple procedure. In each type there can be wide variation in an individual tracing, and a separate and difficult study with considerable experience is necessary for accurate interpretation. The oesophagogram is technically impossible in a routine examination. The carotid pulse has the added disadvantage of giving no information about events in diastole. The venous pulse is liable to a delay of the wave tracing as compared with the mechanical events in the heart, as well as possessing variations in its form. The pneumocardiogram has considerable technical difficulties, and the variables in recording are not fully recognised. The apex cardiogram gives information of events in diastole and, though much variation in individual records occur, it is probably the most valuable of these correlating devices.

In this investigation it was decided that for routine purposes the electrocardiograph would be used. The apparatus was easily available, and its operation simple and non-disturbing even to the most anxious patient. The investigation was primarily of murmurs, the concern with the cardiac sounds themselves being only in association with the murmurs. It was recognised that in the use of the electrocardiograph there were limitations, since there was no constant time relationship with the sounds on which reliance could be placed, and that it provided no information as to events in diastole, apart from a rough guide to auricular systole. The view taken was that the electrocardiograph would indicate the position of the two main heart sounds in a tracing, so preventing confusion of these two sounds, and that correlation of murmurs would be directly to the heart sounds themselves and not to any simultaneously recorded timing device.

For similar reasons a time-marker was considered to be unnecessary. The superimposing of time-marker lines over the tracings led to confusion, and it was difficult to eliminate the regular action produced by this device as a possible source of interference either in mechanically produced vibrations or in electrical discharge.

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CHAPTER 4.

NORMAL RECORDS.

CHAPTER 4.

The phonocardiographic duration of the normal heart sounds have been recorded by various workers with very divergent results, which have been summarised and discussed by Orias and Braun Menéndez (3), Kountz, Gibson and Smith (1), Rappaport and Sprague (4), and Luisada, Mendoza and Alimurung (2). These divergent results again were due to the variable frequency response characteristics of the instruments used, good low frequency amplification resulting in a lengthening of the recorded vibrations.

In records from thirty normal subjects, the length of the heart sounds recorded in the low frequency band approximated to those of the Vibriogram (Kountz et al), and in the unfiltered phonocardiogram to the stethoscopic phonocardiogram (Rappaport and Sprague). The high frequency band, eliminating all frequencies below one hundred and forty cycles per second, registers durations of vibrations rather shorter than those of the logarithmic phonocardiogram (Rappaport and Sprague). In both the unfiltered phonocardiogram and the low frequency band, in some cases, it has been impossible to define accurately the exact moment of onset of the first sound and its duration. This is due to indefinite low frequency, low amplitude vibrations of residual auricular origin, and the coarse final vibrations of the ventricular ejection phase.

In the high frequency band record, however, the position of the first heart sound is often recorded by relatively sharply defined high pitched overtones of the second phase, or second and third components of the first sound. The third component is said to represent the opening of the semilunar valves, thus showing the moment of initiation of dynamic ventricular contraction, and this record has proved most useful in timing systolic murmurs. The second component, indicating, as it does, the moment of closure of the auriculo-ventricular valves, provides a useful indication of the end of auriculo-ventricular blood flow. Using this second component, as registering in the high frequency band, considerable variation is found in its moment of onset in relation to the electrocardiograph.

Records were analysed of the high frequency band taken from the apex in forty cases where no possibly confusing presystolic or very early systolic murmur was present. It was found that, with one exception, the onset of the first sound fell within the time of occurrence of the Q.R.S. complex, varying from 0.01 to 0.11 seconds after the beginning of the Q.R.S. complex. In six cases the moment of initiation occurred during the Q wave or the upstroke of the R wave, but in the great majority it occurred with the downstroke of R, or during the S wave. In the exception mentioned, the first sound began 0.02 seconds after the termination of the Q.R.S. complex. Slight variations were found also from complex to complex in the same record, whether cardiac or technical in origin it was not possible to determine. A consideration of the many variables, including the length of the Q.R.S. complex and the cardiac rate, made it obvious that any more detailed analysis was unjustifiable. It does, however, seem reasonable to state that no point on the Q.R.S. of the electrocardiogram can be shown to bear any constant simple relationship in time to the first heart sound, and, therefore, that the timing of murmurs in relation to ventricular systole by reference to the electrocardiogram cannot be more than approximate. The second heart sound cannot be more than approximately related to the T wave of the electrocardiogram. In the forty records studied, it varied from a position at the apex of the T wave to 0.9 seconds after the end of the T wave. Its position bore no recognisable relationship to cardiac rate. Frequently the exact definition of the second sound in time is difficult, and here again it was found that the high frequency band may register the position by sharply defined, high pitched harmonics derived from the second phase, or semilunar valvular components, often giving a narrowly split appearance. This was found to be convenient in defining the position of the second sound, and, therefore, of great aid in the timing of diastolic murmurs.

The apparatus was simple to operate, and the average time taken for an examination was ten minutes. The routine could be carried out by a technician following the physician's instructions regarding the features to be elicited, and concerning the areas of the chest from which records were to be taken.

Records were taken as a routine from the apical region and base of the heart in areas where ausculation showed the loudest sounds. Thus there were three records at each area, (1) a low frequency record, (2) an unfiltered phonocardiogram, and (3) a high frequency record. In certain cases further photographs were taken at suitable areas, e.g., where a doubtful aortic diastolic murmur was to be elicited, the microphone was placed in the region of the third left costal cartilage.

Instrument.	Duration of 1st Heart Sound.	Duration of 2nd Heart Sound.	Presence of 3rd Heart Sound.	Presence of Auricular Vibrations.
	Secs.	Secs.	%	%
Vibriocardiograph. (Kountz et al).	0.14 - 0.24	0.02 - 0.16	most	most.
Calibrated Phonocardiograph. (Low Frequency Band).	0.14 - 0.18	0.08 - 0.20	85%	91%
Stethoscopic Phonocardiograph. (Rappaport & Sprague)	0.105- 0.165	0.085 - 0.145	85%	88%
Calibrated Phonocardiograph. (Unfiltered).	0.11 - 0.162	0.066 - 0.138	76%	82%
Logarithmic Phonocardiograph. (Rappaport & Sprague).	0.08 - 0.135	0.08 - 0.110	30%	21%
Calibrated Phonocardiograph. (High Frequency Band).	0.058 - 0.12	0.03 - 0.78	0	0

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CHAPTER 5.

MITRAL STENOSIS.

CHAPTER 5.

The abnormalities of cardiac sounds and murmurs in mitral stenosis have been the subject of discussion since the early days of auscultation. The clinicians of that time were acute in their observations, and accurate in the interpretation of such abnormalities. There have been numerous studies in the past, but many have confined themselves to particular points of controversy. It is thought that a correlation and illustration of the development of mitral stenosis, and of the considerable variations and combinations of sounds and murmurs which can occur would be of value, in addition to the critical analysis of a series of eighty cases.

THE DEVELOPMENT OF MITRAL STENOSIS:

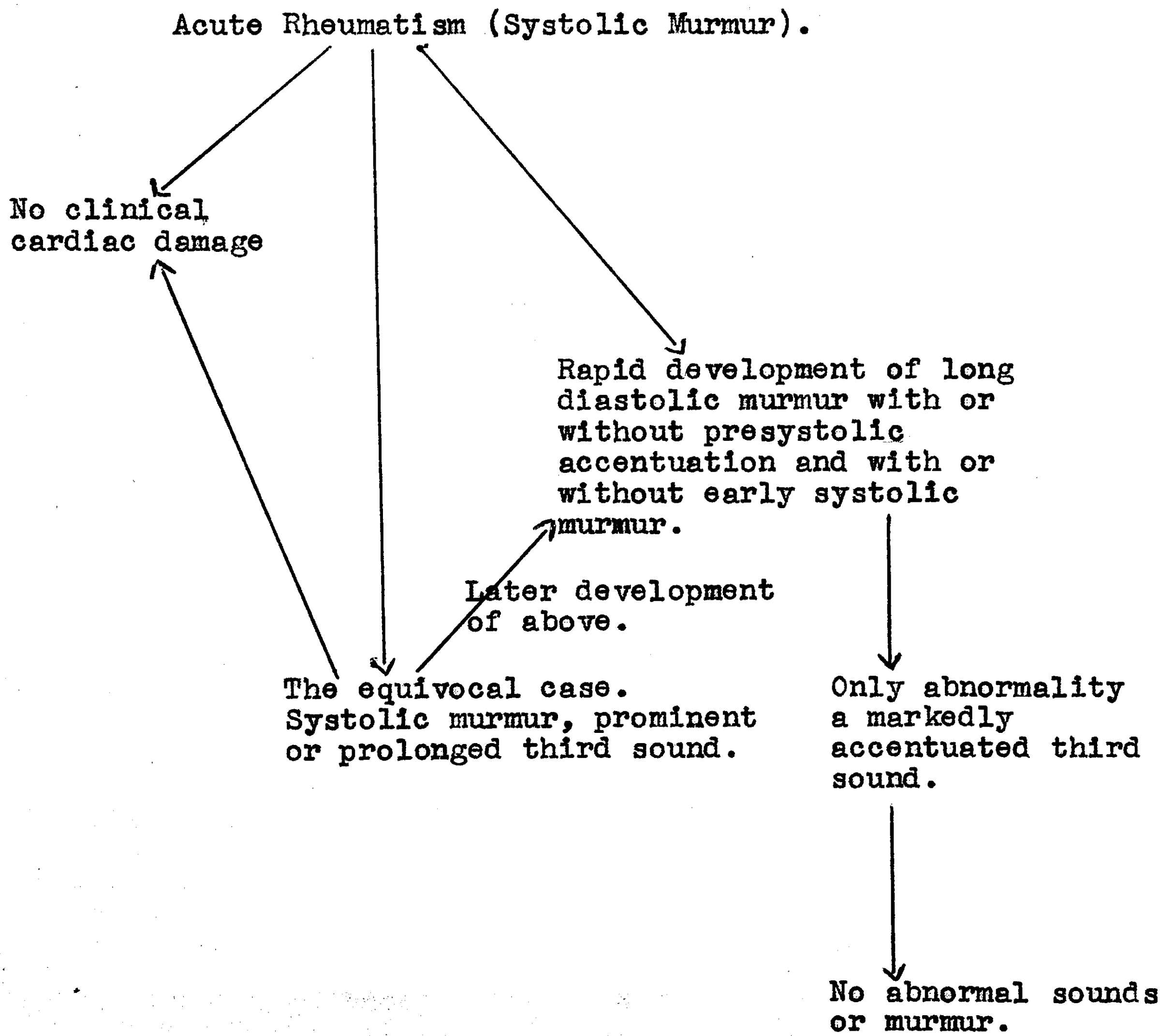
It is necessary to deal, first of all, with the stage of acute carditis, and with the systolic murmur which may then occur. There would appear to be two types of this murmur according to McKee (3), one of which is similar to the functional or innocent murmur, and probably either myocardial in origin or a previous "functional" murmur, the other similar to that of mitral incompetence. It is not possible to determine whether the mitral incompetence is relative or is a true incompetence at this stage. It is also well recognised that both these murmurs may disappear as the acute carditis subsides, and by themselves are evidence only of the acute inflammatory process. The phonocardiograph can confirm that the murmur is of either functional or valvular nature, but cannot distinguish between relative and true incompetence at this stage, (vide infra), though the amplitude and wide frequency range may suggest a true incompetence. But it may be stated that in every case in which stenosis is to develop there is initially present a systolic murmur almost invariably having the characteristics of a mitral incompetence, to remain or disappear later.

The first evidence of stenosis necessarily appears in the diastolic phase. A systolic murmur of mitral stenosis, Evans (2), does not occur. This initial change is prominence of the third sound, prominence not only in amplitude but in increase in the number of vibrations from the normal 1-3 to 4-6. A murmur of this type has been stated to disappear with healing, Bland, White and Jones (1), though this has not yet been recorded on a phonocardiograph. Progression of the stenosis is first shown by an increase in the number of vibrations following the third sound forming a "mid-diastolic" murmur, which characteristically is of very low frequency and of low amplitude. Similar low frequency vibrations appear during the auriculo-systolic phase and extend to join with the "mid-diastolic" murmur. Thus progression tends to a long, low frequency, low amplitude diastolic murmur occupying the

the whole of diastole. The third sound may increase further in amplitude. The "presystolic" or auriculo-systolic crescendo element may then appear. Frequently the amplitude shows no change in the "presystolic" phase, but the frequency definitely rises and thus accounts for the crescendo character, the higher frequency vibrations rendering it more prominent to the human auditory mechanism. Finally, low frequency, low amplitude vibrations become visible between the second and third sound and the murmur occupies the whole of diastole. With the occurrence of auricular fibrillation the auriculo-systolic element disappears, and the murmur, retaining its characteristics of frequency and amplitude, with the presence of the third sound unaltered, becomes variable in length with the variation in the duration of diastole. Beginning either in mid-diastole, or following the second sound, it may extend up to the following first sound in short diastolic phases, and only partially occupy diastole in the long periods.

The majority of cases show abnormal sounds and murmurs, which are a cross section of this natural history of development, a cross section which may progress no further. There are rare cases with unusual features, which will be discussed later.

The auscultatory and phonocardiographic evidence of acute rheumatism of the mitral valve, which is discussed, can be shown diagramatically.



TABULATION OF MATERIAL.

An analysis was made of phonocardiograms in 80 cases of mitral stenosis, 33 of which were associated with rheumatic disease of the aortic valve. Of this series, 47 were female and 33 male. The age groups and number of cases of each are tabulated.

Age Group

Age	1-10 yrs.	11-20 yrs.	21-30 yrs.	31-40 yrs.	41-50 yrs.	51-60 yrs.	61-70 yrs.	TOTAL
Males	1	7	6	5	9	5	0	33
Females	0	10	12	10	9	3	3	47
Total	1	17	18	15	18	8	3	80

Sinus rhythm was present in 57 cases, and auricular fibrillation in 23. The cardiac rates could be summarised as follows:-

Rate	A.F.	Sinus
60/min. and under	2	1
100/min. and over	3	13
Between 60/min. and 100/min.	18	43

The cardiac size, both by clinical examination and X-ray, showed:-

Normal	Slight Enlargement	Moderate Enlargement	Marked Enlargement
9	20	31	20

The electrocardiograph showed various changes. P wave changes consistent with mitral stenosis were found in 22 cases, and in 13 of the 47 cases not associated with aortic disease there was right axial deviation, or right ventricular hypertrophy. Four cases were associated with a moderate degree of anaemia, and in two, blood cultures grew streptococcus viridans as evidence of bacterial endocarditis superimposed upon the rheumatic lesions.

The cases were, therefore, of a widely varied unselected group in which clinical examination and investigation had proved the presence of the mitral lesion. The features found in phonocardiograph records can be tabulated to illustrate the text.

Abnormalities of Sounds.

The 3rd Sound:-

With brevity as the warrant the term "visible" is used to denote when the third sound could be separated from any other diastolic vibrations. "Prominent" is the term used when the third sound was clearly visible and probably slightly accentuated, and "accentuated" means that the sound is unduly large in amplitude and/or in length.

Accentuated	Prominent	Visible	Total
23	13	19	55

The 2nd Sound:-

Accentuated	Split	Total
22	24	46

With regard to the murmurs, the points were:-

Systolic Murmurs:

There was no systolic murmur visible in 15 cases. There was a systolic murmur present in all cases with associated aortic valvular lesions.

The Time of Onset

Early-systole	Mid-systole	Late-systole
63	2	0

The term "early systolic" refers to those murmurs in which the initial vibrations were seen to be superimposed upon the vibrations of the first heart sound. "Mid-systolic" referred to those murmurs in which this phenomenon did not appear, and which followed the first sound by a very short gap. "Late systolic" is self-explanatory.

The Frequency:-

FREQUENCY					
Low	Medium.	High.	All Frequency	Low and Medium	Medium and High
1	8	10	15	10	21

In explanation it may be stated that these refer to the frequency in which the murmur was primarily and most clearly recorded. Medium frequency is used when the murmur was visible in the unfiltered phonocardiogram record and not in the low or high frequency records.

Thus:

46 systolic murmurs were recorded in the High Frequency Band.
26 " " " " " " Low " "
54 " " " " " " Unfiltered Record.

The Duration or Length of the Murmur:

Short	Moderate	Long
15	10	40

A "short" murmur is one in which there was a clear gap between the end of the murmur and the following second sound. A "moderate" length in the systolic murmur means that it reaches almost to the second sound, and a "long" murmur is one which definitely reaches the second sound.

The Amplitude:

Low	Medium	High
32	20	13

Because of the considerable variations, the amplitude can only be expressed in very approximate terms. Comparison with the amplitude of the heart sounds is the only practicable method of comparison in spite of the variation in the amplitude of the sounds themselves. Standardisation of the phonocardiogram as in the electrocardiogram is still to come. The terms used are, therefore, self explanatory.

The Diastolic Murmurs:
The "Time" of Onset:

Mid-Diastolic	Early-Diastolic	Presystolic
54	22	4

The "mid" diastolic is that murmur which ensues with the third heart sound. The "early" diastolic is a group of cases with low frequency vibrations, definitely of a murmur type, filling the gap between the second and third sounds, but not necessarily recorded only in the low frequency band. The "presystolic" murmur occurs during auricular systole.

The Frequency:

FREQUENCY					
Low	Medium.	High.	All Frequency	Low and Medium	Medium and High
10	2	0	8	59	1

Again those are the frequency bands in which the murmurs were predominantly recorded. In a number of cases the high frequency records showed prominent high frequency elements at certain parts of the murmur (vide infra).

Summarising further:-

The murmur was never of high frequency alone.

It was recorded in 77 cases in the Low Frequency Band.

" " " " 70 " " " Unfiltered phonocardiogram.

The Length:

Short	Long	Throughout Diastole
21	38	21

The term "short" means that the murmur terminated before the onset of the auricular complex of the following first sound. "Long" denotes those murmurs extending up to the following first sound, and the group of those throughout diastole are those which are recorded above as of "early" onset, all of which continued up to the first sound.

The Amplitude:

Low	Moderate	High	With "presystolic" Accentuation	With Mid-diastolic Accentuation
63	14	3	33	4

The remarks with regard to the amplitude of the systolic murmurs are also applicable to the diastolic and also throughout the thesis.

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CHAPTER 6.

MITRAL STENOSIS (Contd.)

ABNORMALITIES OF SOUNDS.

CHAPTER 6.

Abnormalities of Sounds.

The "3rd" Sound:

There has been deliberate intention in not identifying the "3rd" sound with the physiological 3rd sound, in the cases of mitral stenosis. The cause of this 3rd sound has been a subject of controversy since the early days of auscultation, and continues so even to-day.

Builland (1), in 1841, first described the "bruit de rappel" of mitral stenosis, and in 1862, Duroziez (4), initiated the onomatopoea "ffout-ta-ta-rou" and agreed with Gendrin (5), that the "ta-ta" represented an asynchronous closure of the semilunar valves. The theory that the "splitting" of the 2nd sound was due to vibrations derived from the mitral valve was put forward by Guttman (6), Samson (12), and Rouches (11), and termed by the latter, "the opening snap of the mitral valve". Potain (10), a master of auscultation, distinguished two types of triple rhythm in mitral stenosis. He defined a basal type due to asynchronous semilunar valve closure, and an apical type due to the "opening snap". With phonocardiography the controversy increased. Mozer and Duchosal (9), correlating phonocardiogram and electrocardiogram, were of the opinion that the extra sound was independent of the second sound and similar in nature to the physiological third sound. Margolies and Wolferth (8), correlating the kymogram, phlebogram, and phonocardiogram, concluded that the sound occurred at the moment of opening of the auriculo-ventricular valves, but apart from this sound, another could be recorded which might be a split second sound. In 1934, Lian (7), working with phonocardiogram and brachial pulse, confirmed the basal triple rhythm of asynchronous, semilunar closure. The apical triple rhythm he postulated might either have been of mitral valve origin, or an accentuated initial part of the diastolic murmur. Duchosal (3), arrived at similar conclusions. A sound 0.06 - 0.08 seconds after the second sound denoted an asynchronous closure of the semilunar valves, and a sound more than 0.11 seconds from the second sound was an initial part of the diastolic rumble which might be mistaken for a physiological third sound. Cassio and Orias (2), were convinced that the extra sound occurred at the moment when the auriculo-ventricular valves open and was undoubtedly due to structural changes produced by disease.

In the present series of eighty cases, a "3rd sound" was "seen", "prominent" or "accentuated" in fifty five cases. It was regarded as a valuable diagnostic feature, and from that point of view the exact origin was not of importance. Nevertheless, the time interval from second to third sound was measured in twenty cases by correlation with the duration of the Q.R.S. of the electrocardiogram, and was found to be from 0.11 to 0.16 seconds. The structure in many cases was indistinguishable from the physiological third sound. This mitral "3rd" sound warrants further investigation with apex cardiogram as correlating device. A few cases investigated with simultaneous cardiac catheterisation records would settle the controversy.

True splitting of the second basal sound denoting asynchronous closure of the semilunar valves occurred in twenty-four cases, and accentuation occurred in twenty-two cases. The importance placed on those features was similar to that in auscultation. These are signs which lead to a closer scrutiny of the diastolic phase in doubtful cases, and are also to be regarded as confirmatory evidence in other cases.

In repetition, a noteworthy feature was the frequent, clear cut, splitting of the second sound recorded in the high frequency band due to the high frequency overtones of the valvular elements of that sound.

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CHAPTER 7.

MITRAL STENOSIS (Contd.)

CHAPTER 7.

THE SYSTOLIC MURMURS.

Though mitral stenosis is the subject of discussion, the characteristics of the associated systolic murmurs are important. In eighty cases, fifteen records showed no systolic murmur to be present.

The time of onset is the first feature to be considered. All but two of the sixty-five murmurs began in early systole. These sixty-three murmurs occupied the isometric systolic phase of the ventricles, as first described in 1911 by Weiss and Joachim (17), and followed by Weitz (18), Eggert (7), Frey and Fromm (9), Antonelli (1), Battro and Braun Menéndez (3), McKee (12), and recently revived by Evans (8). In the present series, however, in the vast majority of cases the murmur could be demonstrated to begin with, and continue from, the second component of the first heart sound, or the 2nd phase of Luisada et al (11). This could be accomplished by critical examination and composite interpretation of the <u>three</u> wave band recordings, with the position of the second component of the first sound being abruptly recorded in the high frequency band by its high pitched overtones. This feature is stressed as being of very great value. In the two cases in which the murmur was mid-systolic, a definite clear area of base line free of murmur vibrations could be defined between the first sound overtones and the onset of the murmur. Similar types of murmur will be discussed in detail later. They can be considered to be non-valvular in origin. It is noteworthy that of the two cases mentioned above, one was an early case in a girl of 13 years of age, and the other a man of 49 years in whom the only other abnormality was a grossly accentuated third sound, and who had considerable cardiac enlargement. The frequency ranges of the initial sixty-three murmurs, which were considered to be due to mitral incompetence, were tabulated. The striking feature was the extremely wide variation in frequency. There was no doubt that the majority of the murmurs have a frequency range over 120 cycles per second. Only one was predominantly below that level. A series of ten were exclusively prominent in the high frequency band, i.e., contained no vibrations below 140 cycles per second, but forty-six cases were of wide frequency range and recorded in two or more of the frequency bands. In view of this wide variation, even with the crude division into ranges of this apparatus, it would appear that there would be little point in pursuing a more exact investigation into the frequency ranges of this murmur, since it is most unlikely that any diagnostic value could be recognised in any particular frequency range. A feature which is again stressed is that the high frequency band almost exclusively allowed recognition of the presence of a murmur in ten cases.

In those cases this wave band eliminated the attenuation of higher frequencies which occurred in the unfiltered stethoscopic phonocardiogram, and in which the murmur could not be clearly defined.

The duration of these systolic murmurs was subject to wide variation, in fact variation was so great that a more exact gradation other than short, moderate, or long was considered unnecessary from a diagnostic point of view. The majority were of long duration and extended up to the second sound; in only fifteen cases was the murmur considered to be short. With certain reservations (vide infra) it may be stated that no correlation could be made of the length of the murmur with the possible degree of incompetence present. There was no relationship of length and cardiac size.

With regard to the amplitude it can only be stated that this again was an extreme variable. Roughly gauged by the amplitude of the sounds, themselves most variable, it was found that the majority were of a low amplitude (32 cases). Twenty cases were of moderate amplitude, and thirteen cases of high amplitude. The amplitude by itself could not be regarded as having diagnostic importance, except in so much that in other systolic murmurs of non-valvular origin a high amplitude is relatively rare, (excluding congenital murmurs).

In discussing these latter three features separately, it might appear that they were of little diagnostic value, but it must be emphasized that in weighing the question of whether a murmur was of valvular origin or not, and especially in cases of doubt, the combined regard of frequency, length and amplitude, may be of considerable value. It can be said that in general, systolic murmurs of valvular origin, recorded at the apex of the heart, have a wider frequency range and a predominantly higher frequency than murmurs of non-valvular origin (excluding certain congenital murmurs). Similarly the high amplitude murmurs are more often organic, and a long duration is more commonly found.

THE DIASTOLIC MURMURS.

The diastolic rumble and the presystolic murmur have been described and discussed by many workers, Weiss and Joachim (17), Lewis (10), Shellong (16), Frey and Fromm (9), Bass and Rossner (2), Bramwell and Ellis (4), Mozer and Duchosal (13), Diliberto (6), Routier and Tavecchi (15), Battro and Braun Menéndez (3), McKee (12), Orias and Braun Menéndez (14) and Evans (8). These murmurs and their variations have already been briefly described. In the more detailed analysis of the eighty cases the following points were found to be worthy of further discussion.

With regard to the time of onset. The considerable majority (54) began in mid-diastole, at the point where the third sound is usually found, and in many cases followed a distinguishable or accentuated third sound (vide supra). In an important group of four cases no mid-diastolic could be distinguished and the murmur occurred during the auriculo-systolic phase of diastole. In two of those a few doubtful mid-diastolic vibrations were seen. In twenty-two cases the murmur followed immediately upon the second sound, the period between second and third sound being occupied by low frequency, low amplitude vibrations. These murmurs were invariably of long duration.

The frequency range of the mitral diastolic murmurs was characteristic. It was never predominantly above 140 cycles per second. It was recorded in both low frequency and unfiltered phonocardiograms in fifty-nine cases, recorded exclusively in the low frequency band in ten cases, and in the unfiltered phonocardiogram in two. The frequency range is characteristically low. This is in agreement with Cabot and Dodge (5) and McKee (12). The value of three wave band recording was again apparent.

There was considerable variation in length. A majority of thirty-eight cases showed murmurs of long duration, extending from mid-diastole to the following first sound. Twenty-one murmurs which began immediately after the second sound occupied the whole of diastole, and lastly murmurs in twenty-one cases were of variable short duration and did not extend from mid-diastole to the following first sound. Again it was not possible to correlate the probable degree of stenosis or cardiac size with the duration of the murmur, except to state that the early cases on the whole showed a shorter duration. A feature which was well demonstrated was the variation in the length of the murmur with the length of diastole, in cases with auricular fibrillation. In a single record the murmur could be demonstrated to be entirely mid-diastolic and not reaching the following first sound in a long diastolic phase, and to fill diastole in a shorter phase. With auricular fibrillation no instance of presystolic accentuation was found (vide infra).

The amplitude was usually low (63 cases). In a few it was moderate (14 cases), and in only three cases could it be regarded as high. This low amplitude can be considered to be a characteristic feature. A most interesting observation, not recorded before, was the "presystolic" accentuation which occurred in twenty-two cases. The crescendo nature has been correctly ascribed to auricular systole by many of the above workers in phonocardiography, but apart from a postulated increase in the amplitude of vibrations, no adequate reason for the "crescendo" nature has been described. By the three wave band recording it was found that those cases with "presystolic" accentuation on auscultation, showed not necessarily an increase in amplitude of vibrations at this period, but constantly there was an increase in the width of frequency range with the appearance of high frequency vibrations which could be clearly recorded in the high frequency band. It is obvious, when correlating this fact with the human audiogram, that these higher frequency vibrations must be much more prominent than the other vibrations of the diastolic rumble which verge on the lower limits of the auditory acuity range, thus accounting for the "crescendo" character. Two rare cases occurred in this series where well established clinical mitral stenosis showed the only changes in sounds to be a grossly accentuated third sound. In a further case with auricular fibrillation with rapid rate, an initial phonocardiogram showed a well marked mid-diastolic murmur, which with slowing of the rate showed no abnormality of sounds, or any murmurs. A similar case showed marked diminution in the length and amplitude of the mid-diastolic murmur.

To sum up. There is no feature which can be considered as pathonomonic in the phonocardiographic pictures in mitral stenosis. An opinion can only be given after a scrutiny of all the features discussed above. The timing of a murmur is of first importance, as is the frequency range in diastolic murmurs. The duration may be of importance, especially in diastolic murmurs, and changes in sounds and the amplitude are of value in proportion to the doubtful nature of any particular case.

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CHAPTER 8.

AORTIC VALVE DISEASE.

CHAPTER 8.

Acquired disease of the aortic valve was divided into the various aetiological groups, and separately summarised in these groups, though it was recognised that from a phonocardiographic point of view they had much in common. There were thirty-three cases of rheumatic aortic valve disease associated with mitral stenosis, five cases thought to be of rheumatic aetiology in which no evidence of mitral valve disease could be defined, twelve cases associated with aortic sclerosis or dilatation, nine cases with a syphilitic infection, and two cases which might have been traumatic in origin.

SUMMARY OF MATERIAL

AETIOLOGY	AGE GROUPS (YEARS)								
(1) Rheumatic	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	TOTAL
(a) Associated with Mitral Stenosis	-	9	8	9	4	3	-	-	33
(b) Without Mitral Stenosis	-	1	1	2	-	1	-	-	5
(2) Associated with Aortic Sclerosis	-	-	1	1	-	3	5	2	12
(3) Associated with Syphilis	-	-	-	-	3	5	1	-	9
(4) Traumatic	-	-	1	1	-	-	-	-	2
TOTAL	-	10	11	13	7	12	6	2	61

RATE AND RHYTHM

AETIOLOGY	RATE	A.F.	Sinus
(1) Rheumatic			
(a) Associated with Mitral Stenosis	60/min and under	3	2
	100/min and over	-	5
	Between 60 - 100/min	2	21
TOTAL		5	28
(b) Without Mitral Stenosis	60/min and under	-	-
	100/min and over	-	2
	Between 60 - 100/min	-	3
TOTAL		-	5
(2) Associated with Aortic Sclerosis	60/min and under	-	-
	100/min and over	-	1
	Between 60 - 100/min	2	9
TOTAL		2	10
(3) Associated with Syphilis	60/min and under	1	-
	100/min and over	-	2
	Between 60 - 100/min	1	5
TOTAL		2	7
(4) Traumatic	Between 60 - 100/min	-	2
TOTAL		9	52

CARDIAC SIZE

The cardiac size both by clinical examination and by X-ray showed:-

AETIOLOGY	NORMAL	SLIGHT ENLARGEMENT	MODERATE ENLARGEMENT	MARKED ENLARGEMENT
Rheumatic (a) Associated with Mitral Stenosis.	3	5	16	9
(b) Without Mitral Stenosis.	1	1	2	1
(2) Associated with Aortic Sclerosis.	1	2	6	3
(3) Associated with Syphilis.	-	-	7	2
(4) Traumatic.	2	-	-	-
TOTAL	7	8	31	15

E.C.G.

The electrocardiograph varied considerably, on the whole showing left axial deviation, left ventricular strain, or left ventricular hypertrophy, as the most frequent changes.

ABNORMALITIES OF SOUNDS.

APICAL 3rd SOUND.

AETIOLOGY	ACCENTUATED	PROMINENT	VISIBLE	TOTAL
(1) Rheumatic.				
(a) Associated with Mitral Stenosis.	6	7	11	24
(b) Without Mitral Stenosis.	-	-	-	-
(2) Associated with Aortic Sclerosis.	-	-	-	-
(3) Associated with Syphilis.	1	1	3	5
(4) Traumatic.	-	-	-	-
TOTAL	7	8	14	29

THE BASAL 2nd SOUND.

AETIOLOGY	ACCENTUATED	SPLIT	TOTAL
(1) Rheumatic.			
(a) Associated with Mitral Stenosis.	8	10	18
(b) Without Mitral Stenosis.	-	1	1
(2) Associated with Aortic Sclerosis.	-	-	0
(3) Associated with Syphilis.	2	-	2
(4) Traumatic.	-	-	0
TOTAL	10	11	21

THE BASAL MURMURS

SYSTOLIC MURMURS

THE "TIME OF ONSET"

AETIOLOGY	NONE	EARLY SYSTOLIC	MID SYSTOLIC	LATE SYSTOLIC
(1) Rheumatic (a) Associated with Mitral Stenosis	2	25	6	-
(b) Without Mitral Stenosis.	-	4	1	-
(2) Associated with Aortic Sclerosis.	-	7	5	-
(3) Associated with Syphilis.	-	8	1	-
(4) Traumatic.	-	1	1	-
TOTAL	2	45	14	-

THE FREQUENCY

AETIOLOGY	LOW	MEDIUM	HIGH	ALL FREQUENCY	LOW AND MEDIUM	MEDIUM AND HIGH
(1) Rheumatic (a) Associated with Mitral Stenosis.	-	2	-	18	8	3
(b) Without Mitral Stenosis.	-	-	-	4	-	1
(2) Associated with Aortic Sclerosis.	1	-	1	7	3	-
(3) Associated with Syphilis.	1	1	-	5	1	1
(4) Traumatic.	-	-	-	1	1	-
TOTAL	2	3	1	35	13	5

THE DURATION OR LENGTH OF THE MURMURS

AETIOLOGY	SHORT	MODERATE	LONG
(1) Rheumatic			
(a) Associated with Mitral Stenosis	4	-	27
(b) Without Mitral Stenosis	-	-	5
(2) Associated with Aortic Sclerosis	2	-	10
(3) Associated with Syphilis	3	-	6
(4) Traumatic	1	-	1
TOTAL	10	-	49

THE AMPLITUDE

AETIOLOGY	LOW	MEDIUM	HIGH
(1) Rheumatic			
(a) Associated with Mitral Stenosis	9	11	11
(b) Without Mitral Stenosis	1	2	2
(2) Associated with Aortic Sclerosis	4	3	5
(3) Associated with Syphilis	2	3	4
(4) Traumatic	1	-	1
TOTAL	17	19	23

The explanatory notes, as already outlined in the summary of the cases of mitral stenosis, apply directly to the above and the following summaries.

DIASTOLIC MURMURS

THE "TIME OF ONSET"

AETIOLOGY	EARLY	MID DIASTOLIC	LATE DIASTOLIC OR PRESYSTOLIC
(1) Rheumatic (a) Associated with Mitral Stenosis.	33	-	-
(b) Without Mitral Stenosis.	5	-	-
(2) Associated with Aortic Sclerosis.	10	-	-
(3) Associated with Syphilis.	8	-	-
(4) Traumatic.	2	-	-
TOTAL	58	-	-

THE FREQUENCY

AETIOLOGY	LOW	MEDIUM	HIGH	ALL FREQUENCY	LOW AND MEDIUM	MEDIUM AND HIGH
(1) Rheumatic (a) Associated with Mitral Stenosis.	-	2	5	5	1	20
(b) Without Mitral Stenosis.	-	1	-	-	-	4
(2) Associated with Aortic Sclerosis.	-	-	3	3	1	3
(3) Associated with Syphilis.	-	-	1	4	1	2
(4) Trau matic.	-	-	-	2	-	-
TOTAL	-	3	9	14	3	29

THE DURATION OR LENGTH OF THE MURMURS

AETIOLOGY	SHORT	LONG	THROUGHOUT DIASTOLE
(1) Rheumatic (a) Associated with Mitral Stenosis	11	15	7
(b) Without Mitral Stenosis	1	3	1
(2) Associated with Aortic Sclerosis	6	4	-
(3) Associated with Syphilis	1	5	2
(4) Traumatic	-	-	2
TOTAL	19	27	12

THE AMPLITUDE

AETIOLOGY	LOW	MEDIUM	HIGH
(1) Rheumatic (a) Associated with Mitral Stenosis	19	10	4
(b) Without Mitral Stenosis	5	-	-
(2) Associated with Aortic Sclerosis	10	-	-
(3) Associated with Syphilis	3	3	2
(4) Traumatic	-	-	2
TOTAL	37	13	8

CHAPTER 8.

DISCUSSION:

There has been comparatively little written on the phonocardiographic appearance of the murmurs of aortic stenosis. The points elicited and agreed upon were two in number. The onset of the murmur has been recognised to coincide with the ejection phase of the ventricles, Joachim and Weiss (4), Lewis (5), Ohm (8), and to occupy most of the ejection phase, with a tendency to crescendo in the maximum point of systole, i.e., near mid-systole, Wiggers (13), Weber (12), Jaenisch and Weber (3), McKee (7), Orias and Braun Menéndez (9). Evans (2) described systolic murmurs of a somewhat similar nature at the mitral area in cases of aortic disease in a study which is not thought to be comparable, though he arrived at similar conclusions.

The present series confirmed these findings. The systolic murmur of true aortic stenosis began in early systole, the initial vibrations being superimposed on the residual vibrations of the first heart sound. In a considerable number of cases the definition of the third component of the first sound by the high frequency band enabled the observation that it arose with the third component of the first sound and was, therefore, slightly later in onset than the systolic murmur of mitral incompetence.

Individual discussion of each group was thought to be worth while.

CASES OF RHEUMATIC AETIOLOGY
AORTIC VALVE DISEASE ASSOCIATED WITH MITRAL VALVE DISEASE.

There were thirty-three cases of which nineteen were female and fourteen male. The age groups were similar in proportion to those of mitral stenosis. There were fewer with auricular fibrillation, and cardiac size was proportionately greater. The apical third sound was seen more frequently, (72% compared with 64%) and the basal second sound was a little less frequently accentuated or split, (54% compared with 61%).

It was considered significant that in the small group of five cases of rheumatic origin without mitral disease no apical third sound was seen in any case. In only one case was the basal second sound split or accentuated.

THE SYSTOLIC MURMURS:

In the group of rheumatic origin no systolic murmur was seen in two cases. There were thus thirty-six systolic murmurs. In twenty-nine cases the murmur began in early systole, and as already described, could be seen to arise with the third component of the first heart sound. In seven cases the murmur began in mid-systole and demonstrated a clear area of baseline between the first sound and the murmur. These two types of murmur were quite distinct in other characteristics.

A considerable majority (22 cases) of the early systolic murmurs had a wide frequency range and were visible in all three recordings, whereas the mid-systolic murmurs were seen in only one or two tracings, and were of distinctly narrower frequency range. The duration of all but four of the murmurs was long and occupied the whole of systole. The four short murmurs were all mid-systolic in onset.

The amplitude of the murmurs was a feature which varied widely but the situation became more clear when it was noted that the seven mid-systolic murmurs were all of low amplitude. The remaining twenty-nine were, therefore, apart from three cases, either of high or moderate amplitude. The feature of crescendo in mid-systole was seen in ten of these twenty-nine cases.

From these records it became clear that the murmur of aortic stenosis, recorded at the base of the heart, was an early systolic murmur which began with the third component of the first heart sound, extended through systole, was of a wide frequency range, and usually had a considerable amplitude.

The mid-systolic murmurs were not thought to originate in the aortic valve lesion. It was very probable that they were conducted elements of a mitral systolic murmur.

The apical murmurs in the five cases of aortic lesions without mitral stenosis were worthy of comment. There were three early systolic murmurs, with relatively wide frequency range, of long duration and moderate or high amplitude, which fitted into the category of mitral incompetence. The other two were mid-systolic, short, of narrow frequency range, and of moderate or low amplitude. They may have been due to ventricular hypertrophy.

AORTIC DISEASE ASSOCIATED WITH AORTIC SCLEROSIS:

In this group of twelve cases, there was one case in which the calcified aortic valve was seen radiologically, but in all the others there was radiological evidence of a calcified, sclerotic, tortuous or dilated aorta. The calcified aortic valve was found in the case aged twenty-seven years, and another aged thirty-six years showed a calcified aorta. The other cases were all over fifty years of age, and the changes were probably of degenerative nature.

In two cases the rhythm was auricular fibrillation. The cardiac size and electrocardiographic changes were consistent with the clinical diagnosis. No third sound was seen in any case nor was there an accentuated or split second basal sound.

Again there were two different types of basal systolic murmur. There were seven early systolic murmurs, in all but one case of wide frequency range, of moderate or high amplitude and of long duration, and five mid-systolic murmurs of relatively narrow frequency range, of low amplitude but of varied length, three being of long duration. The early systolic murmurs were thought to be due to the relative or true aortic stenosis present, and the mid-systolic murmurs due to conduction of systolic vibrations from the apical region of the heart.

There was an apical systolic murmur present in every case. In four of the cases it was early in onset, recorded in all three tracings, of high amplitude and long duration, and was of similar nature to those found in mitral incompetence. Eight cases showed mid-systolic murmurs, of variable features with regard to frequency range, length and amplitude. Their origin was either conducted elements from the aortic area, or the mid-systolic murmur of ventricular hypertrophy.

Summarising the findings in this group, roughly half of the cases showed murmurs considered to be due to aortic stenosis, whether true or functional in nature could only be speculation. The others showed conducted systolic murmurs. A third of the cases produced apical systolic murmurs which suggested a relative mitral incompetence.

THE GROUP ASSOCIATED WITH SYPHILIS:

The features of the systolic basal murmurs in this group were on the whole similar to the above. In eight of the nine cases the time of onset was early, in the other it was mid-systolic. The frequency range of the eight cases was most commonly wide, the duration long and the amplitude moderate or high.

This murmur was that of aortic dilatation or relative aortic stenosis, and was indistinguishable from the rheumatic stenotic murmur. The mid-systolic murmur showed the features of a conducted murmur as described (vide supra) and was probably derived from an aneurysm on the aortic arch.

All these cases had an apical systolic murmur, again fitting into the categories already outlined. Five were of the type associated with mitral incompetence, considered to be relative, and four were of the mid-systolic variety.

CASES ASSOCIATED WITH TRAUMA:

One case recorded an aortic stenotic murmur of typical features and the other a mid-systolic murmur, again with the features of its type. In the first there was a mid-systolic apical murmur and the other had a murmur of relative mitral incompetence at the apex.

THE DIASTOLIC MURMURS:

The graphic recording of the aortic diastolic murmur has been one of the problems of phonocardiography since the earliest days. It was recognised that on auscultation these murmurs were soft in quality, high pitched and varied widely in loudness. Though clearly audible, in many cases the various phonocardiographic instruments failed to record them, McKee (7), Arenberg (1). Rappaport and Sprague (10) clearly showed the scientific basis for this failure. The previous instruments were either not sufficiently sensitive to record low amplitude vibrations, or the periodic response was too low and the instrument failed to vibrate at a speed in sympathy with the frequency of the murmur.

It became obvious that the instrument would require to be modified so that it could respond to higher frequency vibrations while attenuating the lower frequencies. With electrical methods this could be done in two ways, either alteration of the microphone, or by filtration of low frequency sounds. The former would require a multiplicity of microphones, as was done by Wells, Rappaport and Sprague (11), in 1949, who made the first satisfactory phonocardiographic study of these murmurs. They employed a logarithmic microphone with various Bowles chest pieces. The filtration method has been utilised in the present series, with a single microphone requiring only the turning of a switch. It has been found to be efficient. The high frequency band, recording frequencies of 140 cycles per second and above is suitable for this type of murmur, the frequency of which was estimated in four cases by McKee (7), and found to be mainly 180 cycles per second.

The features of the aortic diastolic murmur already elicited have been almost entirely concerned with timing. It began in early diastole, and continued diminuendo for a variable distance into diastole, Wiggers (14), Orias and Braun Menéndez (9), McKee (7), Luisada (6), and Evans (2).

No definite difference could be distinguished in the murmurs in the various aetiological groups and it was therefore more convenient to discuss these murmurs as a whole. In all the cases in the rheumatic groups a diastolic murmur was seen. Incompetence was an invariable accompaniment of stenosis. In two of the sclerotic group and in one of the cases associated with syphilis there was no diastolic murmur.

Therewere thus fifty-eight diastolic murmurs. In all of them the time of onset was in early diastole, and followed immediately upon the valvular components of the second heart sound, clearly demonstrated in most cases by the high frequency tracing. The frequency of these murmurs was again variable but by far the greater number were of comparatively high frequency, with fifty-two murmurs seen in the high frequency band. It was significant that in nine cases it was exclusively reproduced in this tracing, and in many others the adequate amplification and clear visualisation was only possible by this filtration of low frequency elements. Only three murmurs were seen in the low frequency band, and none were exclusively within this range.

The duration varied widely. The majority (39 cases) were long, and twelve of these continued throughout diastole. In comparing the groups, the murmur continued throughout diastole in the two traumatic cases, and on the whole was longer in the syphilitic group than in the rheumatic. It was more commonly of short duration in the sclerotic group. It was not thought that any diagnostic significance could be placed upon this feature.

Generally, the amplitude was low (37 cases) rendering adequate amplification important. Only eight cases could be considered to be of high amplitude and this included the two traumatic cases. It is well known that the loudness of the murmur cannot be said to bear any relation to the amount of regurgitation. It was confirmed by this study that the cardiac size had no constant relation to the amplitude of the murmur, and a feature not previously proved was that, in a similar manner, there was no relationship between cardiac size and the length of the murmur. A feature of crescendo-diminuendo character, with the crescendo occurring shortly after the beginning of the murmur, was found in twenty cases. Little importance is attached to this with regard to diagnosis.

In seven cases a diastolic murmur was recorded which was initially not heard, though on further careful auscultation following their demonstration, five of them were found to be audible. Two cases remained where inaudible vibrations were recorded. It was probable that the amplitude of these vibrations was below the lower limit of auditory acuity; Wells, Rappaport and Sprague (11), record similar phenomena. The diagnostic significance of these vibrations warrants further investigation.

To summarise, it may be stated that the murmurs of aortic incompetence, no matter the cause, were essentially similar. The murmur followed immediately on the valvular components of the second sound. It was sometimes crescendo-decrescendo, of high frequency requiring selective elicitation, generally of low amplitude, and extending for variable periods into diastole.

AORTIC ANEURYSM:

Two cases presented with aortic aneurysm. Records were taken over the site of the aneurysm. The vibrations were of wide frequency range, moderate amplitude and continued throughout systole and diastole. They differed in that one case showed a more prominent systolic murmur, and in the other the diastolic phase was of greater amplitude.

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CHAPTER 9.

THE AUSTIN FLINT MURMUR.

CHAPTER 9.

Though small in number, consisting of only nine cases, the group of aortic disease associated with syphilis is thought to be of especial importance. In five of these cases an apical murmur in diastole was recorded, which was considered to be an Austin Flint murmur. One of these five cases came to post-mortem, and is reported in full (vide infra).

The Austin Flint murmur, commonly described as a presystolic murmur at the apical region in cases with aortic incompetence, has been the cause of much discussion with regard to its characteristics, cause and significance.

With regard to the characteristics, Flint's original description in 1862, was of a blubbering murmur heard at the cardiac apex in patients with aortic valvular regurgitation of syphilitic or arteriosclerotic origin. Since then it has been variously described as a diastolic or presystolic rumble, or a special type of gallop rhythm, Saubry and Pezzi (14). White (17) was of the opinion that the characteristics were similar to those of the diastolic murmur of rheumatic mitral stenosis. Wiggers (16) described it as a mid-diastolic or presystolic murmur and Gouley (6) thought the character to be a presystolic rumble which practically merged with the first sound and was limited to a small area at the apex.

In 1944 Luisada (10) published the first phonocardiographic study and thought that either the third sound, auricular sound, both, or a "crescendo" type of first sound, or a split first sound was responsible in simulating to the ear a diastolic rumble or presystolic murmur. Evans (4) recorded in some syphilitic cases a mid-diastolic murmur, the presence of which in his opinion, therefore, denoted a rheumatic mitral stenosis.

The causation of these vibrations has been the subject of controversy. Many authors including Flint (5), Guiteras (8), Grocco (7), Potain (12), and Vaquez (15), were of the opinion that a functional mitral stenosis existed, the mitral cusps either passively floating upwards or being driven so by the regurgitant blood stream. Da Costa (3) agreed, but thought that the left ventricular dilatation displaced the anterior mitral cusp into the opposing streams of blood. Sansom (13) and Broadbent (1), postulated vibrations of the anterior mitral cusp either directly transmitted from the posterior aortic cusp or due to the regurgitation directly on the valve. Vibration of a dilated and atonic left ventricle was put forward as a theory by Phear (11), and agreed to by Cabot (2). Herrman (9) produced experimental murmurs of this type in dogs by perforation of the posterior aortic leaflet, and supported the theory of functional mitral stenosis which he thought occurred in posterior cusp lesions, to account for the

Austin Flint occurring in only a certain number of cases. White (18) suggested that the normal mitral orifice in comparison with the dilated left ventricle produced a condition of functional mitral stenosis. Gouley (6) expressed the opinion that a thickening of the anterior mitral curtain occurred, due to the constant impinging of the regurgitant blood which occurred with anterior aortic leaflet lesions, this thickening being the aetiological factor.

In the five examples included in this series, in which the clinical diagnosis in every case was syphilitic aortitis, definite apical diastolic murmurs were heard and recorded. The tracings showed that the murmur was mid-diastolic in timing in four cases and of long duration, extending up to the following first sound. In one case it occupied the whole of diastole. It was recorded in the low frequency band and/or in the unfiltered phonocardiogram. The frequency was low. In one case with auricular fibrillation the length varied with the duration of diastole. The amplitude in all cases was low. In four cases the third sound was visible and in two of these it was accentuated.

The murmur, therefore, had characteristics identical with that of organic mitral stenosis and it would appear reasonable to assume that a similar train of events produces an Austin Flint murmur.

It is unlikely that a double pathology existed in all those cases, and that a rheumatic endocarditis was superimposed on the syphilitic infection. Those observers who failed to record the audible murmur were probably using an instrument, the frequency range of which did not permit the adequate recording of these low frequency, low amplitude murmurs.

It is again postulated that a functional mitral stenosis is responsible for the sound waves of the Austin Flint murmur, though whether these are due to valvular movements, turbulent blood stream, or ventricular wall vibrations must remain a speculation.

The following is the report of the case which came to post-mortem. The phonocardiogram was taken on 1.4.49 during a previous admission to hospital:-

Name: R.Y. Age: 59 years.

POST-MORTEM DIAGNOSIS:

Syphilitic Aortitis; Stenosis and Incompetence of the Aortic Valve; Hypertrophy of Myocardium (Left Ventricle); Stenosis of Orifices of Coronary Arteries; Infarction of Myocardium.

SUMMARY OF CLINICAL HISTORY:

Date of Admission: 6.6.49. Date and Hour of Death: 22.6.49.

Occupation: Road-surface Worker. Clinical Diagnosis: Aortic and Mitral Valvular Disease.

Patient was first admitted to Ward II on 17.3.49 complaining of attacks of nocturnal dyspnoea for the previous three weeks.

Previous History: Erysipelas and pneumonia simultaneously - in Ruchill Hospital 10 years ago. No history of rheumatic fever. Examination showed enlargement of heart to the left; presystolic gallop rhythm present. No aortic diastolic murmur was heard on admission, but was detected about two weeks later, also mitral diastolic murmur. B.P. 145/75. Liver enlarged two fingerbreadths below right costal margin. No oedema of feet. Phonocardiogram 1.4.49 suggested aortic stenosis, incompetence and mitral stenosis and incompetence. W.R. and Kahn reactions 1.4.49 - both positive.

Patient was dismissed improved on 23.4.49. He was re-admitted on 6.6.49 complaining of continuous upper abdominal pain since the end of May, which had come on suddenly when he was shovelling coal. He also had some pain in his left lumbar region but it did not last long. The pain did not radiate to any of his limbs. The onset of the pain was followed by a paroxysm of coughing and he became increasingly breathless.

On examination, upper half of chest was very cyanotic; generalised abdominal tenderness and guarding most marked in the epigastrium. The surgeons saw him on two occasions but could not find anything to warrant operation. B.P. 145/60.

Electrocardiogram suggested possible anterior myocardial infarction. The abdominal pain gradually subsided, his legs became grossly oedematous and he coughed up very frequently large clots of blood. His condition slowly deteriorated and he died on 22.6.49 at 5 p.m.

POST-MORTEM REPORT:

EXTERNAL. A tall well-built elderly man. Putrefaction is commencing.

HEAD: Not examined.

THORAX: Pericardium: Normal.

Heart (560g.: left ventricle 2.5 x 8.5. cm.; valve circumference - aortic 8 cm., mitral 11 cm.): is enlarged. This is chiefly due to hypertrophy of the left ventricle. Syphilitic aortitis has caused stenosis of the mouths of the coronary vessels. The left ventricle is hypertrophied and slightly dilated. Thrombus is present in the apex of the left ventricle, right ventricle and the right auricular appendage. On dissection an infarction of the anterior part of the apical region of the interventricular septum is found. This has given rise to the thrombi noted. The aortic valve cusps are thickened, puckered and slightly fused at their extremities. The valve is incompetent to the water test. The mitral and remaining valves are normal. The coronary vessels show slight atheroma, but no thrombus is present. There is syphilitic scarring of the aorta. The lesion extends from the commencement to mid-thoracic region where it ceases abruptly. Atheroma is superimposed.

Pleurae: Slightly thickened. Cavities moist. Recent fibrinous pleurisy is present over large areas of both lungs.

Both Lungs are markedly increased in weight and of turgid consistence. Numerous haemorrhagic infarcts are present in both and in addition there is pneumonic consolidation in both lower lobes. Demarcation of this consolidation does not conform strictly with the lobe.

Trachea and Bronchi show a congested mucosa, with numerous small pits.

Oesophagus is normal.

Thyroid Gland is normal.

ABDOMEN: Peritoneum: normal.

Stomach and Intestines: show only putrefactive change.

Liver: (1,320 g.) is small and very soft due to post-mortem change. The cut surface is is discoloured in blotchy fashion due to putrefaction. No focal lesions are encountered on section. The Gall-Bladder is normal and the Bile Ducts are patent.

Spleen: (110 g.) is small, blackish-crimson colour on section and there is slight increase of fibrous tissue.

Pancreas: shows only post-mortem softening.

Kidneys: (right 110 g., left 110 g.) both organs are small. The capsules strip with difficulty leaving a faintly scarred surface. The cut surfaces show an indistinct pattern due to softening.

Ureters and Bladder are normal.

The Prostate Gland appears healthy.

Adrenal Glands: almost completely softened.

HISTOLOGY: Aorta: Syphilitic Aortitis is confirmed. Endartertitis of vasa vasorum is well shown but destruction of the elastica is not extensive.

Lung: Confluent broncho-pneumonia.

Heart: Infarction confirmed. Organisation of thrombus is present.

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CHAPTER 10.

THE "INNOCENT SYSTOLIC" MURMUR.

CHAPTER 10.

TABULATION OF MATERIAL:

There were fifty-two cases in this series, of which thirty-one were male and twenty-one female.

The Age Groups

1-10	11-20	21-30	31-40	41-50	51-60	61-70	TOTAL
1	19	17	8	5	2	0	52

In all the cases the cardiac size, both by clinical examination and X-ray, was within normal limits. The E.C.G. showed L.A.D. in four cases, R.A.D. in four cases, ventricular extrasystoles in one case and showed no significant abnormality in all the others.

The blood counts were within normal limits.

The third sound:- The physiological third sound was seen in fourteen cases.

The second sound:- In nine cases the basal second sound was split.

Time of Onset:

Early Systolic	Mid-Systolic	Late Systolic
-	46	6

Frequency:

Low	Medium	High	All Frequency	Low and Medium	Medium and High	TOTAL
3	16	-	5	17	11	52

Thus:-

3 Murmurs were seen only in the low frequency record.

0 " " " in the high frequency record.

49 Murmurs were seen in the Unfiltered Phonocardiogram.

The Duration or Length of the Murmur:

Short	Moderate	Long
44	3	5

The Amplitude:

Very Low	Low	Medium	High
4	37	10	1

Area of Maximum Amplitude:

Apex	Base	Equally at Apex and Base
14	16	22.

DISCUSSION:

Confusion and uncertainty have surrounded the subject of the systolic murmur from the days of Laennec (6), and is typified by that great Frenchman's own opinions. Initially, he regarded a cardiac murmur as being due to valvular disease, but latterly, he concluded that murmurs were entirely without significance. The pendulum of opinion with regard to the murmurs found in cases with no other evidence of cardiac disease has been, and still is, swinging in a similar fashion.

There have been a number of studies of the clinical aspects and clinical types of the murmur, but as yet there has been no extensive investigation into the more precise phonocardiographic appearances. Studies of the clinical aspects have been made by Potain (9), Abbott (1), Thayer (10), Gibbes (5), Fineberg and Steir (4) and Levine (7).

There have been more recent contributions by Contratto (2) and Evans (3). These authors have dealt with the age incidence, sex incidence, the site of maximum intensity on auscultation, quality, loudness and propagation, and have commented on variation with respiration and posture. They have suggested various classifications. Phonocardiographic studies have been few. McKee (8), studied one hundred and five normal children and recorded systolic murmurs, some doubtful, in 90%; though a murmur was only audible in five cases. She noted that the murmurs followed the first sound, and postulated a frequency about 120 cycles per second. Evans (3), confirmed that these murmurs had initial vibrations in mid-systole in the majority of cases and that a few began in late systole.

The fifty-two cases summarised above were referred for special investigation with widely varying presenting features, but in every case the question was "what is the type and the significance of the systolic murmur"? Twenty-eight cases were referred because of the finding of a systolic murmur, on routine examination in which no other abnormality was present. Ten cases were associated with haemolytic streptococcal infections, of these four had a history of past acute rheumatism, three had had chorea, two were post-scarlatina and one case suffered from recurrent tonsillitis. Undue fatigue was the complaint in four cases, effort syndrome accounted for two. Rheumatoid arthritis presented in two cases and the remainder were systolic murmurs in a case of pyrexia of unknown origin, chronic bronchitis, a small consolidation at the left lung base, a diabetic and a gravitational oedema of legs.

No inference may be drawn from the sex incidence of this group. The age groups are largely in agreement with previous clinical studies except for the 1st decade, probably due to the hospital dealing largely with the more adult section of the population. It is noteworthy that Potain reported an incidence of 12.2% of this type of murmur in all patients seen in his hospital service. Thayer found the incidence to be 56.4% of patients in the 1st decade, gradually diminishing up to the 4th decade when there was 19.2%. The figures quoted by Gibbes are much similar to this series.

The time of onset of the murmur is of first importance. The initial vibrations in every case could be distinguished to be separate from, and to be later than, the vibrations due to the ejection phase of the ventricles, or third component of the first heart sound. This feature, as already described, being clearly elicited in the high frequency band. The considerable majority of forty-six murmurs were considered to be "mid-systolic" in onset and six were "late" or post systolic.

The frequencies of these murmurs were predominantly within the medium range. The majority, (49 cases), were best recorded in the unfiltered phonocardiogram and there was noticeably less width of frequency range in comparison with those murmurs of organic origin. In only five cases could vibrations be seen in all three recordings.

The duration of the murmur was considered to be second in importance to the time of onset. Apart from a very few cases, the duration was short and most frequently did not extend from the onset in mid-systole to the second sound. In only five cases was a long murmur recorded.

The amplitude was low in all except eleven cases and

and in only one case could it be considered to be high. This case was an unusual type of late systolic murmur which may have been due to an abnormal chordae tendiniae.

The murmurs were almost equally recorded at apex and base and just over a third were recorded at both these areas.

The innocent systolic murmur is, therefore, mid or late systolic in timing, is most commonly of short duration, of medium frequency, relatively narrow frequency range and of low amplitude. A consideration of these various factors in the calibrated phonocardiogram offers valuable additional diagnostic information, and often can give visible confirmation of clinical opinion in an important problem which is so frequently presented to the physician. The actual cause, in view of the essentially innocent nature of the murmur, must remain a matter of speculation and further prolonged observation.

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CHAPTER 11.

EQUIVOCAL PHONOCARDIOGRAMS.

CHAPTER 11

In common with many other methods of investigation in medicine there are phonocardiograms which are borderline between physiological and pathological and which can only be described as equivocal. Previous workers with the phonocardiograph have not discussed such records.

TABULATION OF MATERIAL

Number of cases - 20
Males - 10
Females - 10
Number of cases equivocal with regard to mitral stenosis 18
Number of cases equivocal with regard to aortic stenosis and incompetence - - 2

THE EQUIVOCAL MITRAL GROUP

Age Groups

YEARS		
1-10	11-20	21-30
6	10	2

Sinus rhythm was present in all cases.

The Cardiac Size

Normal	Slight Enlargement	Moderate Enlargement	Gross Enlargement
14	4	-	-

The E.C.G. was within normal limits in eleven cases, L.A.D. was present in two, R.A.D. in three, partial heart block in one and changes consistent with pericarditis in one. There was a slight degree of anaemia in two cases

The 3rd Sound

Accentuated	Prominent	Visible	Total
4	10	3	17

The Number of Vibrations

Up to 3 Vibrations	3 - 5 Vibrations
11	6

The Basal 2nd Sound

Accentuated	Split	Total
4	5	9

THE APICAL MURMURS
SYSTOLIC

The Time of Onset

None	Early Systolic	Mid Systolic	Late Systolic
-	6	12	-

The Frequency

Low	Medium	High	All Frequency	Low and Medium	Medium and High
-	7	-	3	5	3

Thus:-

All the murmurs were recorded in the unfiltered phonocardiogram.

Three murmurs were seen in all three records.

Eight were seen in two records.

The Duration or Length of the Murmurs

Short	Moderate	Long
8	-	10

The Amplitude

Low	Medium	High
16	1	1

THE BASAL MURMURS

SYSTOLIC.

The Time of Onset

None	Early Systolic	Mid Systolic	Late Systolic
5	5	10	-

The Frequency

Low	Medium	High	All Frequency	Low and Medium	Medium and High
-	3	-	4	5	3

The Duration

Short	Moderate	Long
5	-	10

The Amplitude

Low	Medium	High
10	4	1

CHAPTER 11.

DISCUSSION:

These phonocardiograms were derived from cases in which the majority gave a history of past rheumatic infection. A few were discovered to have murmurs during a routine examination, presenting the problem of the significance of a systolic murmur. The ages of the cases were all within the first three decades of life. Each would require individual critical examination of all the clinical findings and investigations before arriving at a diagnosis, but the phonocardiogram, as a separate entity, was considered to show the necessity for a policy of "wait and see" and for further follow up, before a more definite opinion could be expressed.

As already discussed in the cases with established mitral stenosis the features placing these cases in equivocal categories were:- (1) the character of the systolic murmur, (2) the presence of vibrations of doubtful significance in diastole, (3) changes in the basal second sound and (4) other factors in the clinical examination. A combination of two or more of these points was usually present.

The group could be roughly divided into two sub-groups by reference to the character of the apical systolic murmur. Those cases, six in number, in which the murmur was early systolic were thought to have practically all a mitral incompetence, with the question of stenosis arising due to factors such as prominent or prolonged third sounds, split and accentuated second sounds, etc., being present, and as yet no diastolic murmur being seen.

The second sub-group had mid-systolic murmurs (12 cases) in which other factors as described above, and the length, amplitude or frequency range of the systolic murmur itself were of doubtful significance. Though the sub-group as a whole were probably "innocent" yet caution was considered to be necessary. Two cases mentioned above had probably mid-systolic apical murmurs as conducted elements from the early basal murmurs of aortic stenosis.

The more detailed examination of a case in each of these sub-groups may clarify the discussion. In the first sub-group there was a boy, aged seven years, who was admitted with a pericardial effusion of probable rheumatic origin. Following absorption of the effusion the heart was enlarged to the left clinically and radiologically, and the E.C.G. showed evidence of pericarditis. There was a harsh apical systolic murmur conducted to the axilla and an apical diastolic sound of doubtful nature. The phonocardiogram showed an early systolic murmur of high amplitude, long duration and wide frequency range. There was a prominent third sound and both apical and basal second sounds were split. The phonocardiogram was therefore equivocal, and was thought to be indicative of mitral incompetence with possible later development of stenosis. Two further records at monthly intervals showed no change.

A typical case of the second sub-group was J.O., aged eight years who was convalescent following chorea. Clinical examination, E.C.G., X-ray and screening of the heart were all within normal limits. There was a blowing apical murmur. Phonocardiogram showed a mid-systolic murmur slightly more pronounced at the base, of moderate amplitude, low and medium frequency and of long duration. A prominent third sound of 1-3 vibrations was present. This and other records of its type were probably of innocent murmurs.

There were two cases in this group where, because of the type of basal murmur recorded, the problem of an associated aortic stenosis arose, and in one of the two a questionable early diastolic murmur of high frequency and short duration was seen, but these vibrations were not sufficiently definite to warrant a dogmatic opinion.

A case worthy of separate comment was that of a girl of sixteen years of age, (E.A.), who presented as a sero-fibrinous pleurisy. There was partial heart block. No previous history suggestive of rheumatic infection could be elicited. An apical systolic murmur suggestive of mitral incompetence was seen, with a grossly accentuated third sound varying widely in form. The amplitude in some complexes was greater than the first or second sound, and in others it appeared as a short, low frequency, low amplitude, mid-diastolic murmur. This picture was similar to that shown by a case of long established mitral stenosis (vide supra).

There were two other cases of doubtful aortic disease. One showed both early systolic and early diastolic basal murmurs but neither entirely typical in other features. The other case was of a doubtful early diastolic murmur at the base which clinically had been noted to be variable. The murmur was discovered during routine examination and all other clinical findings were within normal limits. In the phonocardiogram there was a mid-systolic apical and basal murmur of innocent nature. It was doubtful whether the diastolic vibrations were due to venous hum or to a minor inter-auricular septal defect.

Equivocal phonocardiograms occur from time to time when no definite opinion can be offered, and when both mitral and aortic valvular lesions, either stenosis or incompetence, may be the features in doubt.

CHAPTER 12

THE MURMURS OF ANAEMIA.

CHAPTER 12

Summary of Material

There were twenty cases in this group, in which twelve were female and eight male.

Age Groups (Years)

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
-	6	6	3	1	2	-	2

There was sinus rhythm in every case, tachycardia was present in two cases. One case had also a degree of hypertension.

The blood counts are tabulated in the index. The degrees of anaemia could be described as varying between moderate and severe. Three cases were associated with chronic myeloid leukaemia, and one was associated with lymphadenoma.

The E.C.G.s were normal save in one case in which a "poor myocardium" was suggested.

The Cardiac Size

Normal	Slight Enlargement	Moderate Enlargement
15	4	1

SYSTOLIC MURMURS

Area Where Best Recorded

Apex	Base	Apex and Base Equally
9	4	7

THE APICAL SYSTOLIC MURMURS

In two cases no apical systolic murmur was seen.

The "Time of Onset"

Early systolic	Mid systolic	Late systolic
3	15	-

The Frequency

Low	Medium	High	All Frequency	Low and Medium	Medium & High
-	5	-	3	8	2

The Duration or Length of the Murmur

Short	Moderate	Long
16	-	2

The Amplitude

Low	Medium	High
13	3	2

THE APICAL DIASTOLIC MURMURS

There were two cases, one of which recorded a presystolic murmur. The other showed a mid-diastolic murmur. They are discussed fully. (vide infra)

THE BASAL MURMURS

In all, sixteen systolic murmurs were seen at the base, two were exclusively recorded at this area.

The "Time of Onset"

Early systolic	Mid systolic	Late systolic
1	15	-

The Frequency

Low	Medium	High	All Frequency	Low and Medium	Medium & High
-	4	-	2	8	2

The Duration or Length of the Murmur.

Short	Moderate	Long
14	2	-

The Amplitude

Low	Medium	High
13	2	1

THE BASAL DIASTOLIC MURMURS

In one case an early diastolic murmur of short duration, high frequency and low amplitude was recorded.

CHAPTER 12.

DISCUSSION:

That cardiac murmurs occur in anaemia in the absence of true valvular lesions has been recognised for nearly one hundred years, and though much has been written on the auscultatory aspects of such murmurs, as yet little has been definitely ascertained with regard to their phonocardiographic appearances.

In the literature, Hope (10) and Laennec (13), are credited with first observing inconstant systolic murmurs in cases of chlorosis. Bamburger (1), Irvine (12) and Barrs (2), made further observations of systolic murmurs in the same clinical condition. They noted the diminution or disappearance of these murmurs with improvement in the anaemia, and were of the opinion that such diminution, coinciding with improvement served to distinguish them from murmurs of valvular origin. Hermann (9) included all cases showing anaemia and thought that they were due to temporary mitral insufficiency caused by dilatation of the mitral ring, while Streick (17) enlarged upon this aspect and included references to cardiac dilatation and fatty degeneration of the heart muscle as further contributing features. Further similar observations were made by Ellis and Faulkner (5), and Hunter (11). The latter recorded on a phonocardiograph, a few mid-systolic murmurs.

He mentioned on auscultation the occurrence of a third sound, and an abrupt accentuated apical first sound associated with cardiac enlargement and tachycardia respectively. Evans (4) recorded a mid-systolic murmur on phonocardiographic examination of some cases of anaemia.

A diastolic murmur in anaemia was first described by Freidrich (6) in 1861, and further observed in two cases by Sahli (16). Cabot and Locke (3), Ortner (15), and Morse (14), each reported a case. These murmurs were soft, short, high pitched diastolic murmurs best heard at the base of the heart. Goldstein and Boas (7), reported an incidence of such murmurs in 10% of thirty-nine cases, which is much higher than generally reported. Ellis and Faulkner (5) found only one in a series of forty-six cases, and Hunter (11) had one similar case in a series of thirty-four. These murmurs were generally agreed to be due to either aortic or pulmonary valve incompetence of a functional nature, and almost invariably disappeared on improvement with the anaemia, which was usually of a severe degree.

Presystolic apical murmurs in anaemia have been described by a number of workers. The earliest record was by von Noorden (18) in 1891, Goldstein and Boas (7) reported a case. Gunewardene (8) found a number of cases in severe anaemia associated with ankylostoma infections, and Hunter (11) observed one case. Ellis and Faulkner (5) were unable to find such a murmur in their series and expressed the opinion that perhaps confusion of a booming first sound, or presystolic gallop in thin chested people with over-active hearts, may have led to previous reports. These murmurs also were noted to disappear with improvement in the anaemia, giving rise to the opinion of their "functional" nature.

The cases showing apical systolic murmurs could be divided into two groups by reference to the time of onset of the murmur. There was, thus, a group of fifteen mid-systolic murmurs and another of three early systolic murmurs. The mid-systolic murmurs were all of short duration, the majority were of low and medium frequency, of relatively narrow frequency range and were of low or moderate amplitude.

Their characteristics were, therefore, similar to those of the "innocent murmur" as already described, and they were considered to have essentially a non valvular origin. In addition to other factors, it is possible that increased cardiac action and altered blood viscosity played a part in their production.

With regard to the early systolic murmurs. In one case the murmur was considered to be due to conducted vibrations from the basal region. The remaining two murmurs were of long duration, wide frequency range and of moderate or high amplitude. These characteristics were similar to those murmurs due to organic mitral incompetence. It was likely that the essential feature causing their production was functional mitral incompetence. It was significant that these murmurs occurred in severe anaemias. In one case there was moderate cardiac enlargement, in the other cardiac size was within normal limits.

There were two cases in which diastolic murmurs were recorded at the apex. In one case, a female, aged forty-six years, with a severe leuco-erthroblastic anaemia associated with the terminal phase of a chronic myeloid leukaemia, a questionable roughening of the first sound became audible as the anaemia progressed. Phonocardiogram showed a short "presystolic" murmur of relatively low amplitude and low frequency, continuous with an early systolic murmur which had the characteristics suggestive of relative mitral incompetence.

Subsequent post mortem examination showed a fatty flabby myocardium but no evidence of mitral valve disease.

The other case is worthy of more detailed report. She was 26 years of age, and complained of breathlessness, retrosternal pain, and sore tongue, of two years' duration. The blood picture was that of Pernicious Anaemia with Hb. 32 per cent of 14 grams, R.B.C. - 1,420,000 per cu.mm. W.B.C. 2.800 cu.mm. The first phonocardiogram was taken on 17.11,48. The apical recordings showed an accentuated third sound, a low frequency, low amplitude, long, mid-diastolic murmur and an early systolic murmur of medium and high frequency, low amplitude and relatively short duration. The appearances were indistinguishable from those of mitral stenosis. At the base the phonocardiogram showed an early systolic murmur of low amplitude, of medium and high frequency and of moderate duration, and a short, high frequency low amplitude early diastolic murmur. These suggested aortic stenosis and incompetence. All these murmurs were audible clinically, the phonocardiogram was requested for confirmation. On 30.1.49, the blood count was Hb. 100 per cent of 14 grams, R.B.C. - 4.410.000 cu.mm., W.B.C. 8.000 per cu.mm. The phonocardiogram taken on that date showed a mid-systolic murmur of low amplitude, medium frequency and short duration, the characteristics of an innocent systolic murmur. There had been no cardiac enlargement.

THE BASAL SYSTOLIC MURMURS:

There were 16 systolic murmurs recorded at the base. Apart from the case described above these murmurs were mid-systolic in timing, were of low or medium frequency, narrow frequency range, short duration and relatively low amplitude. The appearances were those of the "innocent" type of systolic murmur.

To summarise, it may be stated that the majority of the murmurs found in cases of anaemia are systolic murmurs having the characteristics of the "innocent" murmur. In a small proportion of cases and associated with severe anaemia there may be a functional mitral regurgitation. Less commonly, a murmur of functional aortic incompetence and of aortic dilatation may appear at the base. Rarely, and in severe long standing cases, murmurs may be heard and recorded which are indistinguishable from those of mitral stenosis. The important feature is their disappearance with the improvement in the blood picture.

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CHAPTER 13.

MURMURS IN HYPERTENSION.

CHAPTER 13.

TABULATION OF MATERIAL.

Phonocardiograms were taken in cases of Hypertension where murmurs were audible. An estimation of the incidence of murmurs was not attempted.

There were twenty cases of which ten were female and ten male. The ages were from the 4th decade onwards except for two cases in the 3rd decade. Auricular fibrillation was present in two cases. The Electrocardiograms showed changes appropriate to the condition of hypertension.

The Cardiac Size:

Normal	Slight Enlargement	Moderate Enlargement	Marked Enlargement
7	7	5	1

Four cases showed a split 1st sound, and an equal number showed accentuation of the 2nd sound.

APICAL MURMURS

Systolic Murmurs:

In nineteen cases a systolic murmur was recorded at the apex.

Time of Onset:

Early Systolic	Mid Systolic	Late Systolic
2	17	-

The Frequency:

Low	Medium	High	All Frequency	Low and Medium	Medium and High
-	7	-	4	3	5

The Amplitude:

Low	Medium	High
15	3	1

The Length or Duration:

Short	Moderate	Long
13	3	3

Diastolic Murmurs:

In two cases an early diastolic murmur was recorded at the apex. In both, the onset was in early diastole with the frequency high, duration short, and the amplitude low.

BASAL MURMURS.

Systolic Murmurs:

In thirteen cases a systolic murmur was recorded at the base.

Time of Onset:

Early Systolic	Mid Systolic	Late Systolic
3	10	-

The Frequency:

Low	Medium	High	All Frequency	Low and Medium	Medium and High
-	6	-	3	-	4

The Amplitude:

Low	Medium	High
8	3	2

The Duration or Length:

Short	Moderate	Long
6	2	5

Diastolic Murmurs:

In only two cases diastolic murmurs were recorded at the base. They were of predominantly high frequency, of low amplitude and short duration.

CHAPTER 13.

DISCUSSION:

The conception of Hypertension and its effects on the heart may be said to have originated with Bright (1), in 1827. The classical description of the physical signs by Traube (12) in 1870, led to its widespread recognition. Since then the literature on the various aspects of Hypertension has probably become one of the most voluminous in medicine, but there has been surprisingly little written on the subject of associated changes in the heart sounds and murmurs, and there has been no phonocardiographic study. Evans (2) described an apical mid-systolic murmur and an early diastolic murmur which were recorded in cases with hypertension.

A study of the literature has shown general agreement that, with regard to auscultation, there may be a "booming" apical first sound which may seem prolonged. Not uncommonly it is split, though Romberg (10) showed that slight splitting of the first heart sound occurred in 10% of perfectly healthy people. The second apical sound may be unduly loud. The second aortic sound may be accentuated, according to Janeway (7) in two-thirds of all hypertensions and may be of the ringing character known as "bruit de Tabourka". Skoda (11) observed such a ringing note in aortic sclerosis with a healthy aortic valve. Gallop rhythm may occur, proto-diastolic or presystolic, the latter more commonly in left ventricular failure.

In uncomplicated cases, without evidence of failure, a systolic murmur may be audible at apex, base or at both areas, Fahr. (3), Janeway (7), Fishberg (4), White (13), Evans (2). According to these authors the murmurs may have a variable origin. They may be of cardio-respiratory nature or be due to ventricular hypertrophy. Athero-sclerotic changes in the mitral or aortic valves and in the aorta may be responsible. A complicating anaemia in cases with chronic nephritis may cause such murmurs, and lastly a relative mitral incompetence may occur when left ventricular dilatation ensues.

Sclerotic changes in the aortic valves produce aortic diastolic murmurs akin to aortic insufficiency, Gibson (6), Kahler (8), Evans (2) and Garvin (5). In fourteen of the cases described by the latter, autopsy revealed no insufficiency and the murmurs may therefore be functional. He considered this due to a combination of dilatation of the terminal outflow tract of the left ventricle and stretching of the aortic ring by the high aortic pressure.

Fishberg points out the frequent occurrence together of mitral stenosis of rheumatic origin and hypertension which may account for reports of mitral diastolic murmurs in hypertension.

Paullin et al (9), found mitral systolic murmurs in

26%, aortic systolic murmurs in 5.8% and aortic diastolic murmurs in 2.4% of their series of 500 cases.

It is difficult in many cases to determine whether the systolic murmur, audible at apex or base is of functional origin, valvular origin, or due to aortic dilatation. The phonocardiograph can offer additional information in many of such cases.

A series of 20 cases is presented, the majority of which were of hypertension of uncomplicated nature and not accompanied by damage to the cardiac valves. The murmurs of aortic sclerotic lesions have already been described and illustrated in the chapter dealing with aortic disease.

Two distinctive types of systolic murmur were again found. With regard to apical murmurs there were two early systolic murmurs, of wide frequency range, high amplitude and long duration, which therefore could be considered to be of organic origin. One occurred in a case complicated by an aneurysm of the descending arch of the aorta in which the murmur was thought to be conducted from the base of the heart. The other murmur was also in a complicated case where a woman of 32 years of age presented with a severe hypertension and a considerable anaemia. The murmur was probably due to relative mitral incompetence. In this case also, a short, early diastolic murmur of high frequency was recorded at the apex, but not at the base, and may have been due to a relative aortic incompetence.

Of the other seventeen apical systolic murmurs, five were conducted elements of more prominent basal murmurs. All these murmurs were mid-systolic in onset, with the considerable majority of relatively narrow frequency range, low amplitude and short duration. The characteristics were those previously found in murmurs of an essentially "functional" nature.

Four of the thirteen basal systolic murmurs were thought to be conducted elements of more prominent apical murmurs. There were three early systolic murmurs of wide frequency range, high amplitude and long duration. These were therefore considered to be due to sclerotic changes in the aortic valves or in the aorta. On later scrutiny, other clinical features in these cases tended to confirm this opinion.

The remaining ten murmurs were mid-systolic in timing and possessed the other features mentioned above as indicating a "functional" origin.

Three diastolic murmurs of early onset, short duration, high frequency range and low amplitude were recorded. One has already been discussed. The other two occurred in association with early systolic murmurs and were thought to indicate a minor degree of aortic incompetence.

With regard to this small series, the murmurs of uncomplicated hypertension were therefore most commonly of "functional" characteristics, and as Evans (2) suggests may have originated in cardiac hypertrophy. They were recognised in the phonocardiogram by a mid-systolic onset, narrow medium-frequency range, short duration, and low amplitude. The exceptions were those cases where the tracing may have denoted sclerotic changes in the aortic valve, by the "organic" characters of the systolic murmur, and in some of which cases a short, early, high frequency diastolic murmur indicated a degree of aortic incompetence.

It is noteworthy that there was no correlation between cardiac size and the characteristics of the murmurs.

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CHAPTER 14.

MURMURS IN THYROTOXICOSIS.

CHAPTER 14.

TABULATION OF MATERIAL

Phonocardiograms were taken in sixteen cases which had audible murmurs. Thirteen of the cases were female and three were male. In only one case the rhythm was auricular fibrillation.

Severity of Cases:

Slight	Moderate	Severe
2	13	1

Cardiac Size:

Normal	Slight Enlargement	Moderate Enlargement	Marked Enlargement
6	6	2	2

One case had undoubtedly a complicating mitral stenosis, and its murmurs are not included in the following analysis.

SYSTOLIC MURMURS

Place of Maximum Intensity:

Apex	Base	Equally at apex and base
6	6	3

The Time of Onset:

Early Systolic	Mid Systolic	Late Systolic
6	9	-

The Frequency:

Low	Medium	High	All Frequency	Low and Medium	Medium and High
-	2	-	4	-	9

The Amplitude:

Low	Medium	High
10	4	1

The Duration or Length:

Short	Moderate	Long
9	1	5

DIASTOLIC MURMURS

No diastolic murmurs were seen in this series. The heart sounds themselves were not studied in detail, no obvious phonocardiographic abnormality could be discerned.

DISCUSSION:

The heart in Thyrotoxicosis has been the subject of a vast literature since the disease entity became known following Egeberg's (4) work in 1850. Parry (13), the Bath physician who is credited with first describing the clinical features, published his eight cases in 1786. Flajani (7) in 1802, recorded heart disturbance associated with a tumour in the anterior part of the neck. Adelman (1) correlated a type of cardiac disease with goitre and was probably the first to do so. Von Basedow (16), described the association of goitre, exophthalmos, and cardiovascular symptoms, and other authors followed suit. Graves (9) gave a particularly clear description, but it was not until Egeberg that the entire disease entity became known. Since then many works have made the thyrotoxic heart clearly understood. Worthy of mention are Rose (14), with whose work the condition became widely known, and Krause (11), who introduced the conception of the toxic goitre heart. More recent studies have been made by Dameshek (3), Goodall (8), Levine and Sturgis (12), Burnett and Durbin (2), Ernstene (5), and Sitkoff and Levine (15), among many others.

Changes in the sounds and the finding of murmurs have been noted from very early times, as yet no phonocardiographic study has been made. Summarising the literature, in uncomplicated cases of thyrotoxicosis the heart sounds are often loud, in one of Graves' original cases they could be heard at a distance of 4 ft. Many writers stress the feature of an abrupt first sound which may be accompanied by a thrill, and which may easily be mistaken for the presystolic thrill and murmur of mitral stenosis. The second pulmonic sound is frequently accentuated. Kerr and Hensel (10) point out that commonly in the thyrotoxic heart radiography may show a dilated, prominent pulmonary conus, making differentiation even more difficult. There is obvious importance of the phonocardiogram in these cases.

Systolic murmurs are very common, and on auscultation various types have been heard. A systolic murmur is frequently found at the pulmonic area, localised, of blowing character, and thought to be due to pulmonary artery dilatation, Fishberg (6) and Dameshek (3). A superficial scratching character has been described, Goodall (8). Apical murmurs have been heard, of soft or harsh quality, either localised or diffusely conducted. Fishberg (6), considered them to be cardio-respiratory in origin. Others including Willius (17) and Goodall (8), classed those murmurs with a variable transmission as dilatation murmurs, either of ventricular origin or due to a relative incompetence of the mitral ring, or less frequently, of the tricuspid ring.

The bruit over the thyroid gland has not as yet been photographed. It has been described as being sometimes continuous, but more commonly systolic in timing.

The group of cases was small in number, sixteen cases in all, but it was thought to be representative. In addition to the tracings from the cardiac area, records were attempted from over the thyroid gland in three cases where a bruit was clearly audible. In one case there was a complicating mitral stenosis of rheumatic origin which was not included in the analysis.

Six early systolic murmurs were recorded, four at the apex, and two at the base of the heart. All these murmurs had features of frequency range, amplitude and duration, which placed them in the "organic" category. In the two cases with basal murmurs, other features including radiology, suggested that one murmur was due to aortic dilatation, and the other probably caused by pulmonary artery dilatation.

The four early systolic murmurs seen at the apex were regarded as being due to a relative mitral incompetence, one such murmur was not entirely characteristic but other features of the case tended to confirm this opinion. The presence of a marked third sound in another record placed it in an "equivocal" category warranting further observation.

The remaining nine cases showed mid-systolic murmurs with the characters already stressed as indicating a "non-organic" or "functional" origin. Two were seen exclusively at the apex, four exclusively at the base, and three were present at both areas.

No direct correlation of cardiac size with the type of murmur could be made, save that a degree of enlargement was associated with all the murmurs of "organic" nature.

The thyroid bruit in all three records was seen to have both systolic and diastolic elements. In two cases the vibrations were continuous throughout systole and diastole. The other bruit consisted of a long predominantly late systolic element continuous with a short early diastolic phase. The frequency ranges were wide and the amplitudes moderate or high.

Numerous records of a bruit were taken with variation of the position of the microphone over the thyroid, and with pressure separately applied to the jugular veins and the carotid arteries. No significant alteration in the vibrations occurred. This may indicate that the bruit is derived from intra-glandular vessels.

To summarise, it may be necessary to seek the aid of phonocardiography to distinguish the features of sounds and murmurs where a complicating mitral stenosis is suspected. The tracings may indicate the comparatively common presence of a relative mitral incompetence (four out of fifteen cases in this series), and would give added confirmation that a systolic murmur was of "functional" nature.

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ABNORMALITIES OF SOUNDS

Abnormalities of Sound

Though the investigation was primarily concerned with murmurs, during its course abnormalities of sounds occurred in a number of phonocardiograms. No discussion of the abnormalities is contemplated, but it was considered to be worth while showing examples of some of the tracings, to demonstrate the value of phonocardiography as a whole and the excellent results produced by the present method in visualising auditory impressions which may, or may not have been correctly interpreted. In addition, in spite of the recognised inadequacy of the E.C.G. as a timing device, in the majority of cases it can be seen to be adequate for clinical purposes.

CONGENITAL HEART DISEASE

Congenital Lesions

During this investigation phonocardiograms were taken in cases which proved to be various types of congenital heart disease. A number of these records form a section of cases, other aspects of which are being studied by a colleague and no intensive scrutiny was therefore carried out. It was considered, however, worth while demonstrating a number of murmurs thought to be typical of certain lesions. The following representative phonocardiograms are exhibited.

SUMMARY AND CONCLUSIONS

SUMMARY AND CONCLUSIONS

A historical survey of heart sound recording is presented. The various methods employed and their advantages and disadvantages are discussed.

It is concluded that electrical methods are the more simple and efficient for clinical application. The difficulty of individual frequency response of each instrument is thought to be obviated by employing several frequency ranges, and electrical filtration to have advantages over other forms.

The frequency ranges of heart sounds and murmurs are reviewed.

An apparatus producing a simple calibrated phonocardiogram is described. The frequency ranges are not entirely ideal. A survey of the work done suggests that a high frequency band of from 100 cycles per second upwards is probably better than that extending from 140 cycles per second.

There is a discussion of the correlating timing devices which may be employed, and a historical sketch of their methods of recording. Observations are made on the merits of the various types. For routine purposes it was decided that the electrocardiogram is sufficient.

The conditions of work could have been improved upon. A sound-proof room is ideal, but even reasonable quiet is

all that is required. The room in which this investigation took place is situated in a particularly noisy basement corridor; even then good records were produced.

A room screened to prevent electrical interference is not necessary but would be a decided advantage. A simple earthed wire-net screen is all that is required. X-ray appliances are particularly liable to cause such interference. With this apparatus and a reasonably quiet screened room, no difficulty would be found in producing almost perfect phonocardiograms with speed and accuracy. The apparatus is improvised, and therefore slightly more complicated than is desirable, but each component could be easily adapted and built together to become a single compact unit.

In different forms of phonocardiogram, the appearances of the heart sounds, their correlation in time with the electrocardiogram , and the advantages of the harmonics of certain components sharply defined by the high frequency tracing are set forth. It is suggested that the timing of murmurs by reference to these harmonics is most valuable.

The natural history of the development of murmurs and changes in the sounds in mitral stenosis, and findings with regard to diagnosis in a series of eighty cases, are described and illustrated. The characteristics of the murmur of mitral incompetence are defined. There is special reference to the third sound which is a prominent feature. The controversy with regard to its origin is outlined and the opinion offered that the features are similar to an accentuated physiological third sound.

The murmurs of aortic valvular disease of rheumatic, sclerotic, syphilitic and traumatic origin are discussed and illustrated. The value of selective high frequency recording of aortic diastolic murmurs is shown. Examples of the bruit over aortic aneurysms are demonstrated.

The debate on the existence, features and origin of the "Austin Flint" murmur is expounded. Examples are shown. It is thought that it exists and is evidence of a relative mitral stenosis.

The "innocent" systolic murmur is investigated in a series of fifty-two cases. The history of opinion is surveyed, the phonocardiographic features are elicited and illustrations shown.

Certain phonocardiograms fall into an "equivocal" category and the various aspects of such tracings are explained.

Historical sketches are given of the murmurs which may occur in association with anaemia, hypertension and thyrotoxicosis. Series of cases in each condition are analysed and the murmurs discussed and illustrated. Tracings of the thyroid bruit are shown.

Examples of murmurs found in the various types of congenital heart disease, and abnormalities of sounds met with during the investigation are demonstrated.

It is thought that the clinical application of phonocardiography is expanding in scope and increasing in importance with the improved accuracy of recording and interpretation.

INDEX OF CASES

TABULATED

MITRAL STENOSIS

Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	MURMURS Systolic Time of Onset	Frequency	Duration	Amplitude	Diastolic Time of Onset	Frequency	Duration	Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
J.H.	11	M	sinus 120/min.	3rd accentuated	early	all frequency	long	medium	mid.presystolic accent.	low & medium & high	long	medium	moderate, left auricle +	NAD	Rbc. 3.78 mill. Hb. 72% Wbc. 6.200
L.T.	50	M	A.F. 88/min.	3rd prominent 2nd basal split	early	medium & high	short	low	early. mid diastolic accent.	all frequency all frequency	throughout diastole	low	moderate, left auricle +	A.F.	-
Mrs. A.D.	27	F	sinus 70/min.	2nd basal accentuated	-	none	-	-	early. presystolic accent.	all frequency, high	throughout diastole	low	moderate, right ventricle +, left auricle +	auricular hypertrophy	-
Mrs. E.R.	50	F	A.F. 88/min.	-	-	none	-	-	mid.	low	short	low	no definite enlargement	A.F. poor myocardium	-
A.C.	50	M	(1) A.F. 96/min.	3rd accentuated	-	none	-	-	mid	all frequency	variable with diastole	medium	moderate, right ventricle +, left auricle +	A.F.	demonstrated diminution of the murmur with slowing of auricular fibrillation
			(2) A.F. 50/min.	3rd accentuated	-	none	-	-	murmur much diminished in all characters				" " "	A.F.	
T.S.	34	M	(1) sinus 90/min.	-	early	medium & low	long	medium	early. presystolic accent.	all frequency	throughout diastole	low	marked, right ventricle +, left ventricle +.	consistent with mitral disease	
			(2) " ".	-	"	"	"	"	presystolic element more marked.				" " "	"	developed aortic diastolic, seen in 2nd record

Cont'd./

Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	MURMURS								Cardiac Size Enlargement	E.C.G.	Remarks
					Systolic				Diastolic						
					Time of Onset	Frequency	Duration	Amplitude	Time of Onset	Frequency	Duration	Amplitude			
P. McK.	42	M	(1) sinus 90/min.	3rd prominent	early	all frequency	short	low	presystolic.	all frequency prominent in medium range	short	medium	moderate, generalised	tall notched P waves	no mid-diastolic seen
			(2) sinus 80/min.	"	"	"	"	"	similar, low frequency, low amplitude, mid-diastolic of short duration just visible				"	"	mid-diastolic just visible
J.C.	44	M	sinus 80/min.	2nd basal accentuated	-	none	-	-	mid presystolic accent	Low & medium high	long -	medium -	moderate, generalised	tall notched P waves	-
M.K.	19	F	sinus 90/min.	-	early	low & medium	long	medium	mid- presystolic accent	low & medium high	long	low	moderate, left auricle +. left ventricle +	"	-
G.C.	54	M	A.F. 68/min.	-	-	none	-	-	early.	low	throughout diastole	low	slight, left auricle +, pulmonary conus +	A.F. R.A.D.	-
Mrs. A.D.	63	F	A.F. 80/min.	-	early	high	short	low	presystolic.	low	-	-	generalised marked, suggests mitral lesion	AF right ventricular hypertrophy	BP 145/85 long diastolic of rumbling character previously auscultated with AF. 100/min.

Cont'd./

Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	MURMURS Systolic Time of Onset	Frequency	Duration	Amplitude	Diastolic Time of Onset	Frequency	Duration	Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
Mrs. M.S.	41	F	A.F. 50/min.	3rd accentuated 2nd basal accentuated & split	-	none	-	-	mid.	low & medium	long	low	slight, mitral configuration	A.F. right vent. strain	-
J. McL.	55	M	A.F. 80/min.	-	early	medium	short	low	mid.	low & medium	long	low	slight, mitral configuration	A.F. R.A.D.	B.P. 90/45.
T.C.	40	F	sinus 90/min.	2nd basal split	-	none	-	-	mid. presystolic accent }	all frequency high	long LF vibrations between 2nd-3rd sound	low	slight, mitral configuration	R.A.D.	-
M.T.	48	F	A.F. 90/min.	2nd basal split	early	high	short	low	mid.	low & medium	long, variable	low	slight, mitral configuration	A.F. R.A.D.	variable L.F. vibrations between 2nd and 3rd sounds
M.P.	27	F	A.F. 84/min.	-	early	medium	long	low	mid.	low	long	low	moderate, left auricle++	R.A.D.	-
Mrs. M.W.	40	F	sinus 82/min.	2nd basal accentuated & split	-	none	-	-	mid.	low	short	low	marked, left auricle +	R.A.D.	-
F.B.	19	F	A.F. 96/min.	3rd accentuated	early	medium & high	long	low	early.	low & medium	throughout diastole	low	marked, left auricle++	A.F.	-

Cont'd./

					MURMURS										
					Systolic				Diastolic						
Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	Time of Onset	Frequency	Duration	Amplitude	Time of Onset	Frequency	Duration	Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
L.G.	12	M	A.F. 82/min.	3rd accentuated	early	medium & high	moderate	low	mid.	all frequency predominant low & medium	long	high	moderate	A.F.	-
J.B.	45	M	A.F. 84/min.	3rd prominent	-	none	-	-	mid.	low & medium	variable	low	moderate, mitral configuration	A.F. R.A.D.	-
Mrs. A.B.	40	F	A.F. 112/min.	3rd seen	early	high	short	low	early.	low	throughout diastole	low	moderate, left auricle +, left ventricle+	A.F. poor myocardium	-
Mrs. J.McK	34	F	sinus 90/min.	2nd basal split	early	medium	moderate	medium	mid. presystolic accent	low & medium } high	long	medium	slight, mitral configuration	P waves marked	-
Mrs. A.S.	38	F	sinus 82/min.	3rd seen	-	none	-	-	early.	low	throughout diastole	low	slight, left auricle +	R.A.D.	-
									presystolic accent	} high	-	-			
J.H.	30	M	A.F. 90/min.	3rd accentuated, 2nd basal accentuated and split	early	medium & high	long	high	mid.	low & medium	moderate	low	moderate, left auricle +, left ventricle+	A.F.	BP 150/90. Aortic stenotic murmur at base

Cont'd./

Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	MURMURS Systolic Time of Onset				Diastolic Time of Onset				Cardiac Size Enlargement	E.C.G.	Remarks
					Time of Onset	Frequency	Duration	Amplitude	Time of Onset	Frequency	Duration	Amplitude.			
M.S.	61	F	sinus 78/Min.	3rd seen	early	medium & high	long	high	mid. presystolic accent	low & medium — high	long	low	moderate, left ventricle+ calcified aortic valve	L.A.D.	BP 140/80
H. McL.	12	F	sinus 108/min.	-	early	medium & high	moderate	medium	mid.	low	short	low	slight enlargement of left auricle	suggests pericarditis	early case
J.Y.	29	M	sinus 80/min.	2nd basal accentuated and split	early	medium & high	moderate	medium	mid.	low	long	low	slight	sinus tachycardia	-
Mrs. J.O.	26	F	sinus 100/min.	2nd basal accentuated	early	medium & high	long	medium	early.	low	throughout diastole	low	slight, left auricle +	" " "	-
W.B.	42	M	A.F. 90/min.	3rd accentuated, 2nd basal split	-	none	-	-	mid.	low	variable with diastole	low	moderate, left auricle +right ventricle+	A.F.	-
Mrs. M.F.	58	F	sinus 68/min.	-	early	medium & high	short	low	mid. presystolic accent	low medium & high	long	low	slight, same prominence of left ventricle	L.A.D.	-
M. McL.	18	F	sinus 88/min.	3rd accentuated basal 2nd accentuated	early	medium & high	moderate	medium	mid.	low	short	low	no cardiac enlargement	N.A.D.	BP 100/80. an early case with developing stenosis

Cont'd./

					MURMURS										
					Systolic				Diastolic						
Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	Time of Onset	Frequency	Duration	Amplitude	Time of Onset	Frequency	Duration	Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
H.M.	56	M	sinus 88/min.	3rd accentuated, basal 2nd accentuated	Early	medium & high	long	high	mid.	low	long	low	moderate, left auricle + right ventricle +	Broad P in II	-
A.S.	34	M	sinus 90/min.	3rd accentuated basal 2nd split.	early	medium & high	long	low	early. presystolic accent	low high	throughout diastole -	low -	slight, left auricle +	Broad P in II	-
J.T.	9	M	sinus 80/min.	3rd accentuated basal 2nd split	early	high	long	high	mid.	low	short	low	no cardiac enlargement	N.A.D.	an early case
E.B.	24	F	sinus 80/min.	3rd accentuated, basal 2nd split	-	none	-	-	mid. presystolic accent	low medium and high	long -	low -	slight prominence of left auricle	R.A.D.	-
N.P.	13	F	sinus 100/min.	3rd accentuated, 2nd accentuated and split. 4th sound seen 5th sound seen	mid	high	short	low	mid.	low	variable	low	no cardiac enlargement	sinus tachycardia	mid-diastolic best seen in basal murmurs, apical 3rd sound varies to a short diastolic murmur

Cont'd./

					MURMURS										
					Systolic				Diastolic						
Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	Time of Onset	Frequency	Duration	Amplitude	Time of Onset	Frequency	Duration	Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
D. McK.	49	M	(1) A.F. 100/min. (2) similar findings	3rd grossly accentuated	mid.	high	short	low	mid.	low	variable	low	moderate, left auricle + left ventricle+	A.F. poor myocardium	markedly accentuated 3rd sound varies to become a short mid-diastolic murmur
M.F.	41	F	A.F. 90/min.	3rd seen, particularly at the base	early	medium	long	low	early.	low	throughout diastole	low	marked, left auricle ++, left ventricle ++, right auricle +	A.F. poor myocardium	-
Mrs. EMcA.	30	F	sinus 100/min.	3rd seen	early	low & medium	short	low	mid. presystolic accent	low medium and high	long	low	moderate	broad P waves	-
B.T.	20	F	sinus 90/min.	3rd prominent, 2nd basal split	-	none	-	-	early. presystolic accent	low high	throughout diastole	low	slight, pulmonary conus +, left auricle +	P waves of mitral type	-
C. McG.	21	F	sinus 84/min.	3rd visible	early	all frequency	long	high	mid.	low & medium	short	low	no cardiac enlargement	N.A.D.	-
Mrs. AMcC.	30	F	sinus 76/min.	3rd visible	early	low & medium	long	medium	mid.	low	long	low	slight, pulmonary conus +, left auricle +	-	-

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					MURMURS										
					Systolic				Diastolic						
Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	Time of Onset	Frequency	Duration	Amplitude	Time of Onset	Frequency	Duration	Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
J.B.	47	F	sinus 100/min.	3rd visible 2nd basal accentuated & split	-	none	-	-	early.	low	throughout diastole	low	moderate, left auricle +	sinus tachycardia	-
Mrs. S. McG.	43	F	A.F. 64/min.	3rd visible	early	low & medium	long	low	mid.	low	short	low	marked, left auricle +, right ventricle +, left ventricle +	A.F.	-
H.C.	38	M	sinus 90/min.	3rd prominent	early	medium	long	medium	early	low	throughout diastole	low	marked, left ventricle +	L.A.D.	BP 130/40. blood culture + ve streptococcus viridans
G.G.	20	M	sinus 80/min.	-	early	high	long	low	mid.	low	long	low	slight, left ventricle +, left auricle +	L.A.D.	BP 130/50.
Mrs. E.B.	29	F	sinus 90/min.	3rd accentuated	early	medium	moderate	medium	mid.	low	long	high	marked, left auricle + left ventricle +	poor myocardium	BP 110/45, RBc. 4.91 mill. Hb. 70%
E.O.	13	F	sinus 100/min.	-	early	high	very short	low	mid.	medium & high	long	low	moderate, left auricle + left ventricle +	L.A.D.	BP 120/40.

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Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	MURMURS Systolic Time of Onset	Systolic Frequency	Systolic Duration	Systolic Amplitude	Diastolic Time of Onset	Diastolic Frequency	Diastolic Duration	Diastolic Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
J.G.	32	M	sinus 76/min.	2nd basal accentuated	early	medium	long	low	early.	low	throughout diastole	low	no cardiac enlargement	P waves of mitral type	BP 150/70
Mrs. AMcA.	38	F	sinus 84/min.	-	early	medium & high	moderate	low	mid.	low	long	low	no cardiac enlargement	L.A.D.	BP 140/80
A.T.	21	M	sinus 86/min.	3rd accentuated	early	medium & high	long	medium	mid.	low	long	low	marked, left ventricle +, left auricle +, pulmonary conus +	Pwaves of mitral type	BP 150/60.
Mrs. A.T.	45	F	A.F. 45/min.	(1) 2nd basal split (2) similar appearances	early	medium & high	long	low	mid.	low	variable	low	moderate, left auricle +, left ventricle +	A.F. L.A.D.	-
Mrs. A.S.	41	F	A.F. 44/min.	3rd accentuated	early	low	long	low	mid.	low & medium	short, variable	medium	marked, left auricle ++ left ventricle +	A.F.	BP 110/65
M. McE.	17	F	sinus 82/min.	3rd accentuated	early	low & medium	moderate	low	mid.	low	long	very low	no cardiac enlargement	Pwaves of mitral type	BP 120/60.

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Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	MURMURS Systolic Time of Onset	Frequency	Duration	Amplitude	Diastolic Time of Onset	Frequency	Duration	Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
Mrs. M.McK	40	F	A.F. 60/min.	3rd seen	early	all frequency	long	medium	mid.	all frequency predominantly low & medium	short, variable	low	marked, left auricle +, right ventricle +	A.F., R.A.D.	BP 150/100
G.T.	20	M	sinus 92/min.	3rd seen 2nd apical split	early	all frequency	long	high	early.	low	throughout diastole	low	marked, left auricle +, right ventricle + left ventricle +	left ventricular hypertrophy P waves of mitral type	BP 136/0
J.L.	15	M	sinus 70/min.	3rd prominent	early	all frequency	long	high	mid.	low	long	low	moderate, mitral configuration	R.A.D.	BP 130/68
G.F.	41	M	sinus 92/min.	3rd prominent	early	all frequency	long	high	mid. presystolic accent	low high	long -	medium -	marked, left ventricle ++, left auricle +	left ventricular strain	BP 134/40 Rbc. 3,070,000 Hb. 55% Wbc. 4800
G. O'N.	17	M	sinus 114/min.	3rd prominent, 2nd basal accentuated & split	early	all frequency	long	low	mid.	low	short	medium	moderate, mitral configuration	-	BP 120/30
Mrs. H.B.	62	F	sinus 72/min.	3rd prominent 2nd basal accentuated	early	low & medium	long	low	early.	low	throughout diastole	low	moderate, mitral configuration	poor myocardium	BP 120/0 Accentuation in mid diastole

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					MURMURS										
					Systolic				Diastolic						
Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	Time of Onset	Frequency	Duration	Amplitude	Time of Onset	Frequency	Duration	Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
J.Q.	41	M	sinus 100/min.	2nd basal split	early	low & medium	short	low	early.	low	throughout diastole	low	moderate, mitral configuration	auricular hypertrophy. right ventricular hypertrophy	BP 130/100
									presystolic accent	all frequency	-	high			
R.H.	52	M	A.F. 82/min.	3rd sound seen, 2nd basal accentuated	early	all frequency	long	high	mid.	low	short, variable	low	moderate, generalised	A.F., R.A.D.	BP 130/70
A.G.	13	M	sinus 100/min.	-	early	low & medium	long	high	mid.	low	short	low	moderate	sinus tachycardia L.A.D.	BP 140/50
Mrs. A.S.	38	F	sinus 100/min.	3rd visible	early	medium & high	short	high	mid.	low	long	medium	moderate, left auricle +, left ventricle +		BP 120/85 Hb. 55% Rbc. 3.720.000 Wbc. 1200
J.P.	30	M	sinus 74/min.	-	early	high	short	low	early.	low	throughout diastole	low	slight, mitral configuration.	P waves of mitral type	BP 128/64
									presystolic accent	high		-			
H.B.	54	M	sinus 110/min.	3rd accentuated, 2nd basal accentuated	early	medium & high	long	high	mid.	low	long	low	slight, left auricle +	P waves of mitral type	BP 140/98
									presystolic accent	high frequency	-	-			

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Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	MURMURS Systolic: Time of Onset	Systolic: Frequency	Systolic: Duration	Systolic: Amplitude	Diastolic: Time of Onset	Diastolic: Frequency	Diastolic: Duration	Diastolic: Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
J.P.	14	F	sinus 84/min.	3rd prominent, 2nd basal accentuated	early	medium	long	low	mid.	low & medium	long	medium	moderate, left ventricle +, left auricle +	combined ventricular strain	BP 130/30
Mrs. C.M.	54	F	A.F. 44/min.	3rd prominent	early	all frequency	long	medium	mid.	all frequency	short	medium	marked, left auricle ++, left ventricle++	A.F.	BP 104/50
B.W.	11	F	sinus 124/min.	3rd prominent, 2nd basal prominent	early	all frequency	long	medium	very short diastolic phase, 3rd sounds & auricular sounds summating incompletely to form a short, high amplitude presystolic with some vibrations of high frequency				moderate, mitral configuration with incompetence predominating	sinus tachycardia	BP 120/90
A.M.	21	M	sinus 90/min.	3rd seen, 2nd basal accentuated	early	all frequency	long	low	mid. presystolic accent	low high	long -	very low -	moderate, configuration of aortic and mitral lesion	auricular hypertrophy	BP 140/75
E.G.	31	F	sinus 98/min.	3rd visible	early	low & medium	short	medium	late. presystolic	low high	short -	low -	slight, mitral configuration	P waves of mitral type	BP 110/75
J.F.	35	M	sinus 80/min.	3rd accentuated, basal 2nd accentuated & split	early	all frequency	long	high	mid.	low	long	medium	marked, left auricle + left ventricle +	combined ventricular strain	BP 100/40
J.M.	29	F	sinus 90/min.	3rd visible, basal 2nd split	early	medium & high	long	low	early.	low	long	low	marked, left auricle +, right ventricle +, left ventricle +	P waves of mitral type RAD	BP 96/50

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Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	MURMURS Systolic Time of Onset	Systolic Frequency	Systolic Duration	Systolic Amplitude	Diastolic Time of Onset	Diastolic Frequency	Diastolic Duration	Diastolic Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
Mrs. R.McD.	27	F	sinus 88/min.	2nd basal accentuated & split	early	high	moderate	medium	mid.	low	long	very low	slight, mitral configuration	Pwaves of mitral type	BP 132/50
Mrs. A.M.	27	F	sinus 90/min.	3rd accentuated	early	medium & high	moderate	medium	early.	low	throughout diastole	low	slight, mitral configuration	L.A.D.	BP 132/50
A.W.	37	M	sinus 60/min.	3rd visible	-	none	-	-	early.	low	throughout diastole	low	moderate, left auricle +, pulmonary conus +	Pwaves of mitral type	-
C. McG.	24	F	sinus 90/min.	3rd accentuated	early	medium & high	long	low	early. presystolic accent.	low high	throughout diastole -	low -	slight, mitral configuration	Pwaves of mitral type	diastolic recorded only in low frequency band
Mrs. J.McK.	53	F	A.F. 100/min.	3rd prominent, basal 2nd split	early	medium & high	long	low	mid.	low	short	low	marked, left auricle + mitral configuration	A.F. L.A.D.	-
R.J.	42	F	sinus 70/min.	3rd visible	early	all frequency	long	medium	mid.	low	long	low	moderate, left auricle +, left ventricle +	Pwaves of mitral type	-
Mrs. J.W.	40	F	sinus 66/min.	3rd visible, basal 2nd accentuated & split	early	all frequency	long	medium	mid. presystolic accent	low high	long -	low -	moderate, left auricle +, left auricle +, mitral configuration	right ventricular hypertrophy	-

AORTIC VALVE DISEASE

RHEUMATIC

(a) Associated with mitral stenosis.

(b) Not associated with mitral stenosis.

BASAL MURMURS

(a)

Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	MURMURS Systolic Time of Onset	Systolic Frequency	Systolic Duration	Systolic Amplitude	Diastolic Time of Onset	Diastolic Frequency	Diastolic Duration	Diastolic Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
Mrs. C.M.	54	F	A.F. 44/min.	apical 3rd prominent	early	all frequency	long	high	early	medium & high	short	low	marked, left ventricle ++, left auricle++	A.F.	BP 104/50
Mrs. R.McD.	27	F	sinus 88/min.	basal 2nd split and accentuated	early	all frequency	long	high	early	high	long	medium	slight, left ventricle +, left auricle+	L.A.D.	BP 140/70 diastolic elicited by the high frequency band
Mrs. A.L.	36	F	sinus 88/min.	apical 3rd visible	early	all frequency	long	medium	early	medium & high	long, through diastole	low	moderate	-	BP 120/85
J.P.	30	M	sinus 74/min.	split 1st sound, auricular complex -	indefinite midsystolic	medium	short	low	early	medium & high	short, variable	low	slight, mitral configuration	consistent with mitral disease	BP 128/64
Miss J.P.	14	F	sinus 84/min.	3rd apical prominent, 2nd basal accentuated	midsystolic	all frequency	long	low	early	all frequency	long, through diastole	high	moderate	combined ventricular strain	BP 120/30 difficult to estimate the beginning of systole accurately
Miss B.W.	11	F	sinus 124/min.	3rd apical prominent, 2nd basal accentuated	early	low & medium	long	medium	early	all frequency	throughout short diastole	medium	moderate, left ventricle+, left auricle+	sinus tachycardia	BP 120/90
A.M.	21	M	sinus 90/min.	2nd basal accentuated	early	all frequency	long	high	early	high frequency	throughout diastole	high	moderate, suggests aortic & mitral lesion	? auricular hypertrophy	BP 140/75 diastolic elicited by H.F. recording

Cont'd./

BASAL MURMURS (Continued)

(a)

Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	Systolic: Time of Onset	Systolic: Frequency	Systolic: Duration	Systolic: Amplitude	Diastolic: Time of Onset	Diastolic: Frequency	Diastolic: Duration	Diastolic: Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
Miss E.G.	31	F	sinus 98/min.	3rd apical visible	early	all frequency	long	medium	early	medium & high	short	low	slight, mitral configuration	consistent with mitral stenosis	BP 110/75
J.F.	35	M	sinus 80/min.	3rd apical accentuated basal 2nd split	early	all frequency	long	high	early	all frequency	short	low	marked, left ventricle +, left auricle +	anterior coronary insufficiency	BP 100/40
Miss J.M.	29	F	sinus 90/min.	3rd apical visible, basal 2nd split	early	medium & high	long	low	early	medium & high	long, variable	medium	marked, left ventricle +, right ventricle+, left auricle+	consistent with mitral stenosis	BP 96/60
Mrs. A.M.	27	F	sinus 90/min.	3rd apical accentuated	early	medium & high	long	low	early	medium & high	long	medium	slight, consistent with a mitral lesion	consistent with mitral stenosis	BP 132/50 diastolic elicited by high frequency band
Mrs. J.W.	40	F	sinus 60/min.	3rd apical visible, 2nd basal accentuated and split	none	-	-	-	early	high	short	low	moderate, right ventricle+, left auricle+, consistent with mitral stenosis	right ventricular hypertrophy	BP 130/90
Miss R.J.	42	F	sinus 90/min.	3rd apical visible	early	all frequency	long	medium	early	high	moderate	medium	consistent with mitral disease, left ventricle +	consistent with mitral disease	BP 126/72

Cont'd./

BASAL MURMURS (Continued)

(a)

					MURMURS										
					Systolic				Diastolic						
Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	Time of Onset	Frequency	Duration	Amplitude	Time of Onset	Frequency	Duration	Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
Mrs. J.McK.	53	F	A.F. 100/min.	3rd apical visible 2nd basal split	none	-	-	-	early	high	short	low	marked, left auricle +	A.F. L.A.D.	BP 182/116
Mrs. C.McG.	24	F	sinus 90/min.	3rd apical accentuated. 2nd basal split	early	medium & high	long	low	early	high	short	low	slight, consistent with mitral stenosis	consistent with mitral stenosis	BP 120/80
A.W.	37	M	sinus 60/min.	3rd apical visible	early	medium	long	medium	early	medium	long, through diastole	low	moderate, left auricle +, pulmonary conus +	" "	BP 115/65
Mrs. A.T.	45	F	A.F. 45/min.	2nd basal split	early	all frequency	long	high	early	medium & high	short	low	moderate, configuration of an aortic & mitral lesion	A.F. L.A.D.	BP 180/86 diastolic elicited by unfiltered phonocardiograph
A.T.	21	M	sinus 86/min.	3rd apical accentuated	early	all frequency	long	medium	early	all frequency	long	high	moderate, left auricle +, left & right ventricle +	consistent with mitral disease	BP 150/60 marked diastolic in the high frequency
Mrs. McA.	38	F	sinus 84/min.	-	early	low & medium	long	medium	early	medium & high	long	low	normal size	L.A.D.	BP 140/80
J.G.	32	M	sinus 76/min.	2nd basal accentuated	early	low & medium	long	medium	early	medium & high	long	low	normal size	P waves prominent	BP 150/70
H.C.	38	M	sinus 90/min.	apical 3rd prominent	early	low & medium	long	medium	early	medium & high	long	low	moderate, left ventricle +	L.A.D.	BP 130/40
G.G.	20	M	sinus 80/min.	-	mid	low & medium	short	low	early	all frequency	long	medium	slight, left auricle +, left ventricle +	L.A.D.	BP 130/50 diastolic clearly elicited by high frequency

Cont'd./

BASAL MURMURS (Continued)

(a)

Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	Systolic: Time of Onset	Systolic: Frequency	Systolic: Duration	Systolic: Amplitude	Diastolic: Time of Onset	Diastolic: Frequency	Diastolic: Duration	Diastolic: Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
Miss E.O.	13	F	sinus 100/min.	-	mid	low & medium	short	very low	early	medium & high	long	medium	moderate, left ventricle +, left auricle +	L.A.D.	BP 120/40 diastolic elicited by high frequency band
Mrs. M.S.	41	F	A.F. 44/min.	3rd apical accentuated	early	low & medium	long	low	early	low & medium	short	high	marked, left ventricle++, left auricle ++	A.F.	BP 110/65
M. McE.	17	F	sinus 82/min.	3rd apical accentuated, 2nd basal split	mid	low & medium	short	medium	early	medium	long	very low	normal	large P waves	BP 120/60
Mrs. A. McK.	40	F	A.F. 60/min.	3rd apical seen	early	all frequency	long	high	early	medium & high	long	low	marked, left ventricle+, left auricle+, right ventricle+	A.F. R.A.D.	BP 150/100
J.L.	15	M	sinus 76/min.	3rd apical seen	early	all frequency	long	high	early	high	very short	low	moderate, mitral configuration	R.A.D.	BP 130/68
G.T.	20	M	sinus 92/min.	3rd apical seen, 2nd apical split	early	all frequency	long	high	early	medium & high	long	medium	marked, enlargement of all chambers	L.V. hypertrophy, large P waves	BP 136/0

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[illegible]

BASAL MURMURS (Continued)

(a)

Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	MURMURS Systolic Time of Onset	Frequency	Duration	Amplitude	Diastolic Time of Onset	Frequency	Duration	Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
Mrs. E.B.	29	F	sinus 90/min.	3rd apical accentuated	early	all frequency	long	high	early	medium & high	long	medium	marked, left ventricle+, left auricle+	poor myocardium	BP 110/45
G.F.	41	M	sinus 92/min.	3rd apical prominent	early	all frequency	long	med-	early	medium & high	very short	low	marked, left ventricle+, left auricle+	left ventricular strain	BP 134/40
G. O'N.	17	M	sinus 114/min.	3rd apical prominent	early	all frequency	long	medium	early	medium & high	long, through diastole	low	moderate, mitral configuration	-	BP 120/50
R.H.	52	M	A.F. 82/min.	3rd apical seen, 2nd basal accentuated	mid	all frequency	long	low	early	all frequency	long, through diastole	low	moderate, generalised	A.F. R.A.D.	BP 160/80
A.G.	19	M	sinus 100/min.	-	early	all frequency	long	high	early	medium & high	long	medium	moderate,	sinus tachycardia, L.A.D.	BP 140/50

BASAL MURMURS

(b)

Cont'd./

BASAL MURMURS (Continued)

(b)

Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	Murmurs: Systolic Time of Onset	Systolic Frequency	Systolic Duration	Systolic Amplitude	Murmurs: Diastolic Time of Onset	Diastolic Frequency	Diastolic Duration	Diastolic Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
W.H.	31	M	sinus 70/min.	-	early	all frequency	long	high	early	medium & high	long	low	moderate, left ventricle +, left auricle+	L.A.D.	BP 140/50
D.O.	22	F	sinus 114/min.	-	early	all frequency	long	medium	early	medium & high	short	low	marked	-	BP 146/84
J.C.	40	M	sinus 100/min.	2nd basal split	early	all frequency	long	high	early	medium	long	low	slight, generalised	equivocal changes	BP 130/70 3 records
J.A.	18	F	sinus 80/min.	-	mid	low & medium	long	very low	early	all frequency	moderate	low	no enlargement	L.A.D.	BP 120/50
W.M.	56	M	sinus 80/min.	-	early	all frequency	long	medium	early	all frequency	long	medium	moderate, left ventricle+	L.A.D.	BP 170/80

APICAL MURMURS

Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	Systolic Time of Onset	Systolic Frequency	Systolic Duration	Systolic Amplitude	Diastolic Time of Onset	Diastolic Frequency	Diastolic Duration	Diastolic Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
W.H.	-	-	-	-	early	low & medium	long	medium	-	-	-	-	-	-	-
D.O.	-	-	-	-	mid	medium & high	short	medium	-	-	-	-	-	-	-
J.C.	-	-	-	-	early	all frequency	long	high	-	-	-	-	-	-	-
J.A.	-	-	-	-	mid	medium & high	short	low	-	-	-	-	-	-	-
W.M.	-	-	-	-	early	all frequency	long	medium	early	medium & high	short	medium	-	-	-

AORTIC VALVE DISEASE

SCLEROTIC

BASAL MURMURS.

					MURMURS										
					Systolic				Diastolic						
Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	Time of Onset	Frequency	Duration	Amplitude	Time of Onset	Frequency	Duration	Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
J.M.	69	M	sinus 120/min.	-	mid	high	short	low	early	high	short	low	slight transverse	L.A.D.	BP 180/100
W.R.	60	M	A.F. 82/min.	-	mid	low	short	very low	early	high	short	very low	no enlargement, flakes of calcification in aortic arch	A.F.	BP 120/60
A.C.	57	M	sinus 86/min.	-	early	all frequency	long	medium	early	low	very short	low	moderate, left ventricle+, aorta markedly dilated	posterior coronary insufficiency	BP 130/80
Mrs. A.S.	80	F	sinus 78/min.	-	mid	low & medium	long	low	early	all frequency	long	low	moderate, left ventricle+, tortuous, sclerotic aortic		BP 190/75
A.W.	65	M	sinus 90/min.	-	mid	low & medium	long	medium	early	medium & high	short	low	marked, left ventricle+, dilated ascending aorta	left ventricular strain	BP 205/85
W.C.	51	M	sinus 80/min.	-	mid	low & medium	long	low	early	all frequency	long	low	slight, left ventricle+, aorta pulsating & dilated	-	BP 152/78
C.E.	66	M	sinus 86/min.	3rd sound just visible	early	all frequency	long	high	early	high	a few vibrations only	low	moderate, aorta elongated with calcified knuckle	LAD poor myocardium	BP 165/85 myeloid leukaemia & gout
J.F.	36	M	sinus 80/min.	-	early	all frequency	long	high	early	medium & high	long	very low	marked, left ventricle+	left ventricular strain	BP 140/80 no rheumatic history

Cont'd./

BASAL MURMURS.

					MURMURS										
					Systolic				Diastolic						
Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	Time of Onset	Frequency	Duration	Amplitude	Time of Onset	Frequency	Duration	Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
A.G.	71	M	sinus 72/min.	-	early	all frequency	long	medium	early	all frequency	long	low	moderate, left ventricle+	left ventricular hypertrophy	BP 180/80
J. McG.	27	M	sinus 84/min.	-	early	all frequency	long	high	none	-	-	-	moderate, aortic valve calcified	left ventricular strain	BP 90/50
Mrs. A.S.	79	F	sinus 70/min.	-	early	all frequency	long	high	early	high	short	low	moderate	-	BP 160/86 HB.58%, Rbc. 2.780.000 Wbc. 6.800
Mrs. E.S.	70	F	sinus 100/min.	3rd sound accentuated	early	all frequency	long	medium	early	high	a few vibrations only	low	size normal, aorta sclerotic, calcified patch on arch	poor myocardium	BP 180/105

APICAL MURMURS

Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	Time of Onset	Frequency	Duration	Amplitude	Time of Onset	Frequency	Duration	Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
J.M.	-	-	-	-	mid	high	short	low	early	high	short	very low	-	-	-
W.R.	-	-	-	-	mid	medium	short	very low	early	high	short	very low	-	-	-
A.C.	-	-	-	-	early	all frequency	long	high	early	medium & high	long	low	-	-	-
Mrs. A.S.	-	-	-	-	mid	low & medium	short	low	early	medium & high	a few vibrations only		-	-	-
A.W.	-	-	-	-	mid	low & medium	long	low	early	medium & high	a few vibrations only		-	-	-
W.C.	-	-	-	-	mid	medium & high	short	high	early	medium & high	short	low	-	-	-
C.E.	-	-	-	-	mid	all frequency	moderate	medium	early	high	a few vibrations only		-	-	-
J.F.	-	-	-	-	early	all frequency	long	high	early	medium	a few vibrations only		-	-	-

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APICAL MURMURS

					MURMURS										
					Systolic				Diastolic						
Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	Time of Onset	Frequency	Duration	Amplitude	Time of Onset	Frequency	Duration	Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
A.G.	-	-	-	-	mid	all frequency	short	medium	early	all frequency	long	low	-	-	Foster's murmur
J. McG.	-	-	-	-	mid	all frequency	moderate	medium	none	-	-	-	-	-	-
Mrs. A.S.	-	-	-	-	early	all frequency	long	high	none	-	-	-	-	-	-
Mrs. E.S.	-	-	-	-	early	all frequency	long	medium	some indeterminate vibrations after 3rd sound				-	-	?? mitral stenosis

AORTIC VALVE DISEASE

SYPHILITIC

Page 1.

BASAL MURMURS

Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	MURMURS Systolic Time of Onset	Systolic Frequency	Systolic Duration	Systolic Amplitude	Diastolic Time of Onset	Diastolic Frequency	Diastolic Duration	Diastolic Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
W.B.	48	M	sinus 90/min.	apical 3rd prominent, 2nd basal accentuated	early	all frequency	long	high	early	all frequency	long	high	moderate, left ventricle+	left ventricular strain	BP 140/48. two recordings at separate dates
F.S.	44	M	A.F. 70/min.	apical 3rd just visible	early	all frequency	long	high	early	all frequency	long	medium	moderate, left ventricle+, aorta dilated	A.F. L.A.D.	BP 115/50
R.Y.	59	M	sinus 96/min.	apical 3rd accentuated	early	medium	long	low	early	predominantly high	long	medium	marked, left ventricle+	left ventricular strain	BP 135/65
J.S.	53	M	A.F. 46/min.	apical 3rd visible	early	medium & high	long	high	early	medium & high	long	medium	moderate, left ventricle +	A.F. R.A.D.	BP 138/46
J.R.	50	M	sinus 62/min.	-	indeterminate	low	a few vibrations only	low	early	all-frequency	long	medium	marked, cor bovinum. fair sized aneurysm, fusiform, in the ascending aorta	Pot.Heart Block. left ventricular strain	BP 156/80
C. O'S.	51	M	sinus 100/min.	-	early	all frequency	long	medium	early	high	long	low	moderate, left ventricle +, aortic aneurysm	simple tachycardia	BP 140/60
Mrs. M.S.	55	F	sinus 100/min.	-	early	medium & high	short	medium	early	medium & high	short	low	moderate, left ventricle+	left ventricular hypertrophy	BP 140/40
R.M.	61	M	sinus 82/min.	apical 4th sound prominent	early	low & medium	short	high	early	medium & low	long	low	moderate, left ventricle+, right ventricle+, marked aortic pulsation	left ventricular strain	BP 204/80
Mrs. J.T.	55	F	sinus 80/min.	apical 3rd visible	early	all frequency	long	medium	-	-	-	-	moderate, left ventricle+	left ventricular strain	BP 190/130 ? murmur of aortic dilatation only

APICAL MURMURS

Cont'd./

APICAL MURMURS

Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	Murmurs: Systolic: Time of Onset	Systolic: Frequency	Systolic: Duration	Systolic: Amplitude	Diastolic: Time of Onset	Diastolic: Frequency	Diastolic: Duration	Diastolic: Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
W.B.	48	"	"	"	mid	medium & high	short	medium	mid	low with some high elements	not lasting up to 1st sound	medium	"	"	Austin Flint murmur
F.S.	44	"	"	"	early	medium & high	moderate	high	mid	low	long, variable with diastole	very low	"	"	Austin Flint murmur
R.Y.	59	"	"	"	early	all frequency	moderate	medium	early	low	throughout diastole	medium	"	"	Austin Flint murmur
J.S.	53	"	"	"	early	all frequency	moderate	high	mid	low	long	medium	"	"	Austin Flint murmur
C. O'S.	51	"	"	"	mid	medium & high	long	low	early	high	long	very low	"	"	Conducted from aortic area
Mrs. M.S.	55	"	"	"	mid	medium	short	very low	-	-	-	-	"	"	-
R.M.	61	"	"	"	early	all frequency	short	high	(1) mid	low	a few vibrations only	low	"	"	-
									(2) early	medium	short	low			conducted from aortic area
Mrs. J.T.	55	"	"	"	early	all frequency	long	medium	early	high	long	low	"	"	indefinite ?Fosters murmur
J.R.	50	"	"	"	mid	low & medium	short	low	mid	low	long	medium	"	"	Austin Flint murmur

BRUITS OF ANEURYSMS

Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	Systolic: Time of Onset	Systolic: Frequency	Systolic: Duration	Systolic: Amplitude	Diastolic: Time of Onset	Diastolic: Frequency	Diastolic: Duration	Diastolic: Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
J.R.	50	"	"	"	early	low & medium	long	low	early	all frequency	throughout diastole	high	"	"	-
C. O'S.	51	"	"	"	early	medium & high	long	high	early	medium & high	throughout diastole	medium & diminishing	"	"	-

AORTIC VALVE DISEASE

TRAUMATIC

BASAL MURMURS

Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	MURMURS: Systolic: Time of Onset	Systolic: Frequency	Systolic: Duration	Systolic: Amplitude	Diastolic: Time of Onset	Diastolic: Frequency	Diastolic: Duration	Diastolic: Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
J.N.	34	M	sinus 90/min.	-	mid	low & medium	short	low	early	all frequency	long	very high	normal contour, marked aortic pulsation	NAD	BP 130/45
N.D.	25	M	sinus 82/min.	-	early	all frequency	long	high	early	all frequency	long	high	normal contour, marked pulsation of left side of heart	NAD	BP 170/90

APICAL MURMURS

Name	Age	Sex	Rhythm Rate	Abnormalities of Sounds	Systolic: Time of Onset	Systolic: Frequency	Systolic: Duration	Systolic: Amplitude	Diastolic: Time of Onset	Diastolic: Frequency	Diastolic: Duration	Diastolic: Amplitude	Cardiac Size Enlargement	E.C.G.	Remarks
J.N.	34	M	"	"	early	all frequency	moderate	medium	early	all frequency	long	low	"	"	"
N.D.	25	M	"	"	mid	medium & high	short	low	-	-	-	-	"	"	"

"INNOCENT" MURMURS

Name	Age	Sex	B.P.	Presenting Feature	MURMUR					Cardiac Size	E.C.G.	Remarks
					Time of Onset	Frequency	Duration	Area	Amplitude			
W.S.	24	M	126/82	systolic murmur	mid-systolic	low and medium	long	base	low	normal	sinus arrhythmia	rheumatic fever age 14, no symptoms since
Mrs. A.C.	57	F	128/80	rheumatoid arthritis	mid-systolic	low and medium	short	apex & base	medium	normal	LAD	no complaints referable to C.V.S.
J. McC.	14	F	108/76	recurrent tonsilitis	mid-systolic	medium & high	short	base	medium	normal	vertical heart	" " " " "
J.L.	28	M	130/80	bradycardia	mid-systolic	medium & low	short	base & apex	medium	normal	-	-
P.B.	23	M	140/84	chorea	mid-systolic	medium	short	base	low	normal	NAD	-
T.T.	47	M	150/90	extra-systoles	late systolic	all frequency	short	apex & base	high	normal	NAD	abnormal chordae tendinae
J.M.	20	M	120/72	loss of weight	mid-systolic	medium	short	base & apex	low	normal	NAD	murmur variable with respiration
J.C.	21	F	120/80	routine exam.	mid-systolic	low & medium	short	base	low	normal	NAD	
D.D.	24	M	136/80	systolic murmur	mid-systolic	low & medium	long	apex & base	low	normal limits	NAD	3rd apical sound visible
J.F.	34	M	124/82	systolic murmur	mid-systolic	low & medium	short	base & apex	very low	normal	NAD	-
P.D.	50	M	140/80	chronic bronchitis	mid-systolic	low & medium	short	base	low	normal	RAD	-
Mrs. B.P.	28	F	120/80	amenorrhoea	mid-systolic	medium	short	apex & base	low	normal	NAD	-
P. McN.	20	M	146/70	vaso-vagal attacks	mid-systolic	medium	short	apex	very low	normal	NAD	-
J.F.	27	F	140/80	routine exam.	mid-systolic	low & medium	short	base	low	normal	NAD	tachycardia - rate 100/min.

cont'd./

Name	Age	Sex	B.P.	Presenting Feature	MURMUR Time of Onset	Frequency	Duration	Area	Amplitude	Cardiac Size	E.C.G.	Remarks
Mrs. J.B.	36	F	136/84	dyspepsia	late systolic	low	short	apex	very low	normal	NAD	variation with respiration
A. McC.	24	F	120/70	routine exam.	mid-systolic	low & medium	short	apex & base	low	normal	NAD	-
A.S.	43	M	120/80	small consolidation left lung base	mid-systolic	low & medium	throughout systole	base	low	normal	NAD	-
Miss P.R.	17	F	132/80	systolic murmur	mid-systolic	low & medium	long	apex	medium	normal	NAD	-
H.B.	14	F	128/70	systolic murmur	mid-systolic	at apex low and medium, at base medium & high	short	apex, base	medium	normal	NAD	physiological 3rd sound clearly seen
N.C.	22	F	140/80	routine exam.	mid-systolic	low frequency	short	apex	very low	normal	NAD	-
F.O.	13	M	128/80	systolic murmur	mid-systolic	low & medium	short	apex	low	normal	sinus arrhythmia	physiological 3rd sound seen
M.C.	23	F	130/70	systolic murmur routine exam.	mid-systolic	medium	short	base	low	normal	NAD	-
J.H.	55	M	140/86	systolic murmur c/o debility	mid-systolic	medium & high	short	apex	low	normal	NAD	prominent auricular sound
Miss J.S.	13	F	140/70	joint pains	mid-systolic	low, medium & high	short	base	low	normal	NAD	-
D.D.	35	M	128/80	diabetic	late-systolic	medium & high	short	apex	medium	normal	RAD extra-systoles	murmur elicited by high frequency

Cont'd./

Name	Age	Sex	B.P.	Presenting Feature	MURMUR Time of Onset	Frequency	Duration	Area	Amplitude	Cardiac Size	E.C.G.	Remarks
G.G.	22	M	98/65	pyrexia of unknown origin	mid-systolic	all frequency	short	apex	low	normal	LAD	Temperature 100°, pulse 90/min.
M.F.	34	F	120/80	fatigue	late systolic	medium	short	apex	low	normal	LAD	(1) Hb. 64% Rbc. 3.620.000 Wbc. 6200 (2) HB. 100%)2nd Rbc. 4.800.000)trac- Wbc. 8.400)ing no change.
A.A.	24	M	150/85	undue fatigue	mid-systolic	medium	short	base	low	normal	NAD	
Mrs. A.B.	32	F	130/80	undue fatigue	mid-systolic	low & medium	short	apex	low	normal	-	
T.H.	15	M	108/70	listlessness	mid-systolic	all frequency	short	apex & base	medium	normal	NAD	marked physiological 3rd sound showing respiratory variation in amplitude and length.
R.T.	8	M	104/62	post scarlet fever	mid-systolic	medium & high	short	base & apex	low	normal	NAD	physiological 3rd sound prominent at apex
G.P.	24	M	116/80	routine exam.	mid-systolic	medium & high	short	apex & base	medium	normal	NAD	-
M.L.	17	F	104/76	routine exam.	mid-systolic	medium	short	apex & base	low	normal	NAD	1st, 2nd, 3rd & 4th sounds visible, 2nd sound split at base
M.D.	23	F	116/80	loss of weight	mid-systolic	medium	short	base	low	normal	NAD	split 2nd sound at base
A.M.	16	M	115/70	doubtful rheumatic fever	late systolic	low & medium	short	apex & base	low	normal	NAD	2nd basal sound split

Cont'd./

Name	Age	Sex	B.P.	Presenting Feature	MURMUR Time of Onset	Frequency	Duration	Area	Amplitude	Cardiac Size	E.C.G.	Remarks
R.H.	42	M	120/95	routine exam.	mid-systolic	medium	short	apex & base	low	normal	NAD	2nd basal split
D. McP.	33	M	144/92	routine exam.	mid-systolic	all frequency	relatively short	apex base	medium	normal	NAD	physiological 3rd sound seen
R. McE.	43	M	125/80	systolic murmur	mid-systolic	medium	short	apex	low	normal	NAD	-
J.W.	17	M	135/60	effort syndrome	mid-systolic	medium & high	short	base	low	normal	nAD	-
W.M.	16	M	130/70	chorea	mid-systolic	medium & high	short	apex base	low	normal	NAD	-
M.T.	28	F	120/70	post haematemesis	mid-systolic	low & medium	long	apex base	low	normal	NAD	-
R.B.	13	M	115/70	post scarlatina	mid-systolic	medium & high	short	apex base	low	normal	NAD	-
G.H.	19	M	128/80	depressed sternum effort syndrome	mid-systolic	low frequency	short	base	low	normal transverse lying heart	LAD	-
M.D.	23	F	120/85	loss of weight	mid-systolic	medium frequency	short	base	low	normal	NAD	marked auricular sound, split 2nd at base
W.T.	13	M	120/80	systolic murmur	mid-systolic	medium & high	moderate	apex	low	normal	NAD	-
A.M.	34	M	128/76	dyspepsia systolic murmur	mid-systolic	medium & high	moderate	apex base	low	normal	RAD	-

Cont'd./

Name	Age	Sex	B.P.	Presenting Feature	MURMUR Time of Onset	Frequency	Duration	Area	Amplitude	Cardiac Size	E.C.G.	Remarks
M.D.	27	M	120/70	rheumatoid arthritis	mid-systolic	medium & high	short	base	moderate	normal	NAD	Hb. 85% Rbc. 4.3 mill. Wbc. 6.500
M.W.	32	F	120/80	gravitational oedema	mid-systolic	medium	short	apex	low	normal	NAD	3rd sound just visible
G. McD.	12	F	115/65	post chorea	mid-systolic	medium	short	apex	low	normal	NAD	3rd sound visible, auricular sound marked 2nd sound split at base
I. McC.	15	M	120/80	post rheumatic fever	mid-systolic	medium	short	base	low	normal	NAD	physiological 3rd sound visible at apex
A.M.	16	M	115/70	doubtful post rheumatic fever	late systolic	low & medium	short	apex & base	low	normal	NAD	2nd basal sound split
M.L.	17	F	104/70	routine exam.	mid-systolic	medium	short	apex & base	low	normal	NAD	physiological 3rd sound seen at apex, auricular sound seen, basal 2nd sound split

EQUIVOCAL PHONOCARDIOGRAMS

Page 1.

Name	Age	Sex	Pulse	B.P.	Cardiac Size	E.C.G.	Tentative Diagnosis	Place of Minimum Intensity	Time	Amplitude	Length	Frequency	Abnormality of Sounds	Remarks
I.L.	7	M	sinus 100/min.	105/75	slightly enlarged to left	consistent c pericarditis	pericardial effusion ?rheumatic 2 records	apex	early systolic	high	long	all frequency esp. medium & high	3rd sound prominent but not prolonged, 2nd basal split, 2nd apical split	murmur of considerable mitral incompetence stenosis probably develop later. no evidence of I.V. septal defect
								base	" " probably conducted from apical area	"	"	" "		
E.A.	16	F	sinus 70/min.	155/75	normal	partial H.B.	?rheumatic carditis & pleurisy	apex	early systolic	low	long	medium	grossly accentuated, 3rd sound sometimes seen as a short mid-diastolic murmur of low amplitude & frequency	-
A.K.	8	F	sinus 88/min.	110/75	normal	R.A.D.	known cardiac murmur since birth	base & apex	mid-systolic	low	long	all frequency	3rd sound prominent with 3 vibrations, 2nd basal accentuated	-
H.M.	20	F	sinus 72/min.	120/80	normal	N.A.D.	pain in lumbar region of rheumatic nature	base & apex	early systolic	low	long	low & medium	3rd sound marked, 4 vibrations	-
J. McC.	14	F	sinus 80/min.	108/76	(1) slight prominence of LA doubtful (2) normal	vertical heart	post-scarlet fever	base	mid-systolic	medium	short	medium & high	3rd sound prominent of 2-4 vibrations, 2nd basal split & accentuated	-
								apex	mid-systolic	low	short	medium & high		
H. F.B.	15	M	sinus 80/min.	110/76	normal	L.A.D.	sexual infantilism & secondary anaemia	apex	mid-systolic	medium	short	low & medium	3rd sound of 4 vibrations	Blood count- Hb. 64% Rbc. 4.760.000 Wbc. 6.400
								base	mid-systolic	low	short	low & medium		

Cont'd./

Name	Age	Sex	Pulse	B.P.	Cardiac Size	E.C.G.	Tentative Diagnosis	Place of Minimum Intensity	Time	Amplitude	Length	Frequency	Abnormality of Sounds	Remarks
J.O.	11	M	sinus 48/min.	90/40	slight enlargement of left ventricle	sinus arrhythmia	history of fleeting joint pains preceded by sore throat	apex	mid-systolic	very low	long	medium & high	3rd sound accentuated 2-4 vibrations, marked split 1st sound c̄ separate auricular complex	Three records at monthly invals show no change
								base	early systolic	medium	long	low & medium	similar appearances	
									early diastolic?	low	very short	high	2nd sound accentuated	
Miss S.R.	20	F	sinus 90/min.	125/70	normal	N.A.D.	haematemesis	apex	mid-systolic	low	long	low & medium	prominent 3rd sound of 2-3 vibrations	Blood count- Hb. 80% Rbc. 4.400.000 Wbc. 5.000
								base	mid-systolic	medium	long	low & medium	split 2nd sound	
J. O'H.	8	M	sinus 80/min.	108/60	normal	N.A.D.	post-chorea	apex	mid-systolic	low	short	medium	prominent 3rd sound of 1-4 vibrations	-
								base	mid-systolic	low	long	all frequency	3rd sound of 1-3 vibrations	
J.H.	13	F	sinus 80/min.	110/70	normal	N.A.D	post-rheumatic fever	apex	mid-systolic	low	long	medium	3rd sound of 3 vibrations	-
								base	mid-systolic	medium	long	medium	auricular sound prominent	
A.B.	12	M	sinus 90/min.	115/75	normal	N.A.D.	post-rheumatic fever	apex	mid-systolic	low	long	medium	3rd sound of 1-2 vibrations	-
								base	mid-systolic	low	long	all frequency	3rd sound of 1-2 vibrations	
C.F.	27	F	sinus 90/min.	130/70	slight increase of left auricle	N.A.D.	post-tonsillitis	apex	mid-systolic	low	short	low & medium	3rd sound visible	
								base	early systolic	low	long	medium & high	2nd basal accentuated and split	-
S.G.	9	F	sinus 100/min.	130/80	normal	slight R.A.D.	post-rheumatic fever	base apex	mid-systolic	low	short	medium	3rd apical sound just visible	-

Cont'd./

Name	Age	Sex	Pulse	B.P.	Cardiac Size	E.C.G.	Tentative Diagnosis	Place of Minimum Intensity	Time	Amplitude	Length	Frequency	Abnormality of Sounds	Remarks
F.R.	26	M	sinus 90/min.	128/78	moderate, generalised	L.A.D. simple tachycardia	rheumatoid arthritis	apex	early systolic	medium	very short	medium & high	none	? early aortic stenosis and incompetence
								base	early systolic	low	long	medium & high		
									early diastolic	low	short	high		
J.R.	15	M	sinus 100/min.	110/76	normal	N.A.D.	? rheumatic carditis	apex	early systolic	low	short	medium	3rd sound very marked 1-5 vibrations	? early organic mitral lesion
								base	mid-systolic	low	short	medium	" " "	
J.H.	32	M	sinus 80/min.	130/76	normal	N.A.D.	murmur discovered on routine exam.	apex) base)	mid-systolic	low	short	medium & low	none	?patent foramen ovale, record taken at base of neck with the query of venous hum.
								base	early diastolic	low	short	high	none	
								base of neck, right side	mid-systolic	low	short	all frequency	none	
C.W.	7	F	sinus 108/min.	120/80	? slight increase to left	sinus tachycardia L.A.D.	chorea	apex	mid-systolic	low	short	medium	marked 3rd sound at apex, 3 vibrations	-
								base	" "	"	"	"	split 2nd sound at base	
M.T.	28	F	sinus 72/min.	120/70	normal	N.A.D.	rheumatic carditis	apex & base	early systolic	low	long	low & medium	none	
I. McC.	15	M	sinus 80/min.	120/80	normal	N.A.D.	post-rheumatic fever	apex	early systolic	low	short	low & medium	3rd marked, 1-3 vibrations	-
								base	-	-	-	-	split 2nd sound	
R.B.	7	M	sinus 76/min.	135/80	normal	N.A.D.	repeated tonsillitis, undue fatigue	apex	mid-systolic	low	long	all frequency	3rd prominent, 1-4 vibrations	-
								base	mid-systolic	"	short	medium & high		

MURMURS IN ANAEMIA

Name	Age	Sex	Rate & Rhythm	B.P.	Blood Count	Cardiac Size	E.C.G.	Murmurs: Place of maximum intensity	Murmurs: Time	Murmurs: Amplitude	Murmurs: Length	Murmurs: Frequency	Remarks
Mrs. E.T.	46	F	sinus 110/min.	120/85	Hb. 28% Rbc. 1.31 mill. Wbc. 13500	normal transversely placed heart	NAD	(1) apex	systolic, early, pre-systolic	moderate	long	low and medium	myeloid leukaemia ? severe anaemia
								(2) apex	continuous with systolic	low	short during auricular systole	low and medium	no abnormality of mitral valve seen at post mortem myocardium fatty and soft
Mrs. A.McK.	26	F	sinus 86/min.	125/75	Hb. 50% Rbc. 3.7 mill. Wbc. 4.600	normal	NAD	(1) apex) (2) base)	mid-systolic	high	short	all frequency	
J.O'M.	16	F	sinus 78/min.	120/70	Hb. 55% Rbc. 4.6 mill. Wbc. 8200	normal	NAD	base	mid-systolic	low	short	medium	
J.O'm.	16	M	sinus 92/min.	135/70	Hb. 70% Rbc. 3.94 mill. Wbc. 38000	normal	NAD	(1) base (2) apex	mid-systolic	low	short	low and medium, a few vibrations in high frequency	myeloid leukaemia
Mrs.A. Mc. I.	23	F	sinus 80/min.	120/88	Hb. 58% Rbc. 2.91 mill. Wbc. 4200	normal	NAD	apex	mid-systolic	low	short	medium and low	
Mrs. H.W.	38	F	sinus 60/min.	122/74	Hb. 68% Rbc. 3.200mill. Wbc. 6000	normal	NAD	(1) apex (2) ba se	mid-systolic	low	short	medium and low	
R.D.	29	M	sinus 90/min.	100/65	Hb. 55% Rbc. 3.1 mill. Wbc. 7800	slight prominence of left ventricle	NAD	base	mid-systolic	low	short	low and medium	
A.C.	30	F	sinus 90/min.	120/75	Hb. 68% Rbc. 3.5 mill. Wbc. 5000	normal	NAD	(1) apex (2) base	mid-systolic	moderate	short	all frequency	

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(Continued)

								Murmurs					
Name	Age	Sex	Rate & Rhythm	B.P.	Blood Count	Cardiac Size	E.C.G.	Place of maximum intensity	Time	Ampli-tude	Length	Frequency	Remarks
M.F.	18	F	sinus/ 80/min.	110/85	Hb. 65% Rbc. 3.61 mill. Wbc. 4000	normal	NAD	(1) base (2) apex	mid-systolic	low	short	medium and low	
Mrs. A.C.	26	F	sinus 104/min.	120/74	Hb. 32% Rbc. 1.42 mill. Wbc. 2800	normal	NAD	(1) apex	early systolic	low	short	high and medium	1st recording 17/11/48
								(2) apex	mid-systolic	very low	contd. up to 1st sound	all fre-quency, presystolic accentuation seen in HF band	
								(3) base	early systolic	low	short yet longer than 1	medium and high	
								(4) base	early systolic	low	short	high	
					Hb. 102% Rbc. 4.41 mill. Wbc. 8000	"	"	base	mid-systolic	low	short	mid frequency	2nd recording 30/1/49
W. S.	40	M	sinus 96/min.	160/105	Hb. 50% Rbc. 1.99 mill. Wbc. 10.000	slight prominence of left ventricle	suggests poor myo-cardius	(1) apex (2) base	mid-systolic	mode-rate	short	medium and low	complicating sub-acute nephritis
J.D.	16	M	sinus 92/min.	120/70	Hb. 60% Rbc. 2.74 mill. Wbc. 360.000	normal	NAD	(1) apex (2) base	mid-systolic	low	short	medium	myeloid leukaemia

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(Continued)

Name	Age	Sex	Rate & Rhythm	B.P.	Blood Count	Cardiac Size	E.C.G.	Murmurs: Place of maximum intensity	Murmurs: Time	Murmurs: Amplitude	Murmurs: Length	Murmurs: Frequency	Remarks
Mrs. A. S.	79	F	Sinus 80/min.	160/86	Hb. 38% Rbc. 1.780.000 Wbc. 6800	moderate enlargement left ventricle+ right auricle+ & left auricle+	-	apex	early systolic	high	long	all frequency	also seen at base, later in onset and less marked
C.D.	71	M	Sinus 82/min.	110/70	Hb. 65% Rbc. 3.800.000 Wbc. 10,200	Normal	NAD	apex, also seen at	mid-systolic	low	short	low and medium	post haematemesis
Mrs. M.R.	38	F	sinus 82/min.	150/60	Hb. 38% Rbc. 3.800.000 Wbc. 7000	slight generalised enlargement	NAD	apex, also seen at base, less prominent	mid-systolic	low	short	medium	physiological 3rd sound visible
A.K.	14	M	sinus 90/min.	140/84	Hb. 65% Rbc. 3.450.000 Wbc. 9000	normal	NAD	apex, also seen at base	mid-systolic	low	short	medium	nephrotic syndrome with anaemia
Mrs. C.W.	57	F	sinus 90/min.	108/96	Hb. 62% Rbc. 2.800.000 Wbc. 7800	normal	NAD	apex, also seen at base	mid-systolic	low	short	medium and high	
A.McD.	26	M	sinus 80/min.	110/70	Hb. 45% Rbc. 3.200.000 Wbc. 6200	normal	NAD	apex	mid-systolic	low	short	medium frequency	
R.McL.	16	F	sinus 94/min.	125/60	Hb. 30% Rbc. 2.050.000 Wbc. 6200	slight general cardiac enlargement	NAD	(1) apex	mid-systolic	low	short	medium	physiological 3rd sound visible
								(2) base	mid-systolic	low	mode-rate	low and medium	murmur more prominent at the base
W.McR.	60	M	sinus 80/min.	150/70	Hb. 50% Rbc. 2.000.000 Wbc. 2800	normal	NAD	apex and base	mid-systolic	low	short	low and medium	

MURMURS IN HYPERTENSION

Page 1.

Name	Age	Sex	Rate & Rhythm	B.P.	Cardiac Size Enlargement	E.C.G.	Abnormalities of Sound	Basal Murmurs	Apical Murmurs	WR.	Remarks
Mrs. M.C.	49	F	sinus 86/min.	146/104	moderate, LV+, slight tortuous elongation of aorta	LAD	none	systolic: early systolic, all frequency, high amplitude, long	systolic: mid systolic, medium & high frequency, medium amplitude, short	-ve	
D.B.	60	M	sinus 80/min.	180/100	marked, LV+, congestive changes at lung bases	left ventricular hypertrophy	marked auricular sounds causing a "presystolic" gallop rhythm split ventricular complexes giving a triple 1st sound	systolic: mid-systolic, medium frequency, very low amplitude, short	systolic: mid-systolic, medium frequency, very low amplitude, short	-ve	chronic nephritis, Hb. - 70% Rbc.- 3.5 million Wbc.- 7600
C. McD.	62	M	sinus 84/min.	190/100	moderate, generalised, elongation and dilation of aorta	left ventricular strain	None	systolic: mid-systolic, all frequency, medium amplitude, short	systolic: mid-systolic, all frequency, medium amplitude, short	-ve	
Mrs. McD.	49	F	sinus 94/min.	218/118	slight LV enlargement	LAD		systolic: mid-systolic, medium and high frequency, rather long, low amplitude	systolic: mid-systolic, all frequency, low amplitude, long	-ve	
Mrs. J.M.	44	F	sinus 110/mn.	180/90	normal, marked elongation of aorta	sinus tachycardia	None	systolic: mid-systolic, medium & high frequency, low amplitude, short	systolic: a few, medium frequency, low amplitude vibrations	-ve	

Cont'd./

Name	Age	Sex	Rate & Rhythm	B.P.	Cardiac Size Enlargement	E.C.G.	Abnormalities of Sound	Basal Murmurs	Apical Murmurs	WR.	Remarks
J.M.	69	M	sinus 120/min.	180/100	slight enlargement, left ventricle mainly	LAD	none	systolic: mid-systolic, medium & high frequency, moderate length, low amplitude	systolic: mid-systolic, medium & high frequency, low amplitude, short		murmur more marked at the base
Mrs. C.A.	45	F	sinus 115/min.	210/130	normal	simple tachycordia	2nd basal sound accentuated	systolic: mid-systolic, medium frequency, low amplitude, moderate length	systolic: mid-systolic, medium frequency, low amplitude, moderate duration	-ve	
Mrs. E.S.	68	F	A.F. 86/min.	118/110	large aneurysm of descending arch of aorta left ventricle-	A.F. left ventricular hypertrophy	2nd basal sound accentuated	systolic: early systolic, all frequency, high amplitude, long diastolic: early diastolic, medium and high frequency, low amplitude, short	similar to base, diastolic shorter and seen only in H.F.	-ve	
J.C.	51	M	sinus 88/min.	168/98	slight enlargement of left ventricle	left ventricular hypertrophy	2nd basal sound slurred	none	systolic: mid-systolic, low & medium frequency, low amplitude with accentuation in late systole, moderate duration	-ve	
E.L.	54	M	sinue 80/min.	190/100	slight enlargement of left ventricle	left ventricular hypertrophy	none	systolic: mid-systolic, medium & high frequency, medium amplitude, long	Similar murmur, less well seen	-ve	

Cont'd./

Page 3.

Name	Age	Sex	Rate & Rhythm	B.P.	Cardiac Size Enlargement	E.C.G.	Abnormalities of Sound	Basal Murmurs	Apical Murmurs	WR.	Remarks
Mrs. A.P.	32	F	sinus 92/min.	210/100	normal	-	none	systolic: systolic murmur similar to apex but diminished	systolic: early systolic, all frequency, low amplitude, long diastolic: early diastolic, medium and high frequency, low amplitude, short	-ve	Hb. - 33% Wbc.- 6.200 Rbc.- 2.680.000 microcytic anaemia
W.D.	55	M	sinus 80/min.	280/160	slight left ventricular enlargement	left ventricular enlargement	isometric split 1st sound, split 2nd sound	mid-systolic, conducted from apex	mid-systolic, medium & high frequency, low amplitude, short		
J.G.	71	M	sinus 64/min.	210/130	moderate, left ventricule +	-	1st sound at apex prolonged	early systolic, long duration, medium frequency long, medium amplitude, doubtful early diastolic present, high frequency, short	mid-systolic, medium & high frequency, low amplitude and short		
D.G.	35	M	sinus 78/min.	195/135	normal	left vent. preponderence	isometric splitting of apical 1st sound	none	mid-systolic, medium frequency, low amplitude, short		
Mrs. B.C.	45	F	sinus 84/min.	180/100	normal	left vent. preponderence	-	elements of apical murmur seen	mid-systolic, low & medium frequency, low amplitude, short		
F.H.	54	M	AF 100/min.	190/100	moderate, left ventricule +	A.F. left vent. strain	split apical 2nd sound, markedly split basal 2nd sound	mid-systolic, short medium frequency, low amplitude	elements of basal murmur seen		
Mrs. E.McN.	41	F	sinus 80/min.	166/102	normal	N.A.D.	-	elements of apical murmur seen	mid-systolic, low and medium frequency, short low amplitude		

Cont'd./

Page 4.

Name	Age	Sex	Rate & Rhythm	B.P.	Cardiac Size Enlargement	E.C.G.	Abnormalities of Sound	Basal Murmurs	Apical Murmurs	VR.	Remarks
J.B.	40	M	sinus 120/min.	240/150	slight, left ventricule +	left vent. strain	well marked summation gallop rhythm	none	mid-systolic, medium frequency, very low amplitude, short		
Mrs. J.A.	45	F	sinus 80/min.	190/115	normal	left ventricular strain	-	mid-systolic, medium frequency, low amplitude, short	similar murmur, equally well seen		
Mrs. B.W.	52	F	sinus 90/min.	190/96	slight left ventricule +	LAD	-	mid-systolic, medium frequency, low amplitude, short	similar murmur		

MURMURS IN THYROTOXICOSIS

Name	Age	Sex	Pulse	B.P.	B.M.R.	Cardiac Size	E.C.G.	Severity	Murmurs: Place of maximum intensity	Murmurs: Time	Murmurs: Frequency	Murmurs: Amplitude	Murmurs: Length	Remarks
Mrs. E.S.	51	F	sinus 100/min.	150/100	+ 40	slight to left, dilation and elongation of aorta	LAD	moderate	(1) base	early systolic	medium and high	medium	long	probably aortic dilation
									(2) apex	early systolic	"	low	short	perhaps conducted from aorta or due to mitral incompetence
									thyroid	late systolic) early diastolic)	medium and high / medium only	medium / low	long) short)	continuous bruit, systolic most prominent
Mrs. A.B.	57	F	sinus 100/min.	140/80	+ 30	moderate, all chambers save rt. atrium	Flat T in I LV hypertrophy coronary insuff.	moderate	apex	early	medium and high	low	short	probably relative mitral incompetence
Mrs. M.F.	25	F	sinus 78/min.	106/60	+ 16	normal	sinus tachycardia	moderate	apex and base	mid-systolic	medium and high	medium	short	
A.W.	46	M	sinus 100/min.	140/50	+ 62	slight, mainly left ventricle	NAD	moderate	apex	mid-systolic	medium and high	low	short	rapid cardiac action
Mrs. M.M.	30	F	sinus 106/min.	138/68	+ 67	normal	LAD	moderate	base	mid-systolic	medium and high	low	short	rapid cardiac action
Mrs. R.R.	35	F	sinus 90/min.	120/80	+ 18	normal	vertical heart	slight	base	mid-systolic	medium	very low	short	thyroid adenoma, no definite evidence of thyrotoxicosis - treatment sedation

Cont'd./

Name	Age	Sex	Pulse	B.P.	B.M.R.	Cardiac Size	E.C.G.	Severity	Murmurs: Place of maximum intensity	Murmurs: Time	Murmurs: Frequency	Murmurs: Amplitude	Murmurs: Length	Remarks
A.W.	46	M	sinus 80/min.	140/80	+ 62	slight, left ventricle mainly involved		moderate	apex	mid-systolic	medium and high	medium	short	
Mrs. G.S.	29	F	sinus 108/min.	150/80-0	+ 47	normal	simple tachycardia	moderate	base	mid-systolic	medium and high	low	short	Hb. - 84% Rbc.- 4.02 Wbc.- 6,600
									thyroid) base of) neck)	systolic and early diastolic bruit continuous throughout systole & diastole	all frequencies, predominantly medium and high	high	long	unaffected by pressure on jugular or carotids
Mrs. E.A.	30	F	sinus 100/min.	150/80	+ 40	mitral configuration	P waves consistent with mitral disease	moderate	(1) systolic and diastolic murmurs of mitral (2) stenosis and incompetence					mitral stenosis complicating thyrotoxicosis
									thyroid base of neck	systolic and early diastolic bruit continuous.	all frequencies predominantly medium and high	medium	long	
Mrs. M.W.	57	F	A.F. 48/min.	140/90	+ 62	slight enlargement, pulmonary conus +	AF poor myocardium	severe, becoming quiescent	base	early systolic	all frequency	medium	long	pulmonary artery dilatation

Cont'd./

Name	Age	Sex	Pulse	B.P.	B.M.R.	Cardiac Size	E.C.G.	Severity	Murmurs: Place of maximum intensity	Murmurs: Time	Murmurs: Frequency	Murmurs: Amplitude	Murmurs: Length	Remarks
Mrs. H.W.	42	F	sinus 90/min.	150/78	+ 44%	normal	NAD	moderate	apex and base	early systolic	medium and high	low	long	marked 3rd sound with respiratory variation - an equivocal phonocardiogram
Mrs. M.McG.	44	F	sinus 90/min.	145/70	+ 60%	normal	-	moderate	apex and base, more marked at base	mid-systolic	all frequency	low	short	auricular sound clearly seen
H.P.	39	F	sinus 100/min.	130/85	+ 6%	slight prominence of pulmonary conus	NAD	slight	apex	mid-systolic	medium	low	moderate	
M.N.	59	F	sinus 76/min.	160/70	+ 39%	considerable, right ventricle +, pulmonary conus +	RAD	moderate	apex also at base	mid-systolic	medium and high	low	short	Rbc. 3.490080 Hb. 75% Wbc. 6.200
Mrs. M.C.	44	F	sinus 64/min.	150/82	+ 42%	moderate, generalised left auricle +, right ventricle +	suggests poor myocardium	moderate	apex	early systolic	all frequency	high	long	1st sound prominent, physiological 3rd sound visible at base, .blood normal, suggests mitral incompetence.
H.L.	63	M	sinus 84/min.	140/80	+ 61%	slight, left ventricle +, plus calcification of the aortic arch	NAD	moderate	apex and base	early systolic	all frequency	low	long	physiological 3rd sound visible at apex

SIMPLE CALIBRATED PHONOCARDIOGRAPHY.

By

JOHN H. RAMAGE, M.B., Ch.B., F.R.F.P.S.(G).

VOL 11.

ILLUSTRATIONS.

The Apparatus

A. The Cardiotron, direct writing E.C.G. machine of American manufacture.

B. Standard Static Cambridge Electrocardiograph.

C. Microphone.

D. Amplifying Stethoscope.

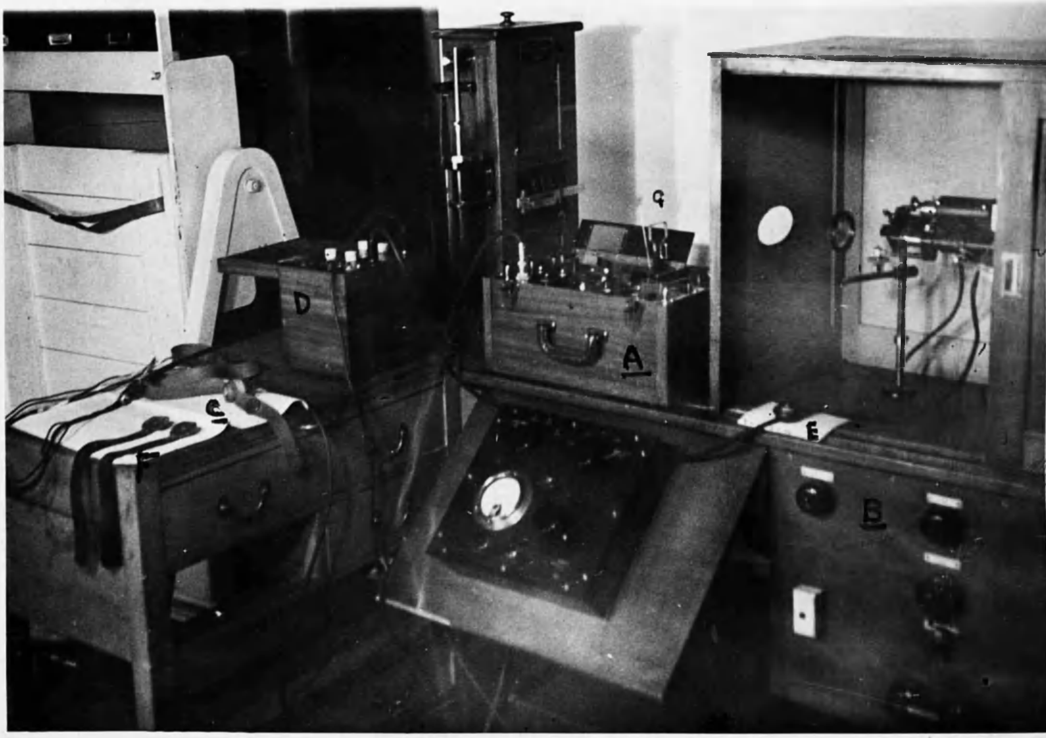
E. Rheostat.

F. Electrodes for E.C.G.

G. Stylus of Cardiotron.

The lead from the microphone passes via the amplifying stethoscope to the standard Cambridge electrocardiograph, interrupted by a rheostat for the fine adjustment of the amplitude of the vibrations. The controls on the amplifying stethoscope which are used are two in number, a wave band change switch and a rheostat for coarse amplitude adjustment. The two other switches varying tone are not used.

The stylus of the Cardiotron machine in the upright position interrupts the light beam from the Cambridge machine and simultaneously records the electrocardiogram.



G
D
A
C
F
E
B

NORMAL RECORDS

A.B., aet 10 years

The two normal heart sounds are recorded, with the 2nd basal sound split.

L.F. - Low Frequency Tracing.

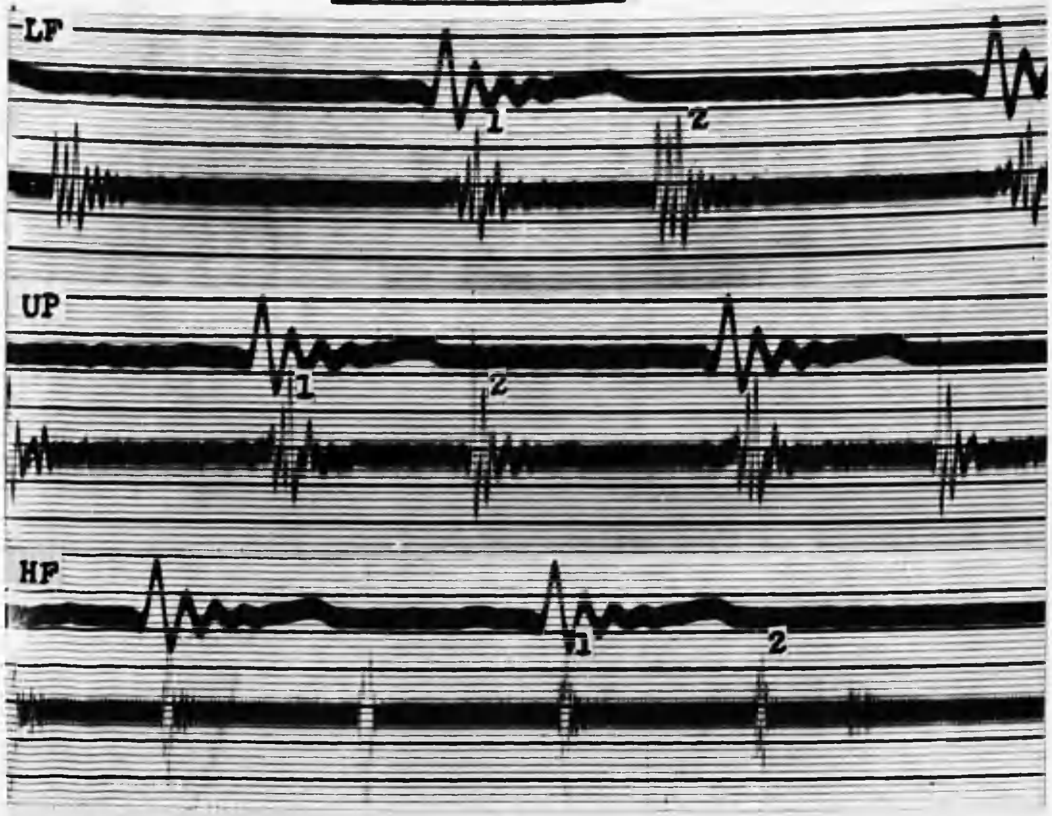
U.P. - Unfiltered Phonocardiogram.

H.F. - High Frequency Tracing.

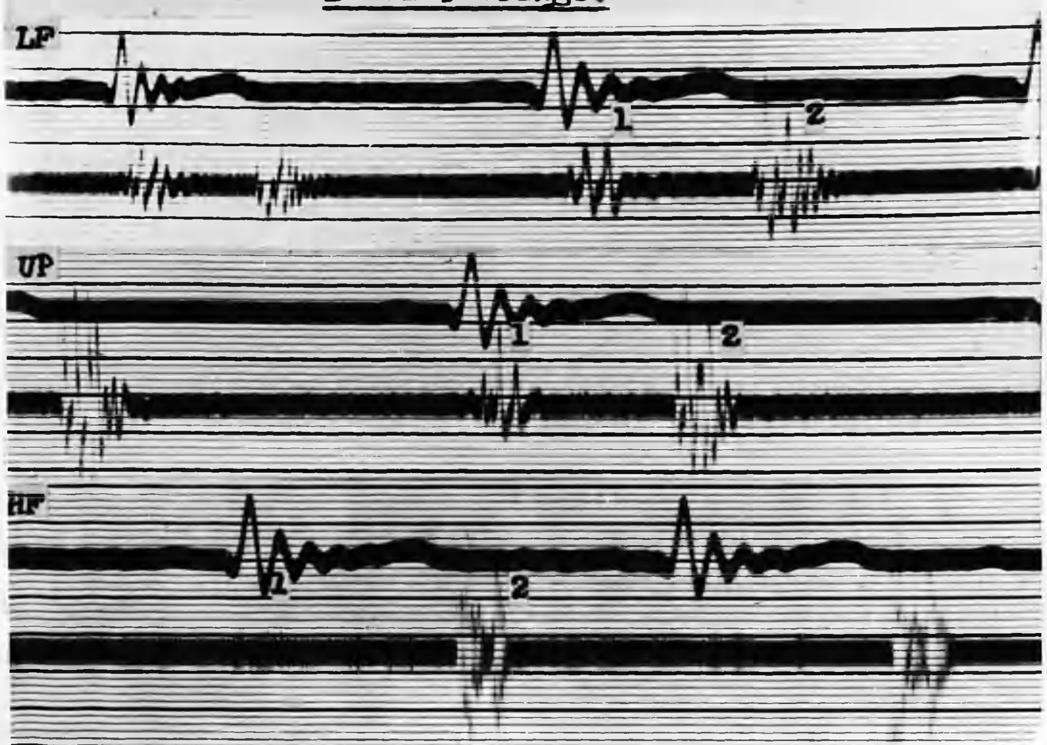
The vibrations of the E.C.G. at the T wave are unavoidable, and due to the high speed of the recording with an instrument not entirely aperiodic.

Normal Records (1).

Apical Tracings.



Basal Tracings.

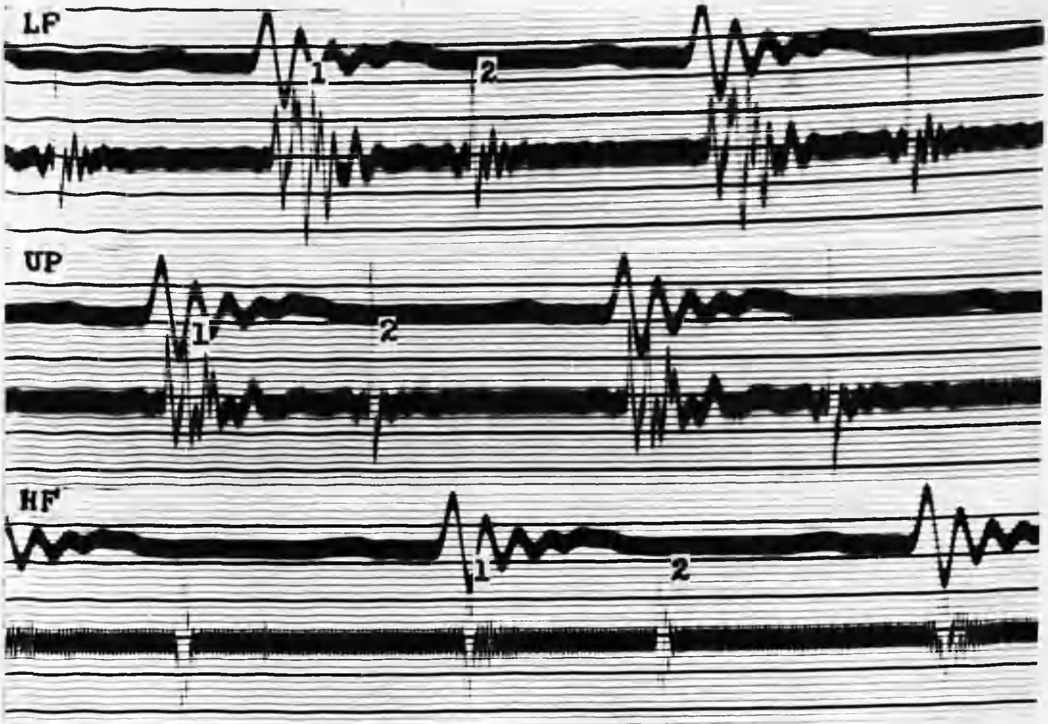


W.F., aet 29 years

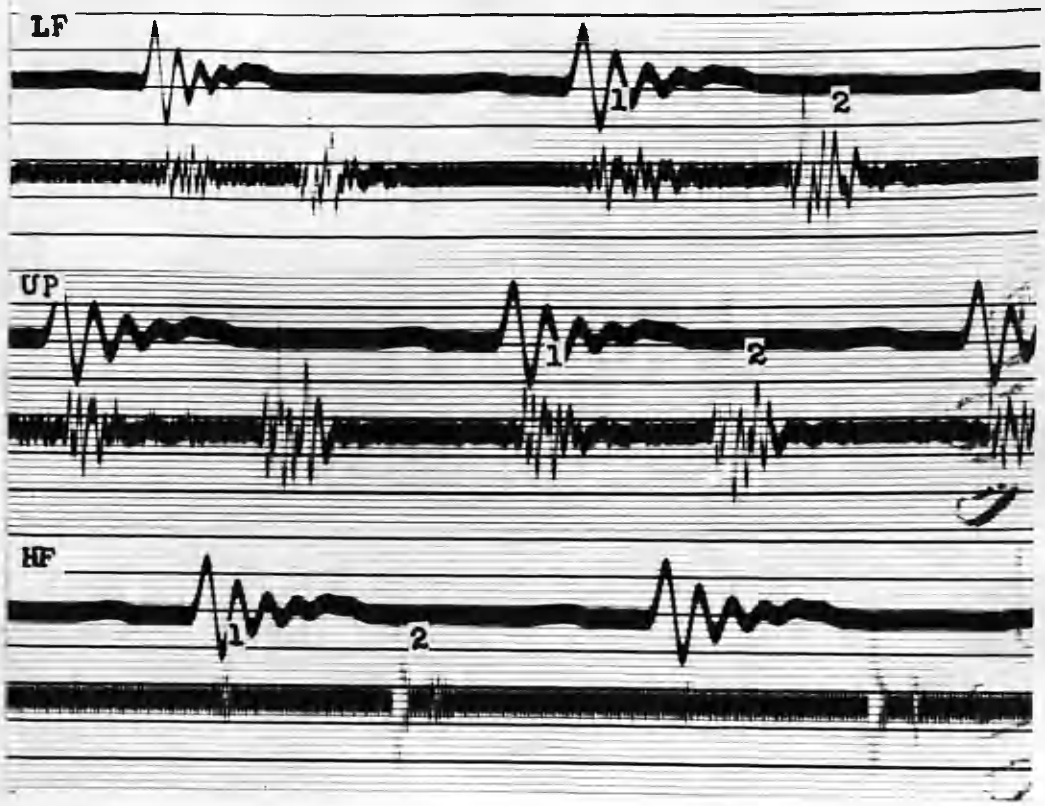
The form of the heart sounds are well shown in the apical tracing. A physiological 3rd sound is doubtfully present. The 2nd basal sound is split.

Normal Records (2).

Apical Tracings.



Basal Tracings.

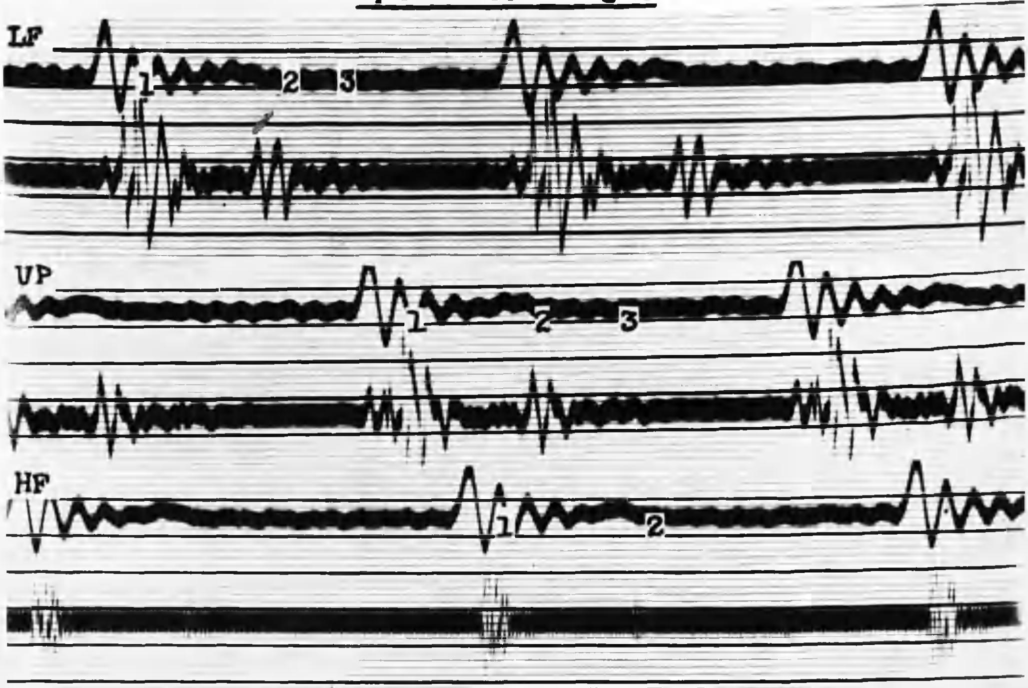


W.McG. aet 24 yrs.

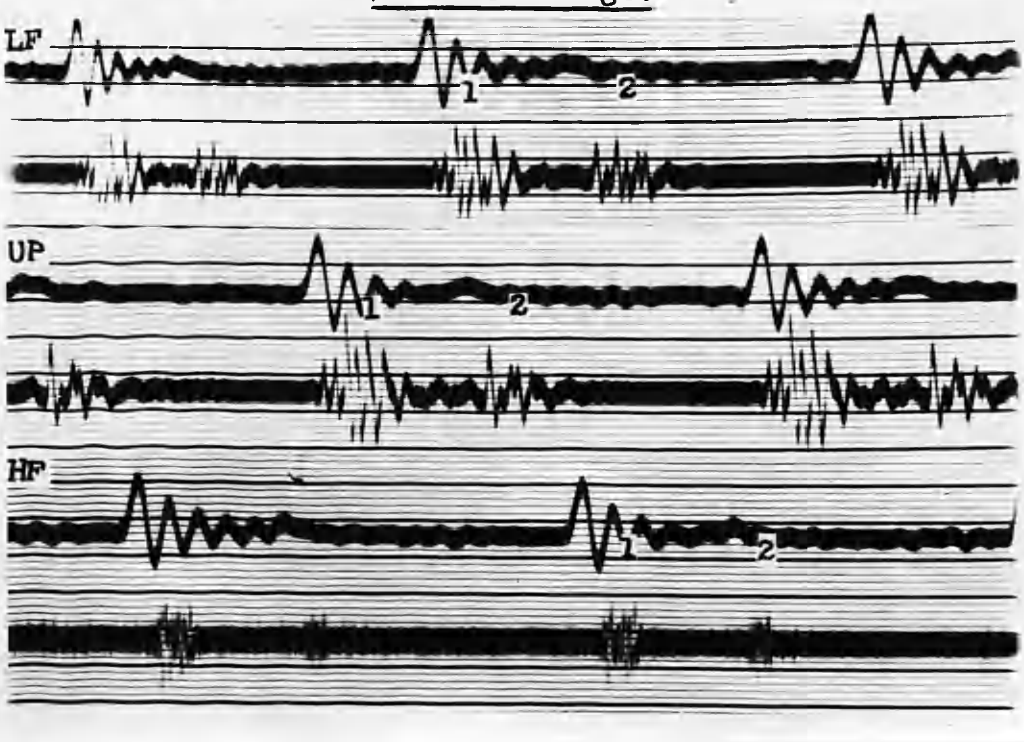
This case was one of spontaneous pneumothorax. The cardiovascular system was normal.

Normal Records.(3).

Apical Tracings.



Basal Tracings.

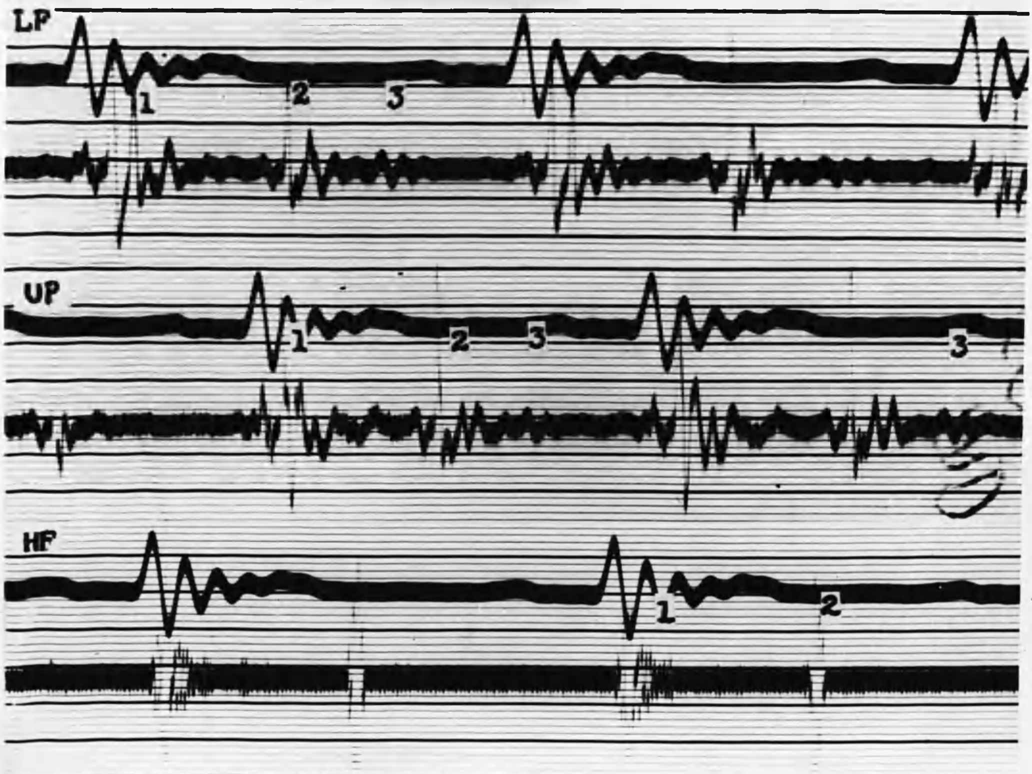


W.F., aet 29 yrs.

Apical tracings from the case already demonstrated in Fig. 2 showing the physiological 3rd sound elicited by further amplification.

Normal Records.(4).

Apical Tracings.



ILLUSTRATIONS.

MITRAL VALVE DISEASE.

FIG. 1.

J.T., aet 9 yrs.

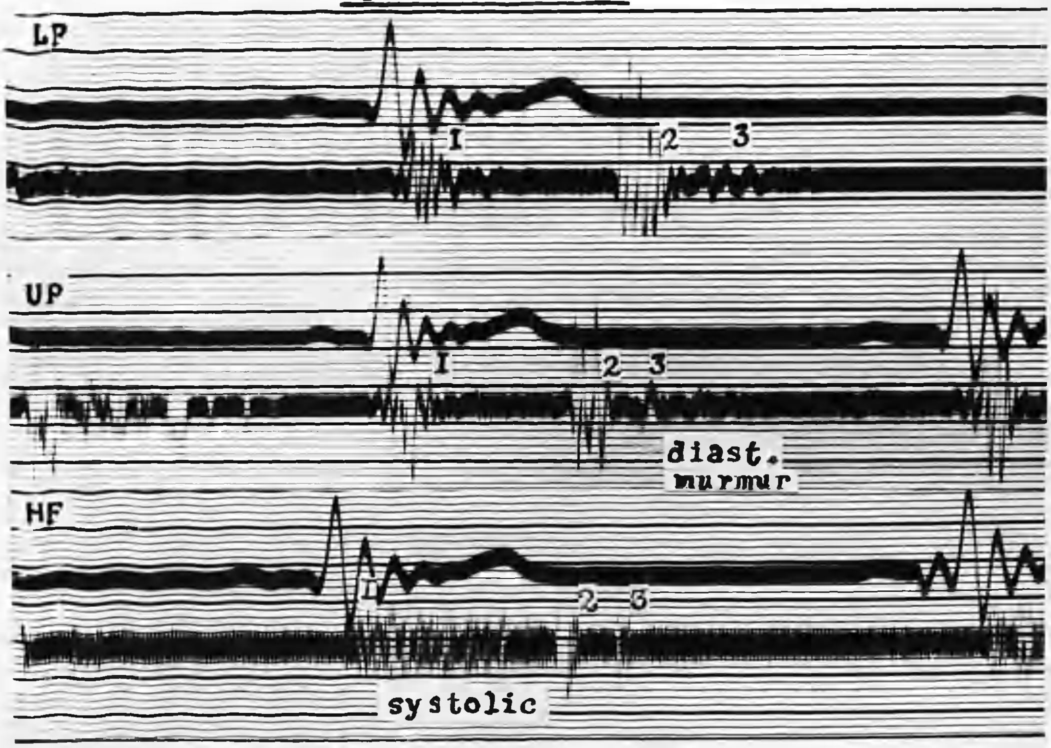
This type of case is discussed fully in the text, in a chapter on the "equivocal phonocardiogram". It demonstrates a long, low amplitude, fairly wide frequency, early systolic murmur at the apical region, associated with a 3rd sound which is prolonged; 3-5 vibrations. The 3rd sound is also visible at the base and the 2nd basal sound is split.

Fig. 1.

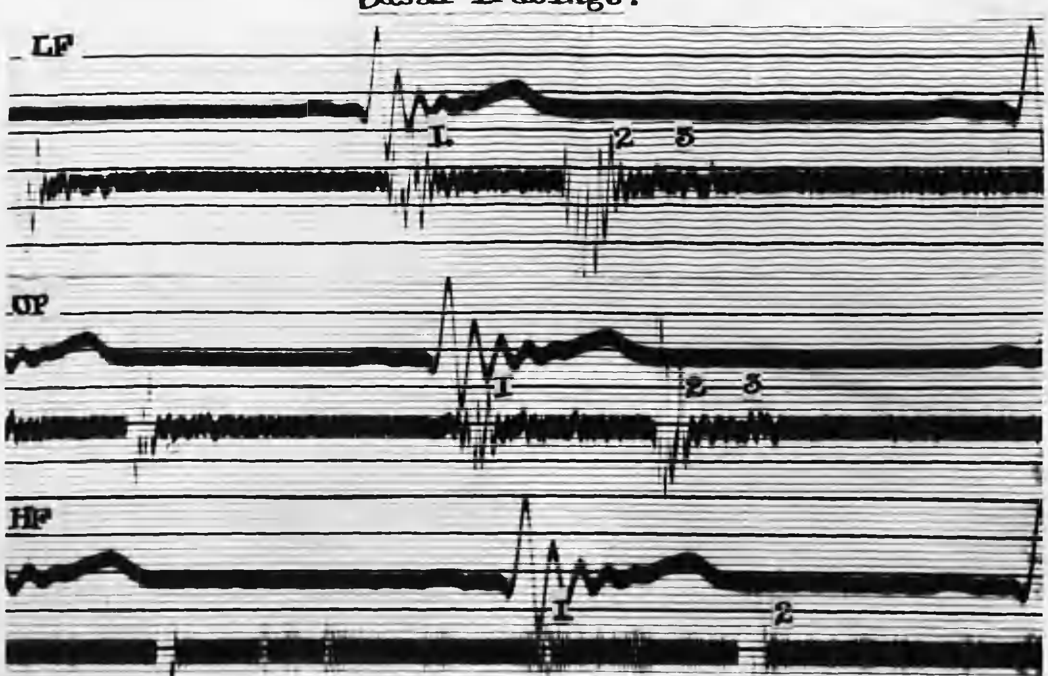
Mitral Stenosis

The Equivocal Early Case.

Apical Tracings.



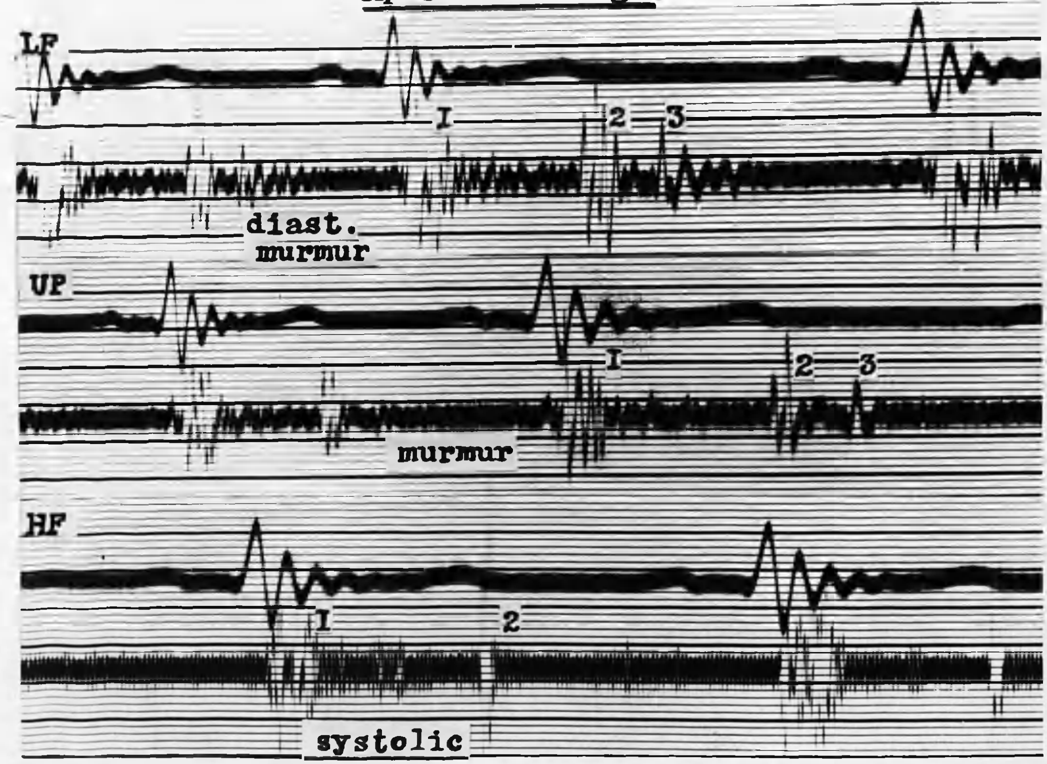
Basal Tracings.



Mitral Stenosis.

The Early Case.

Apical Tracings.



M. McL. aet. 18 years.

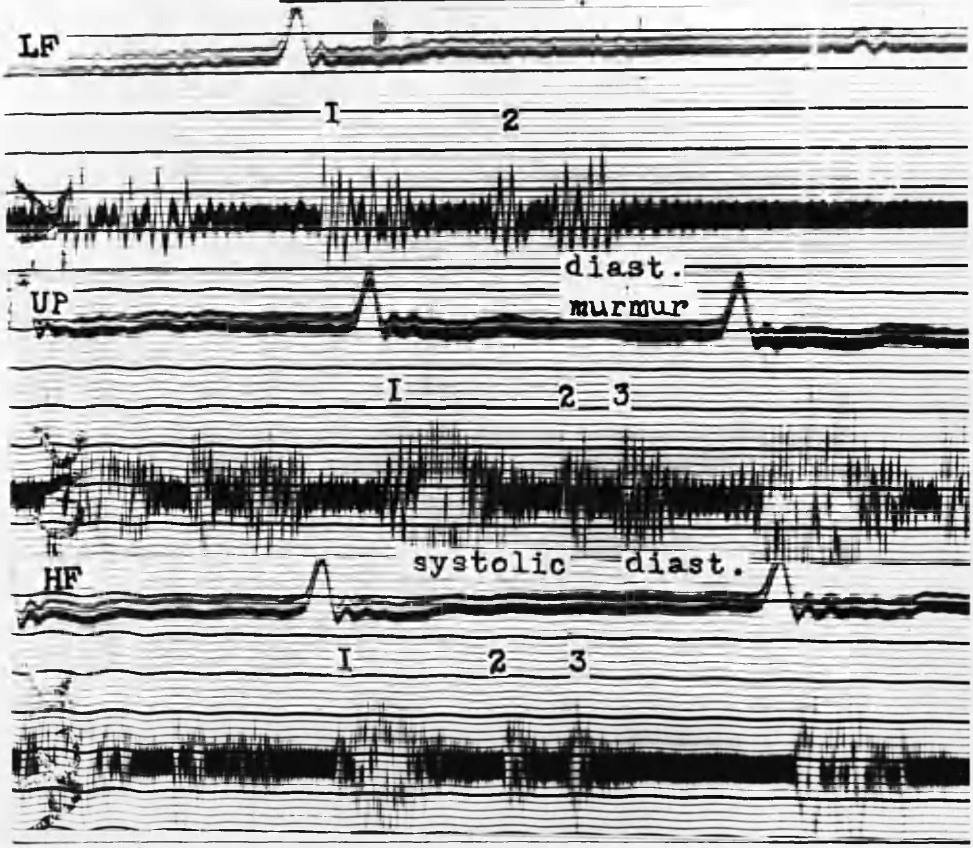
This is visualised as a further stage in the production of stenosis with the third sound increasing in length to form a short mid-diastolic murmur. The third sound is also increased in amplitude.

Fig.3.

Mitral Stenosis.

The Early Case.

Apical Tracings.



F.B. aet. 19 years.

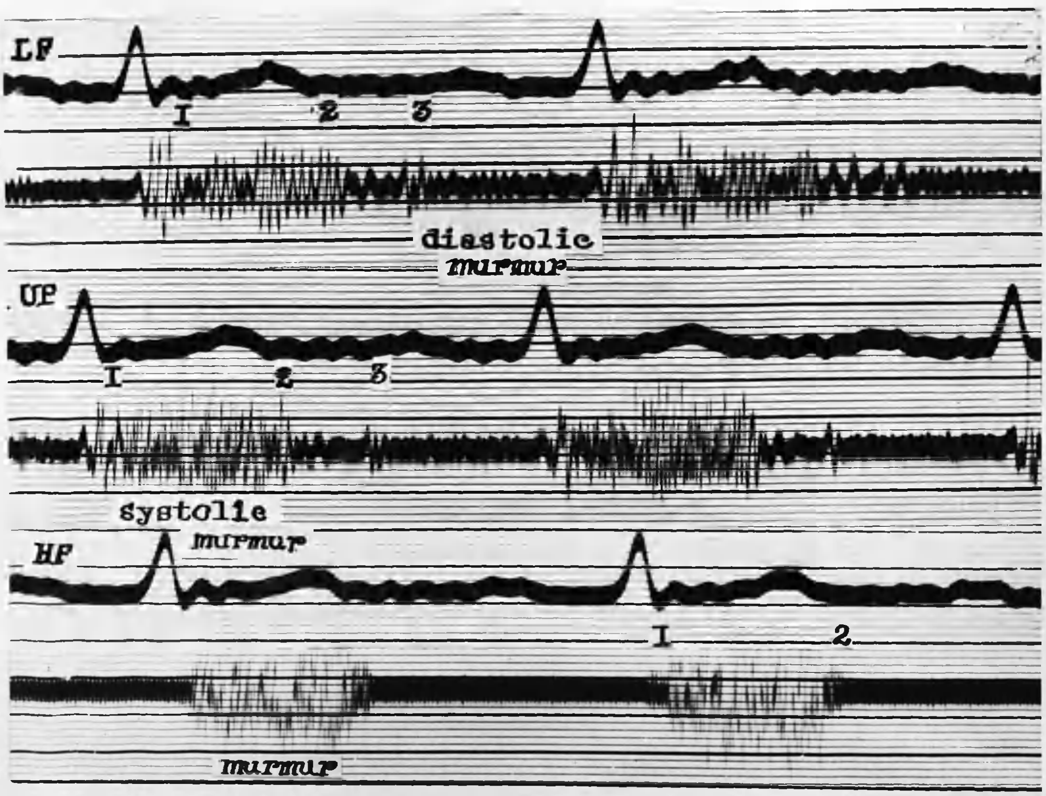
A further example of the short mid-diastolic murmur in a case with established mitral stenosis. The record was taken during an exacerbation of acute carditis which caused auricular fibrillation, The systolic murmur is well demonstrated, and the slurring of the second sound is due to conducted vibrations of an early diastolic murmur of aortic incompetence.

Fig. 4.

Mitral Stenosis.

The Systolic Murmur of Incompetence.

Apical Tracings.



H.M. aet. 56 years.

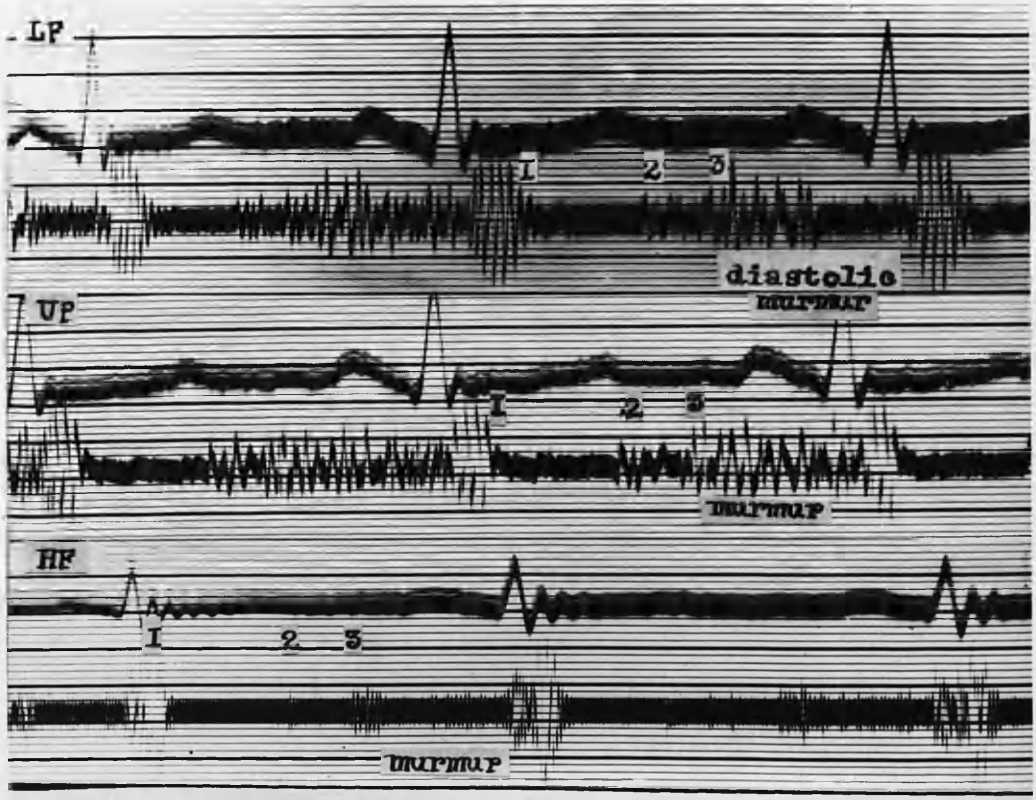
This case illustrates two points. There is a marked systolic murmur of mitral incompetence, which is clearly shown to begin with the 2nd component of the 1st. heart sound. The mid-diastolic murmur of relatively short duration is clearly visible only in the low frequency record. The 3rd. sound is prominent.

Fig. 8.

Mitral Stenosis.

The Long Diastolic Murmur.

Apical Tracings.



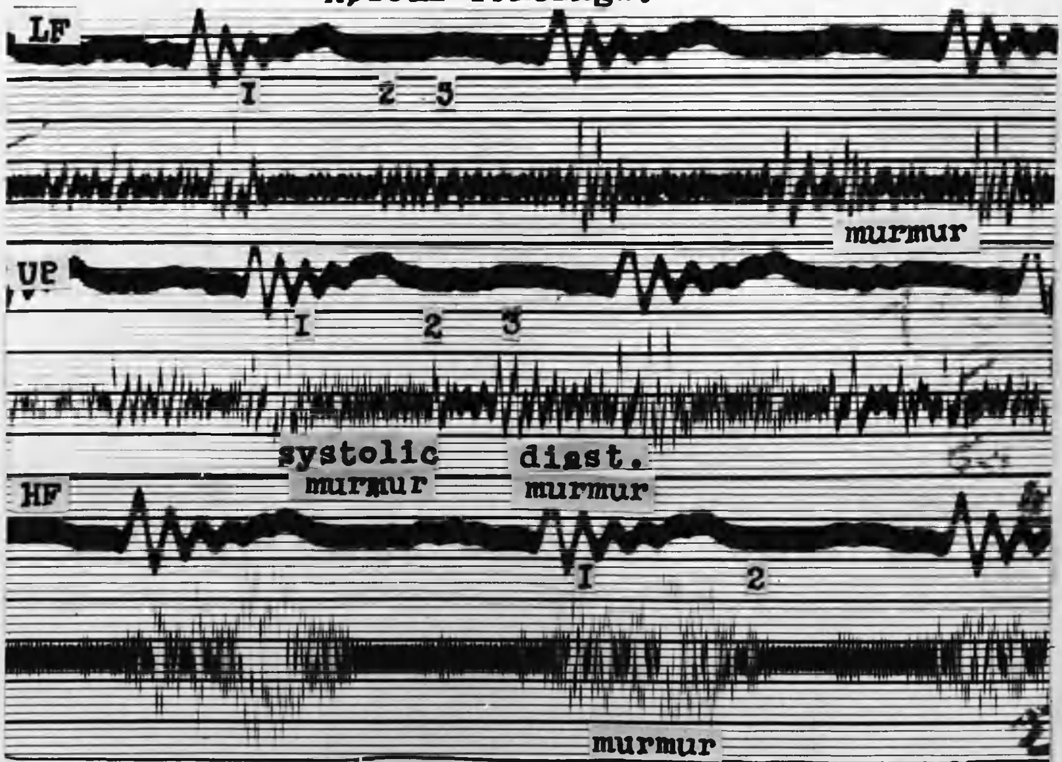
J.C. aet. 44 years.

Shows a long mid-diastolic murmur following the 3rd sound, of predominantly low frequency. No presystolic accentuation could be detected but for the high frequency tracing where it is clearly visible. There is no systolic murmur.

Mitral Stenosis

Incompetence and Stenosis. A fully developed case.

Apical Tracings.



H.B. aet. 54 years.

This record demonstrates several features. (a) The systolic murmur is typical of mitral incompetence, though not well seen in the low frequency record. (b). The diastolic is throughout diastole with the vibrations between 2nd and 3rd sounds of particularly low frequency. (c). The 3rd sound is accentuated. (d) The high frequency nature of "presystolic" accentuation is shown.

FIG. 7.

B.I., aet 20 yrs.

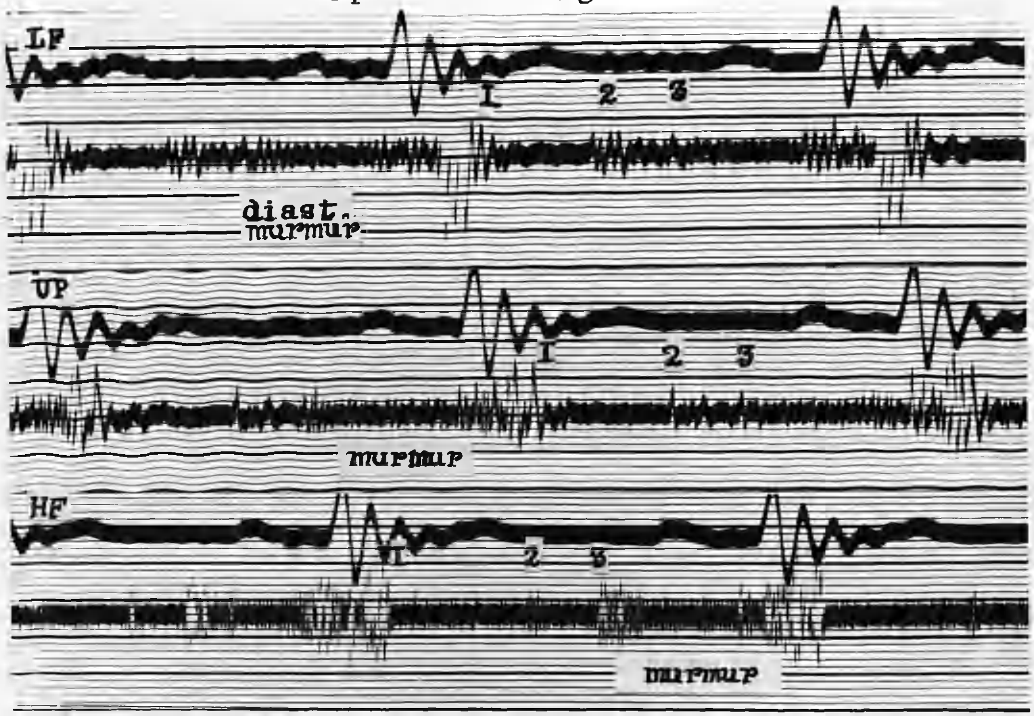
This case again illustrates a number of points discussed in the text. There is no systolic murmur. The diastolic murmur, of low frequency and low amplitude, begins immediately after the 2nd sound and continues throughout diastole. The 3rd sound is visible and the high frequency presystolic accentuation is marked. Elements of these features are also recorded at the base, where a very short, high frequency early diastolic murmur of aortic origin is visible. This murmur was heard following it's demonstration by phonocardiogram.

Fig. 7.

Mitral Stenosis.

The Early Diastolic Murmur.

Apical Tracings.



Basal Tracings.

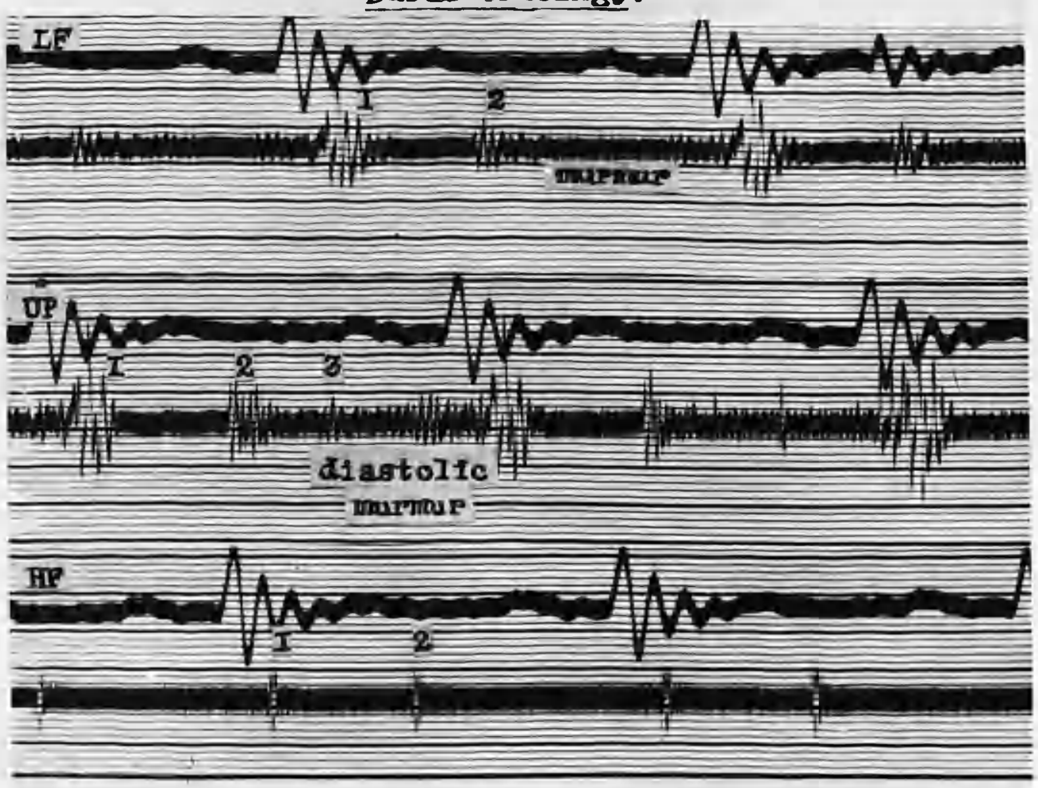
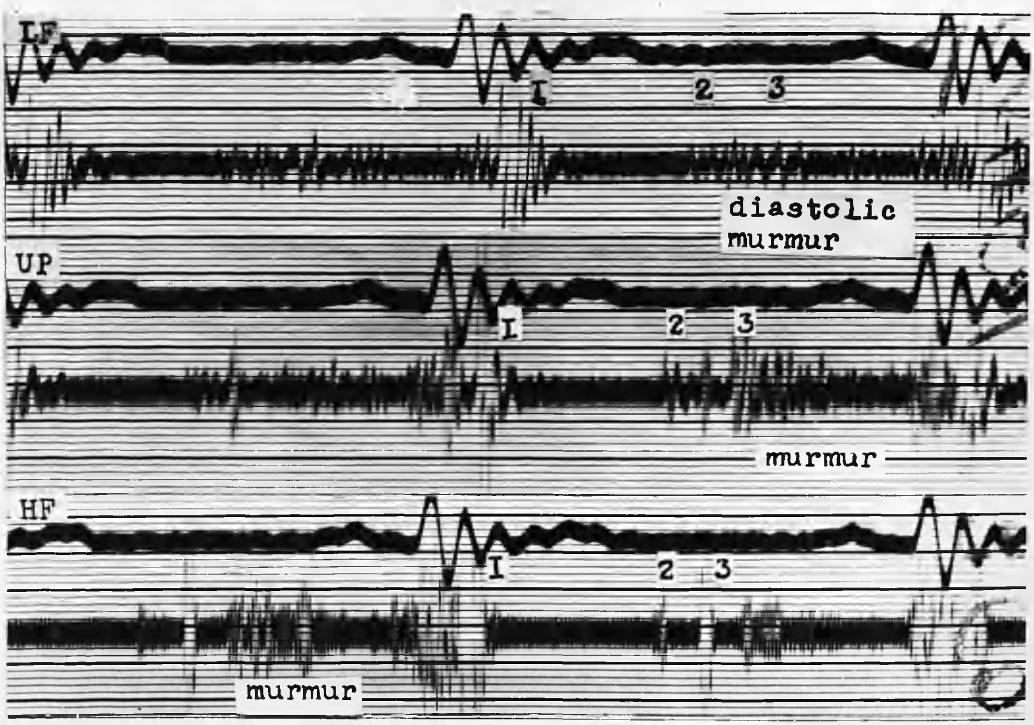


Fig. 8.

Mitral Stenosis.

Mid-diastolic accentuation.

Apical Tracings.



T.C. aet. 40 years.

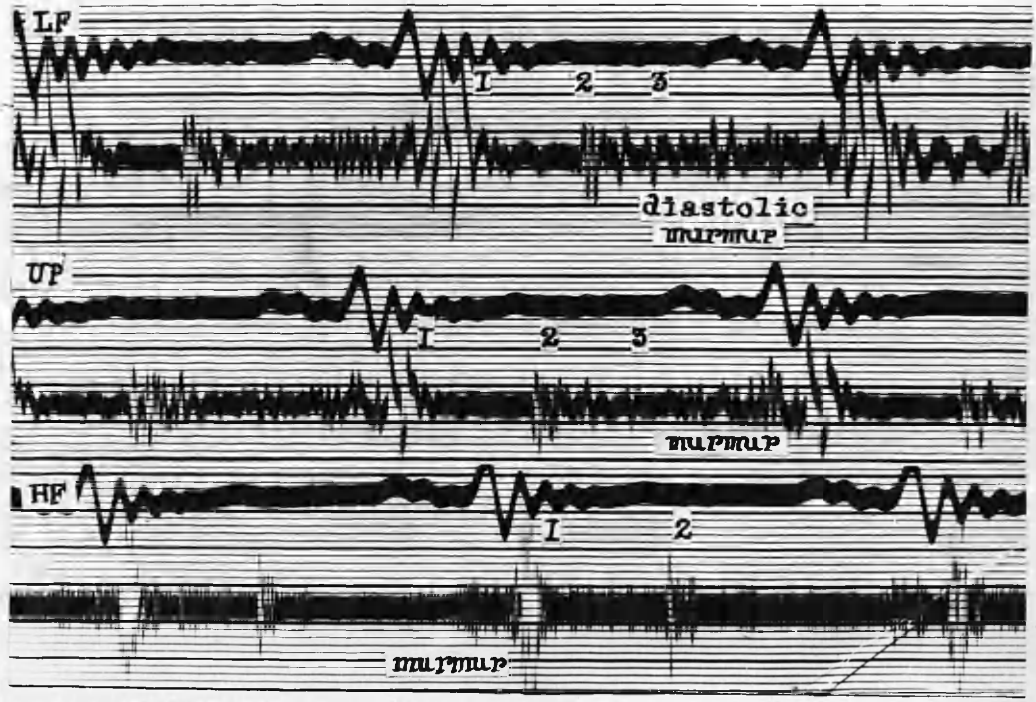
The diastolic murmur is seen to extend throughout diastole, with low frequency vibrations between 2nd and 3rd sounds. The accentuated 3rd sound and mid-diastolic accentuation is demonstrated. The high frequency presystolic accentuation is again visible.

Fig. 9.

Mitral Stenosis.

The Early Diastolic Murmur.

Apical Tracings.



G.P. aet. 50 years.

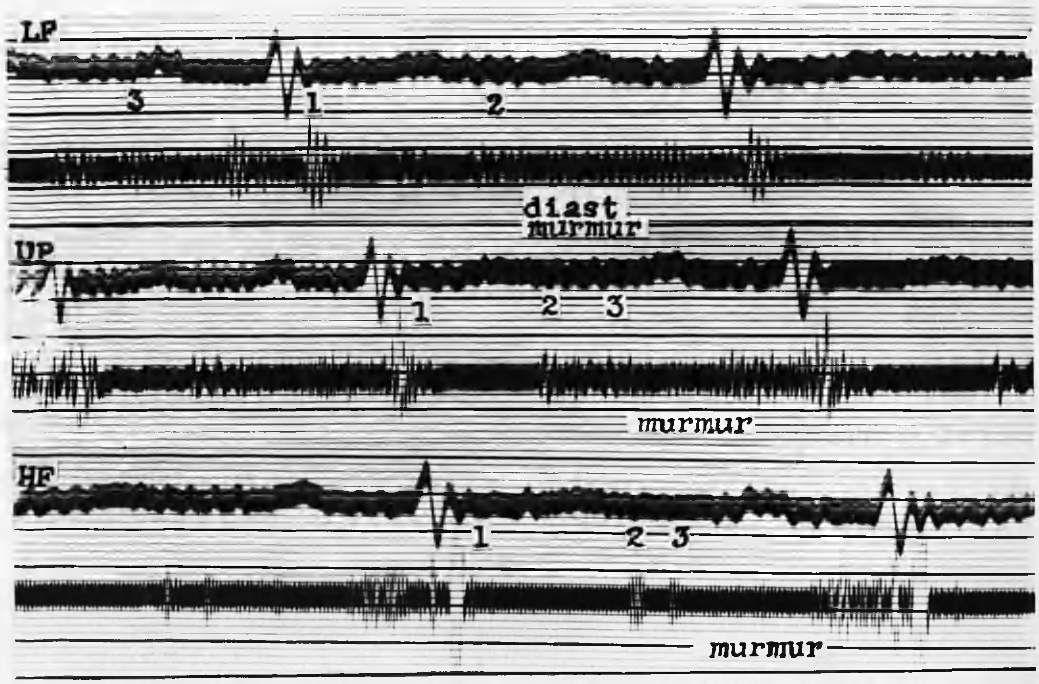
Again shows the long, low frequency, low amplitude diastolic following immediately on the 2nd sound, with high frequency presystolic accentuation.

Fig. 10.

Mitral Stenosis.

The Early Diastolic Murmur.

Apical Tracings.



Mrs A.S. aet. 38 years.

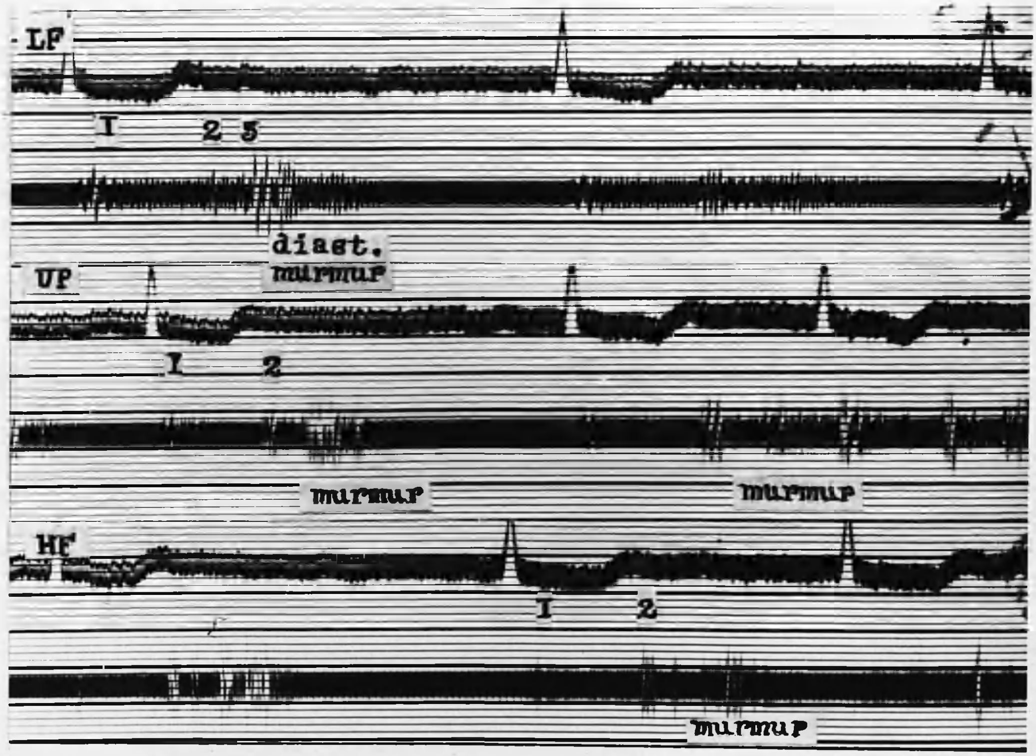
A further record of a mitral diastolic murmur extending throughout diastole, with a visible 3rd sound and presystolic high frequency accentuation.

Fig 11.

Mitral Stenosis.

Variation in Murmurs with Auricular Fibrillation.

Apical Tracings.



Mrs B.S. aet. 41 years.

Auricular fibrillation at the rate of 44/min The variable position of the mid-diastolic murmur according to the length of diastole is demonstrated. It is visualised in the unfiltered phonocardiogram in a "presystolic" position. Due to the slow rate a more rapid record was taken, accounting for the appearance of a higher frequency than was usually seen.

FIG. 12.

T.S., aet 34 yrs.

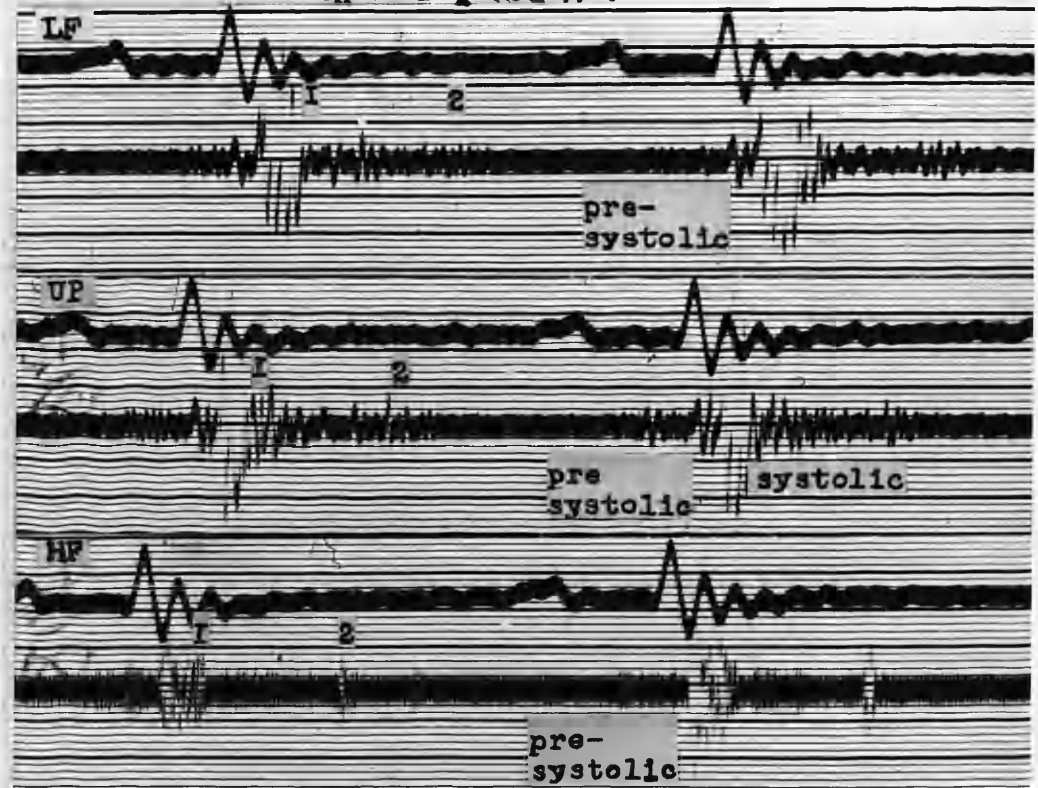
Both apical and basal tracings show a definite "presystolic" murmur. No mid-diastolic is visible. The basal tracings show in addition an early, high frequency, diastolic murmur of aortic incompetence.

Fig. 12.

Mitral Stenosis.

The "Presystolic" Murmur.

Apical Tracings.



Basal Tracings.

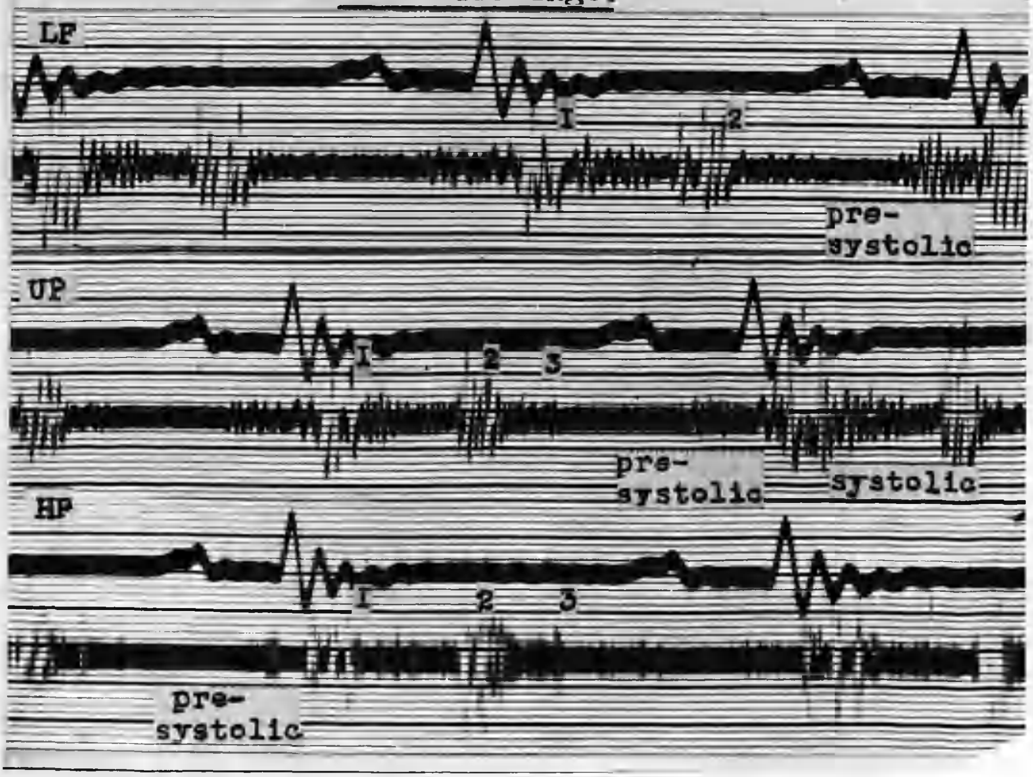


FIG. 13.

P.McK., aet 50 yrs.

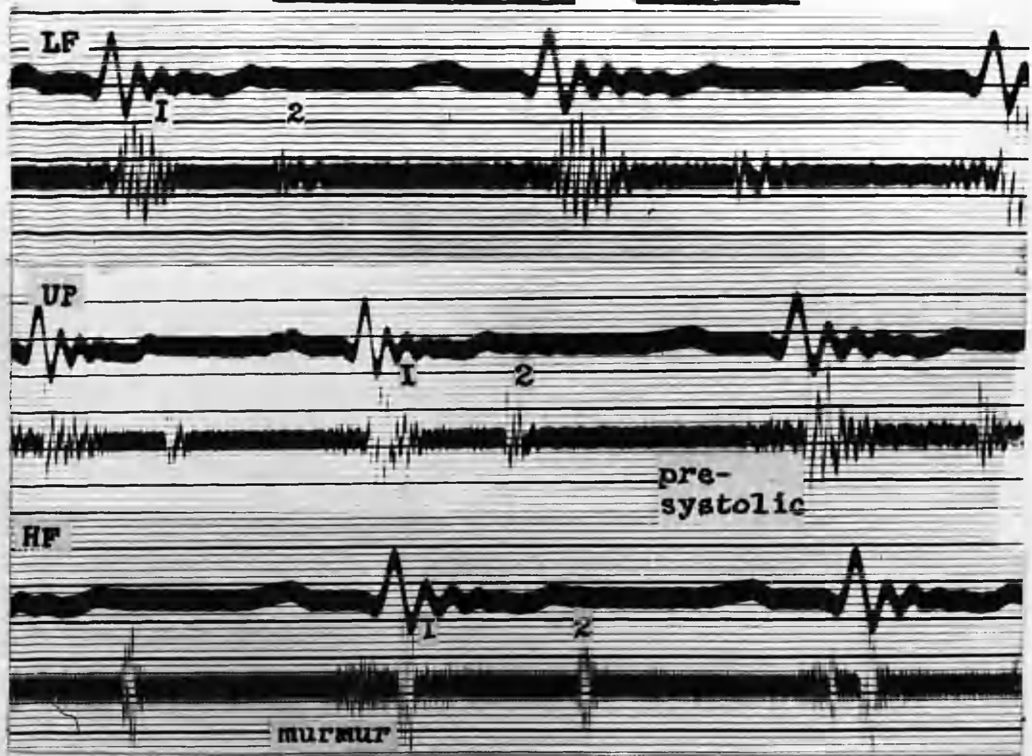
There are two tracings from the cardiac apex taken at different dates and with varying amplification. A "presystolic" murmur was audible. In the initial record this "presystolic" murmur is recorded. In the second tracing, with further amplification, the accentuated 3rd sound becomes visible with very low amplitude, low frequency vibrations of a mid-diastolic murmur following the 3rd sound. The high frequency nature of the "presystolic" murmur is clearly demonstrated.

Fig. 13.

Mitral Stenosis.

The Presystolic Murmur.

Apical Tracings. 27/12/48.



Apical Tracings. 14/1/49.

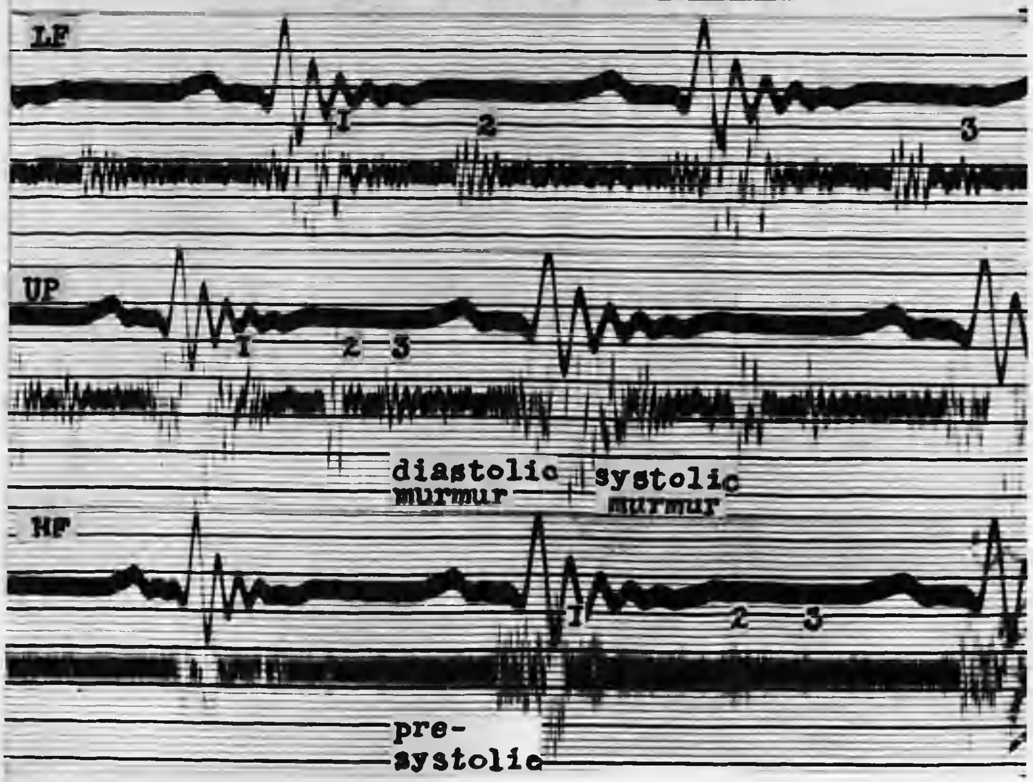
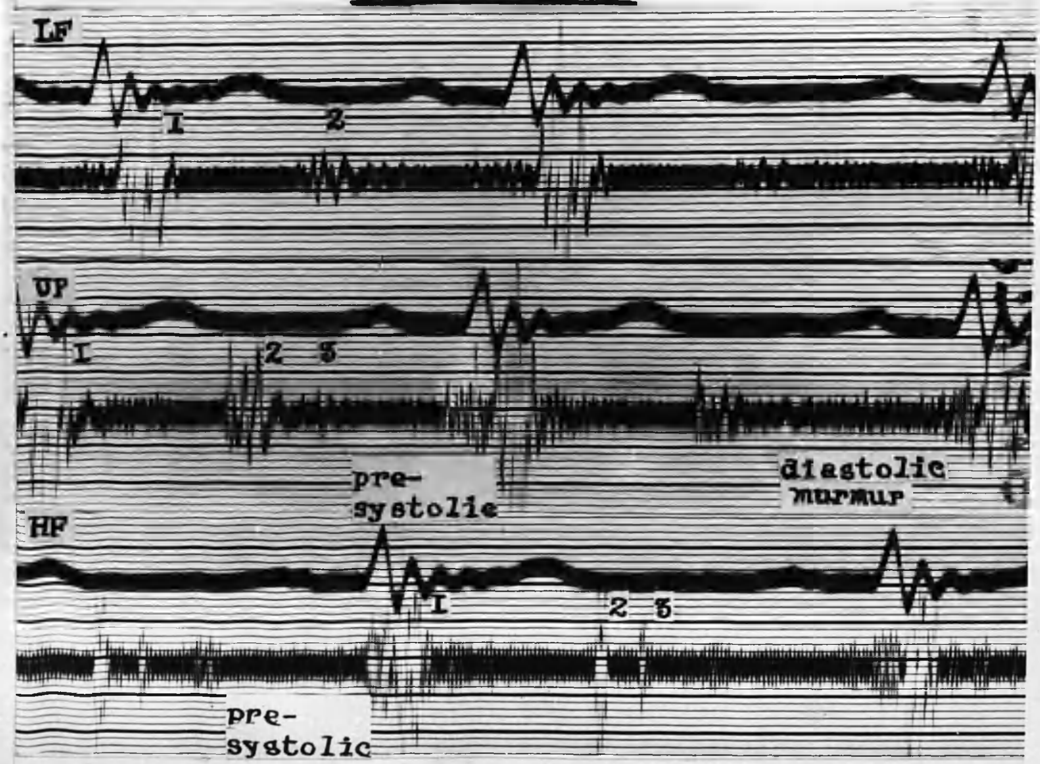


Fig. 14.

Mitral Stenosis.

Mid-diastolic and Presystolic Murmurs.

Apical Tracings.



Mrs E. McA, aet. 30 years.

This case is demonstrated because of the separation of the diastolic murmur into two components in the low frequency band. There is a mid-diastolic and "presystolic" component.

In the other records it is revealed as a murmur occupying all diastole, with presystolic accentuation.

FIG. 15.

C.McG., aet 24 yrs.

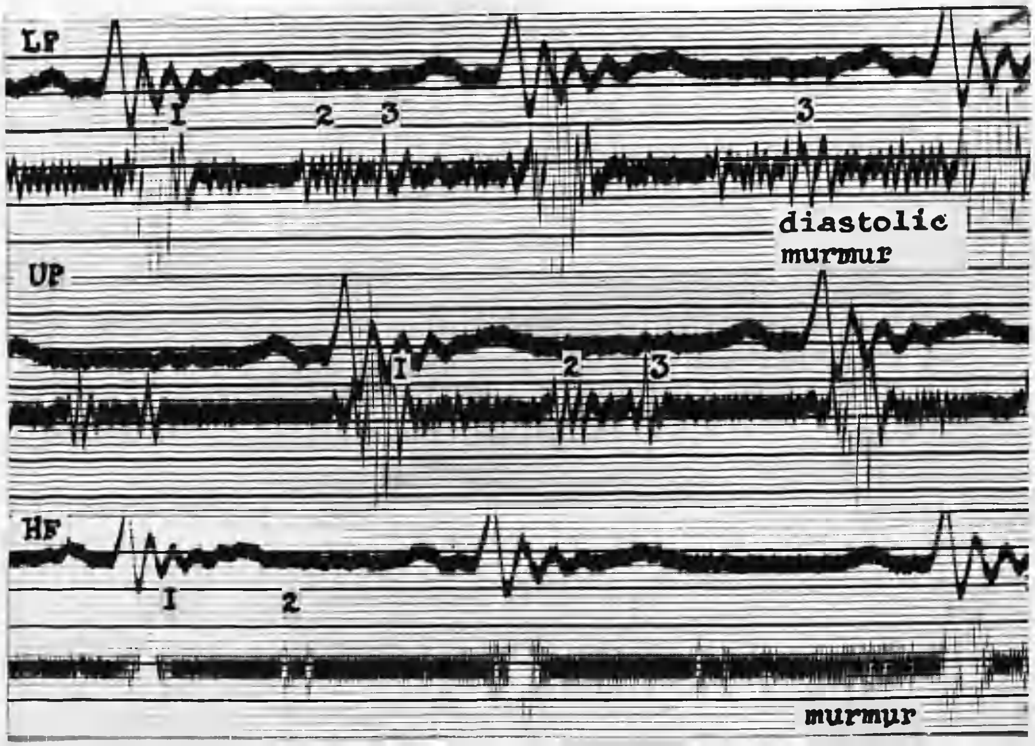
This record demonstrates how the low frequency diastolic murmur may be clearly visible only in the low frequency record. The sole evidence of abnormality in the unfiltered phonocardiogram, apart from the systolic murmur, is the markedly accentuated 3rd sound. High frequency presystolic accentuation is seen in the high frequency tracing. At the base, are a long, low amplitude, early systolic murmur with a relatively wide frequency range, and an early diastolic of medium and high frequency due to an aortic incompetence.

Fig. 15.

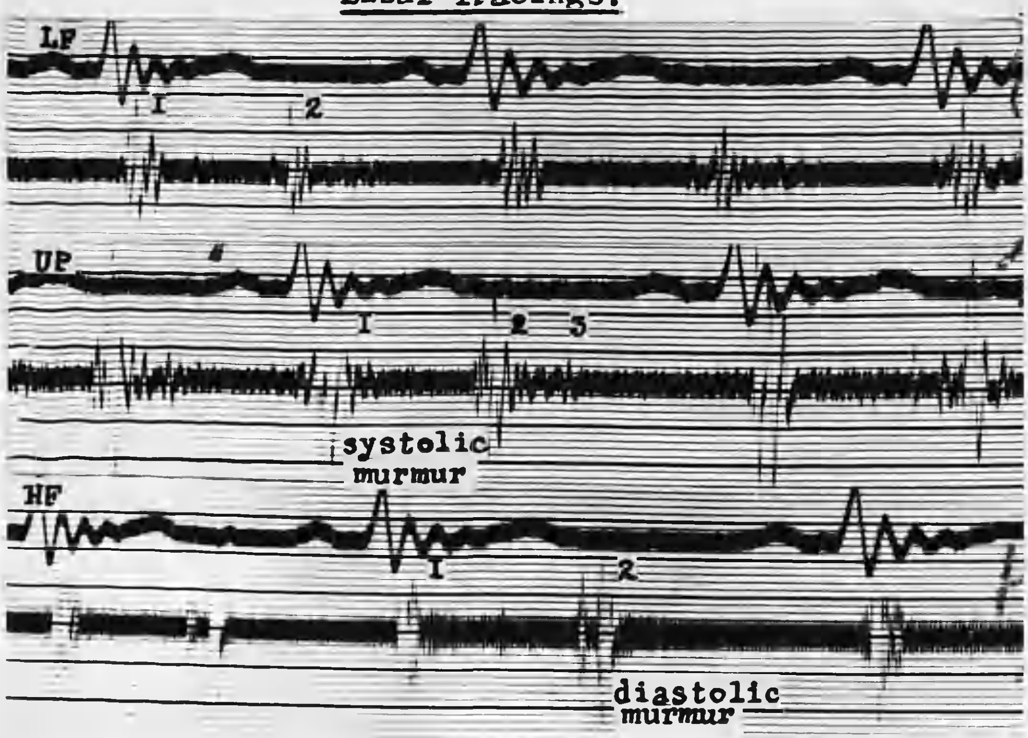
Mitral Stenosis.

The Diastolic Murmur.

Apical Tracings.



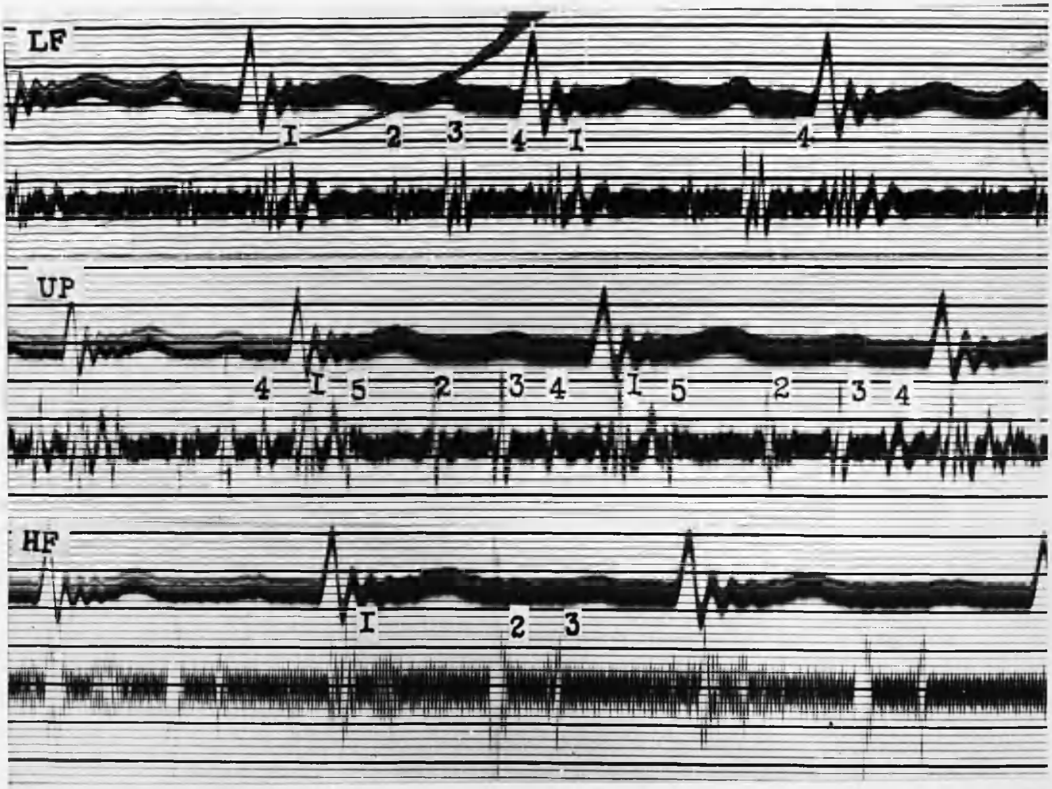
Basal Tracings.



Mitral Stenosis.

The "5" Heart Sounds.

Apical Tracings.



N.P. aet. 13 years.

This phonocardiographic curiosity was taken in a case with an acute exacerbation of carditis. All five heart sounds as described in the literature are visible. In the low frequency band a few low frequency diastolic vibrations follow the 3rd sound.

FIG. 17.

A.C., aet 50 yrs.

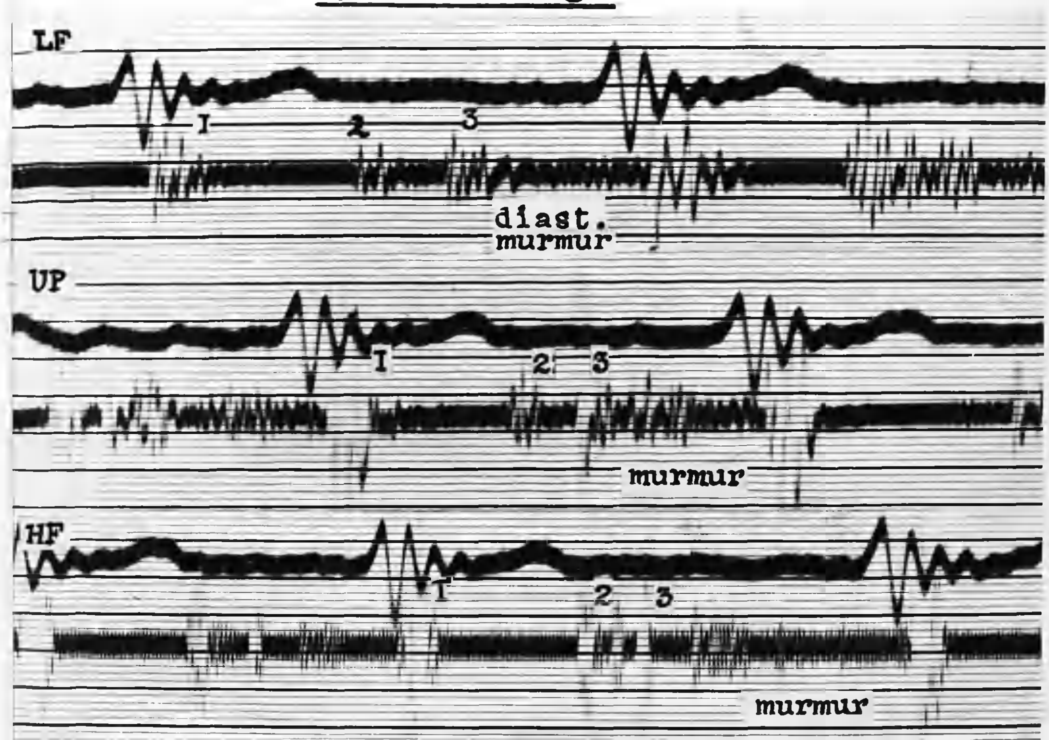
A case which demonstrates the changes in sounds in mitral stenosis with alteration in the cardiac rate. The initial tracing was taken on 25.2.49 with the rate 96/min. The rhythm was auricular fibrillation. This record showed no systolic murmur. A long mid-diastolic murmur followed a markedly accentuated 3rd sound, with some variation in length proportionate with the length of diastole.

The 2nd tracing was dated 23.3.49. The ventricular rate was 50/min. Apart from some doubtful low frequency diastolic vibrations (which were inaudible), the only abnormality is the accentuated 3rd sound.

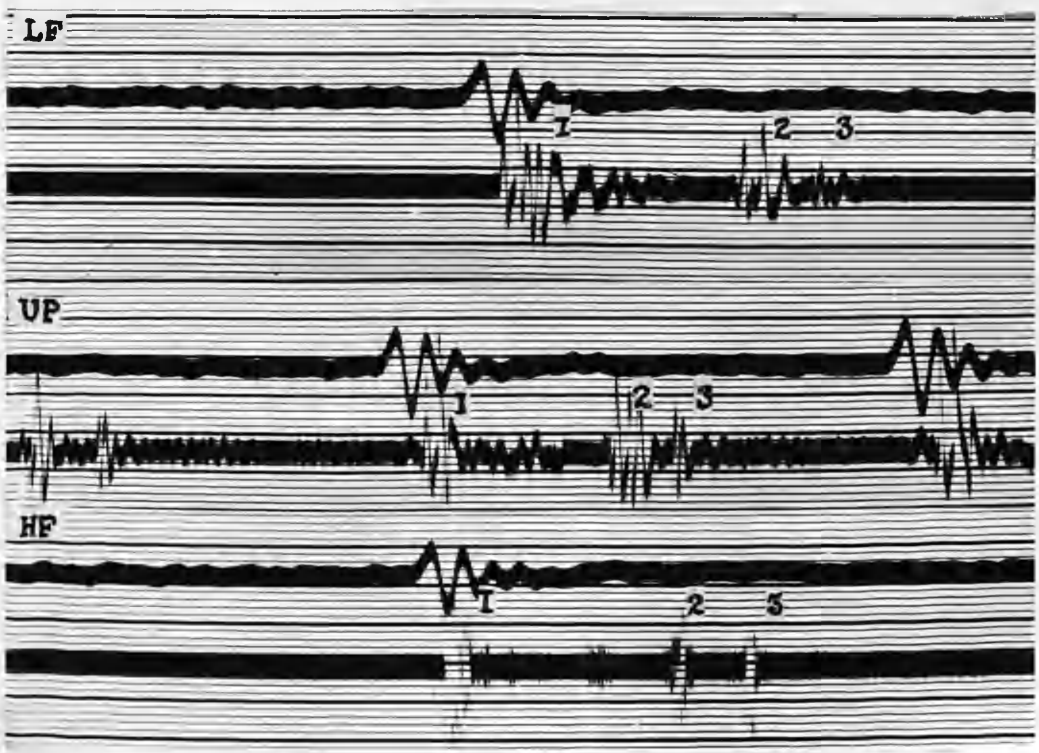
Mitral Stenosis.

Variation of Murmurs.

Apical Tracings.



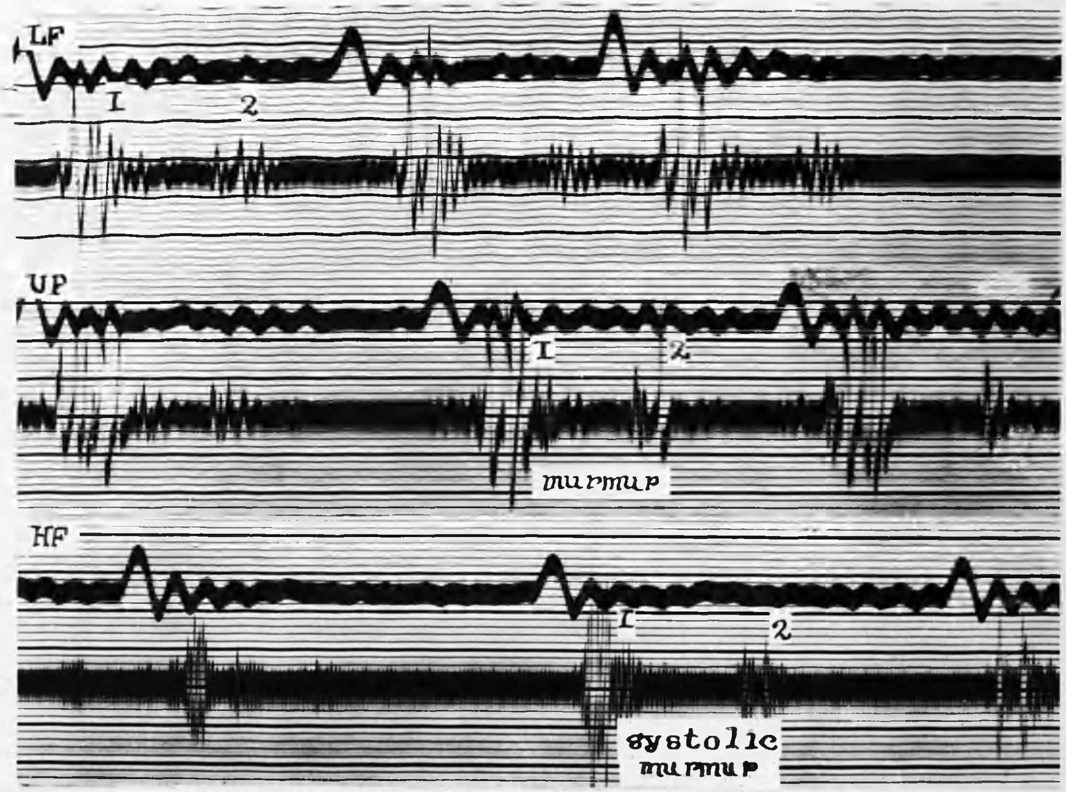
Apical Tracings.



Mitral Stenosis.

An Unusual Case.

Apical Tracings.



Mrs A.D. aet. 63 years.

When initially seen at the Outpatient Dept., this case had a short apical systolic, and a long rumbling diastolic with presystolic accentuation.

Three months later, on admission to hospital, only the short apical systolic was audible, and the above record was obtained. The rhythm was slow auricular fibrillation. The only visible abnormality was a very short, but early, wide frequency systolic murmur. The 2nd sound was split.

FIG. 19.

D.McK., aet 49 yrs.

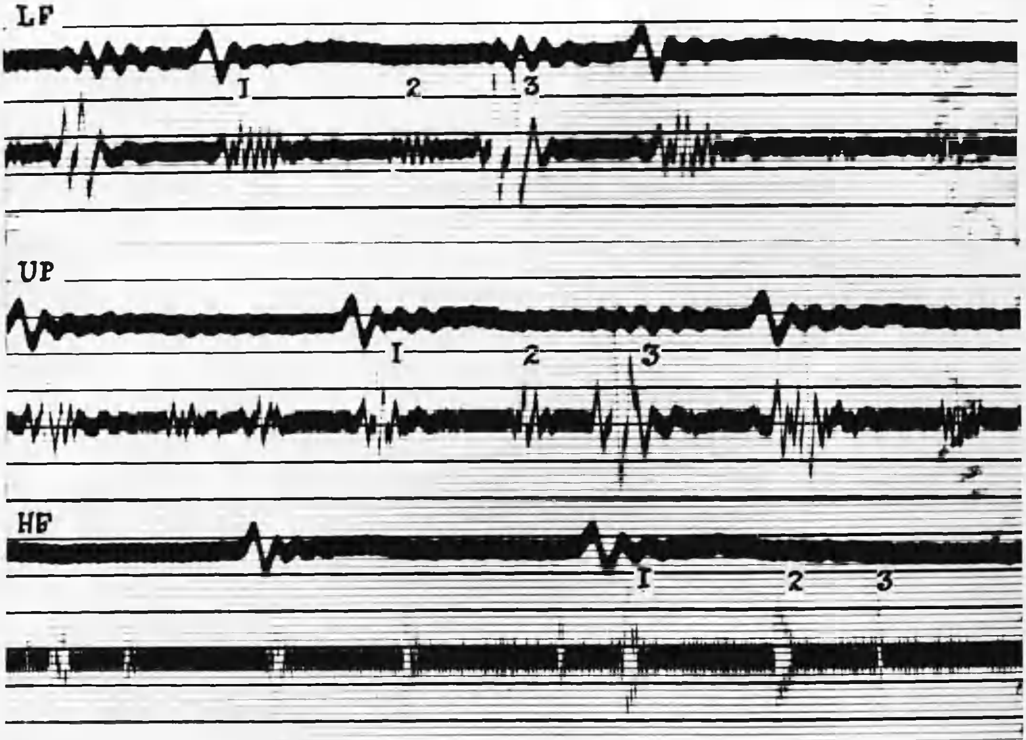
This case had been diagnosed as mitral stenosis by Dr. John Cowan, 11 years ago. The initial phonocardiogram was taken on 21.1.49. The second was recorded on 20.9.49. Both tracings show a gross accentuation of the 3rd sound, subject to considerable variation in size, and seen in one complex of the 1st record as a short mid-diastolic murmur of low amplitude and low frequency.

Fig. 19.

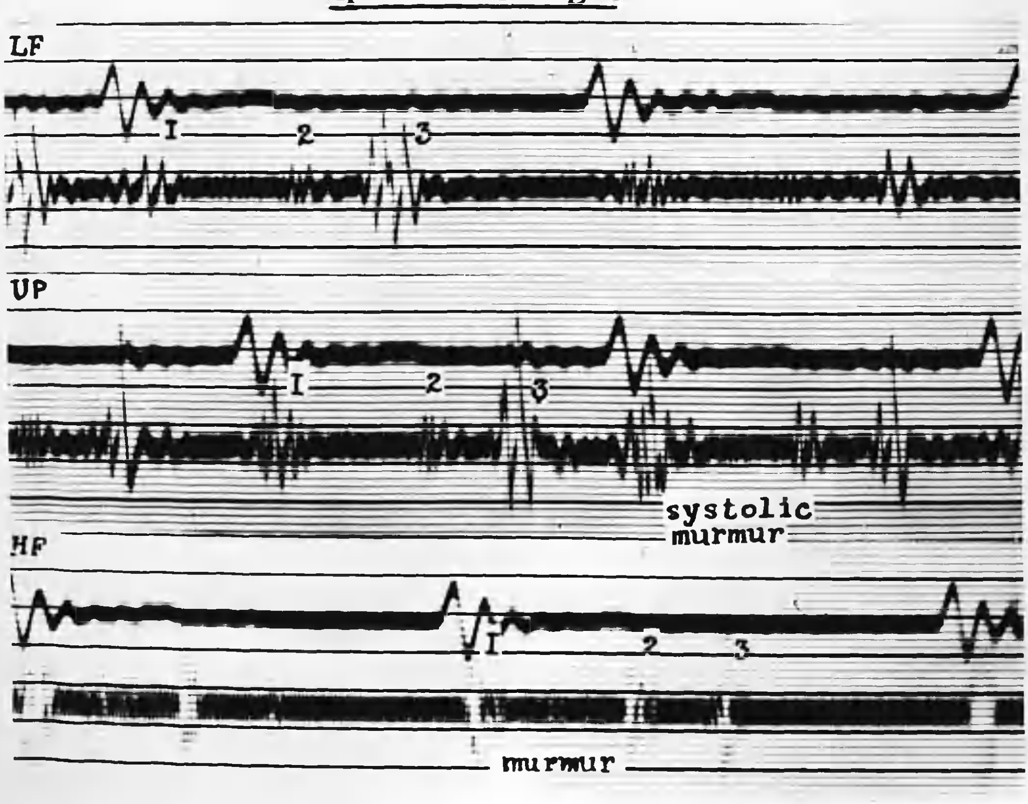
Mitral Stenosis.

An Unusual Form.

Apical Tracings.



Apical Tracings.



ILLUSTRATIONS

AORTIC VALVE DISEASE.

FIG. 20.

The tracings opposite demonstrate the type of systolic murmur associated with aortic stenosis.

Mrs. A.T., aet 45 yrs.

The systolic murmur begins with the 3rd component of the 1st heart sound, is seen in all three records and is, therefore, of wide frequency range. The duration is long and the amplitude high. The diastolic murmur is of medium and high frequency, short duration, low amplitude, and follows immediately upon the 2nd sound.

Mrs. M.McK., aet 40 yrs.

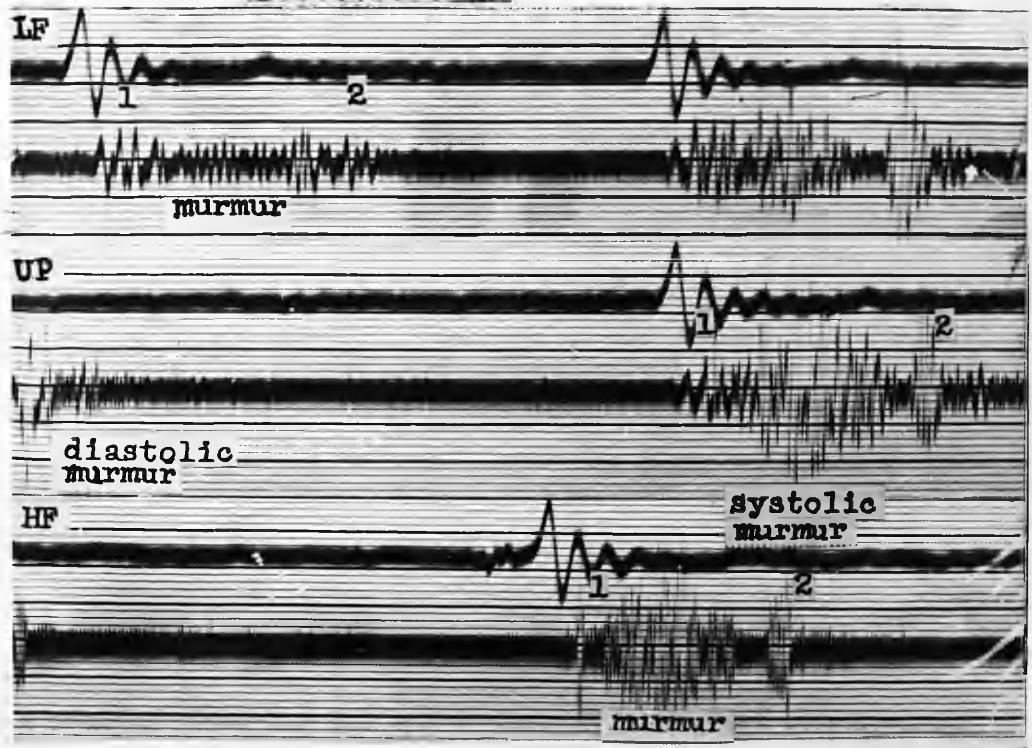
A similar type of systolic murmur is seen. The diastolic murmur in this case is of relatively low frequency and is best seen in the unfiltered phonocardiogram. There is a slight crescendo-decrescendo character.

Aortic Stenosis and Incompetence. Fig 20.

Rheumatic.

Associated with Mitral Stenosis.

Basal Tracings.



Basal Tracings.

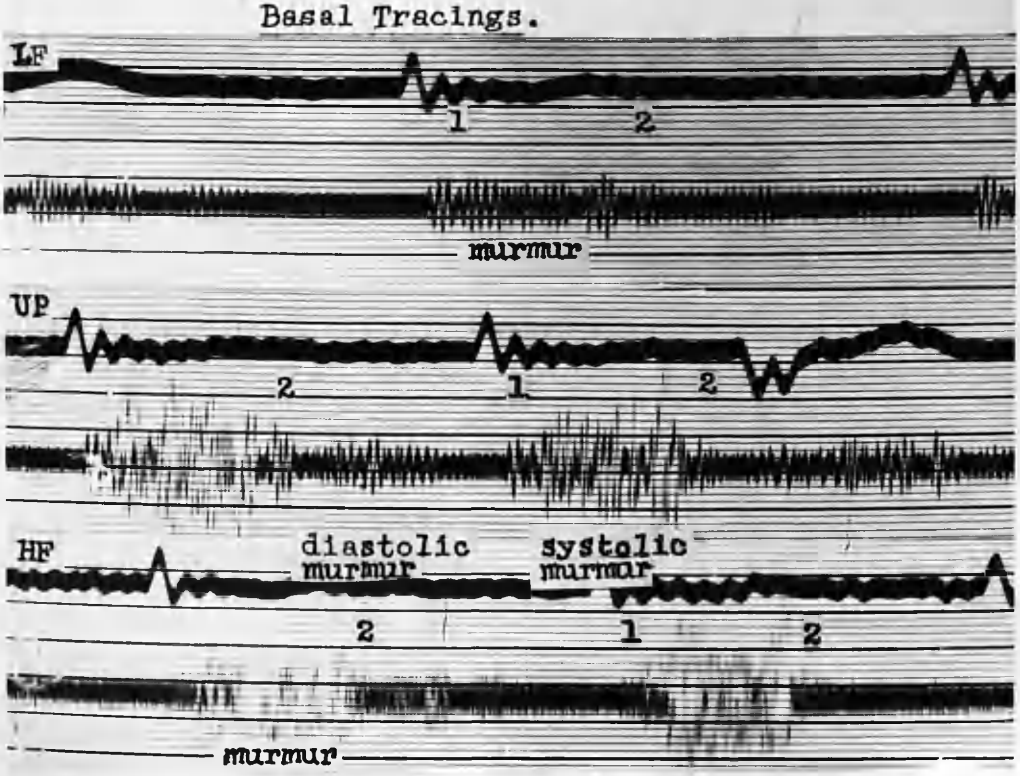


FIG. 21.

These two tracings demonstrate variations in the aortic diastolic murmur.

A.T., aet 21 yrs.

There is a relatively low frequency systolic murmur of aortic stenosis. The long early diastolic murmur is of such high frequency that it produces an almost linear response during early diastole, in the high frequency band.

J.P., aet 14 yrs.

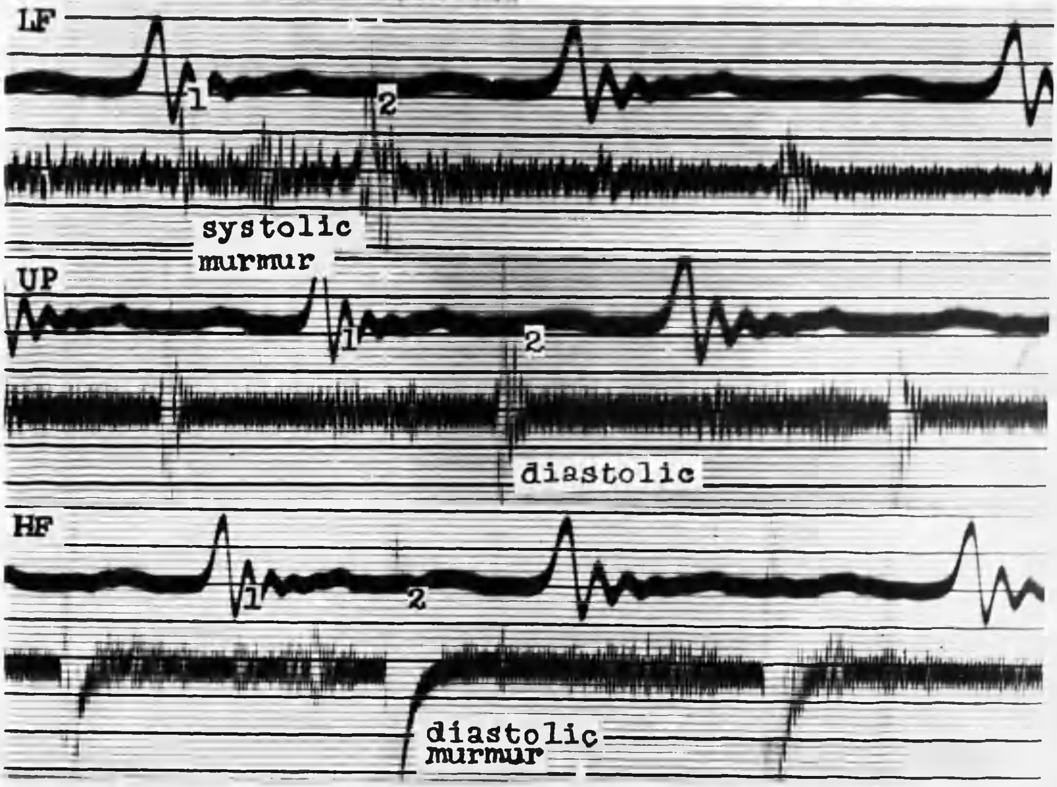
In this case the systolic murmur is mid-systolic in timing, of low amplitude and narrow frequency range. The early diastolic murmur is in the higher frequency ranges, and has a crescendo-decrescendo character.

Aortic Stenosis and Incompetence. Fig 21.

Rheumatic.

Associated with Mitral Stenosis.

Basal Tracings.



Basal Tracings.

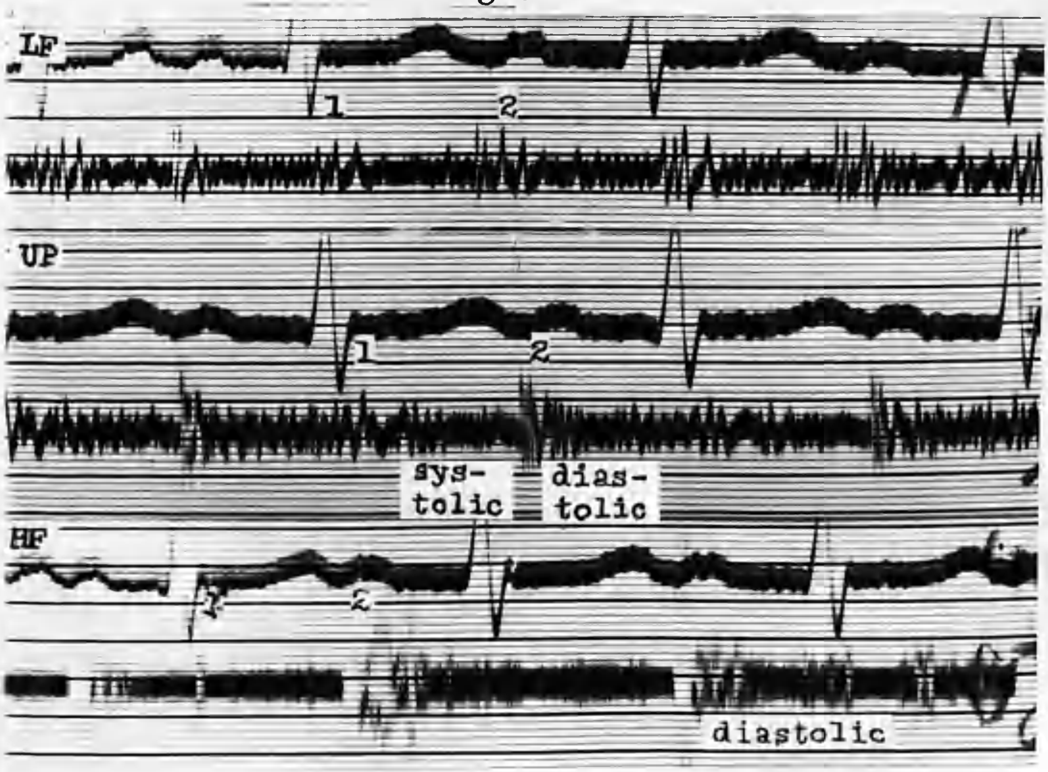


FIG. 22.

The record opposite, and the following two, all demonstrate a feature described in the text. The diastolic murmur is elicited clearly by the high frequency band. The degree of amplification possible is also shown.

Mrs. R.McD., aet 27 yrs.

The systolic murmur has the features of aortic stenosis. The diastolic murmur could only be stated to be doubtfully present in the low frequency and unfiltered tracings, but the high frequency record leaves no doubt as to it's presence.

Aortic Stenosis and Incompetence.

Rheumatic.

Associated with Mitral Stenosis.

Basal Tracings.

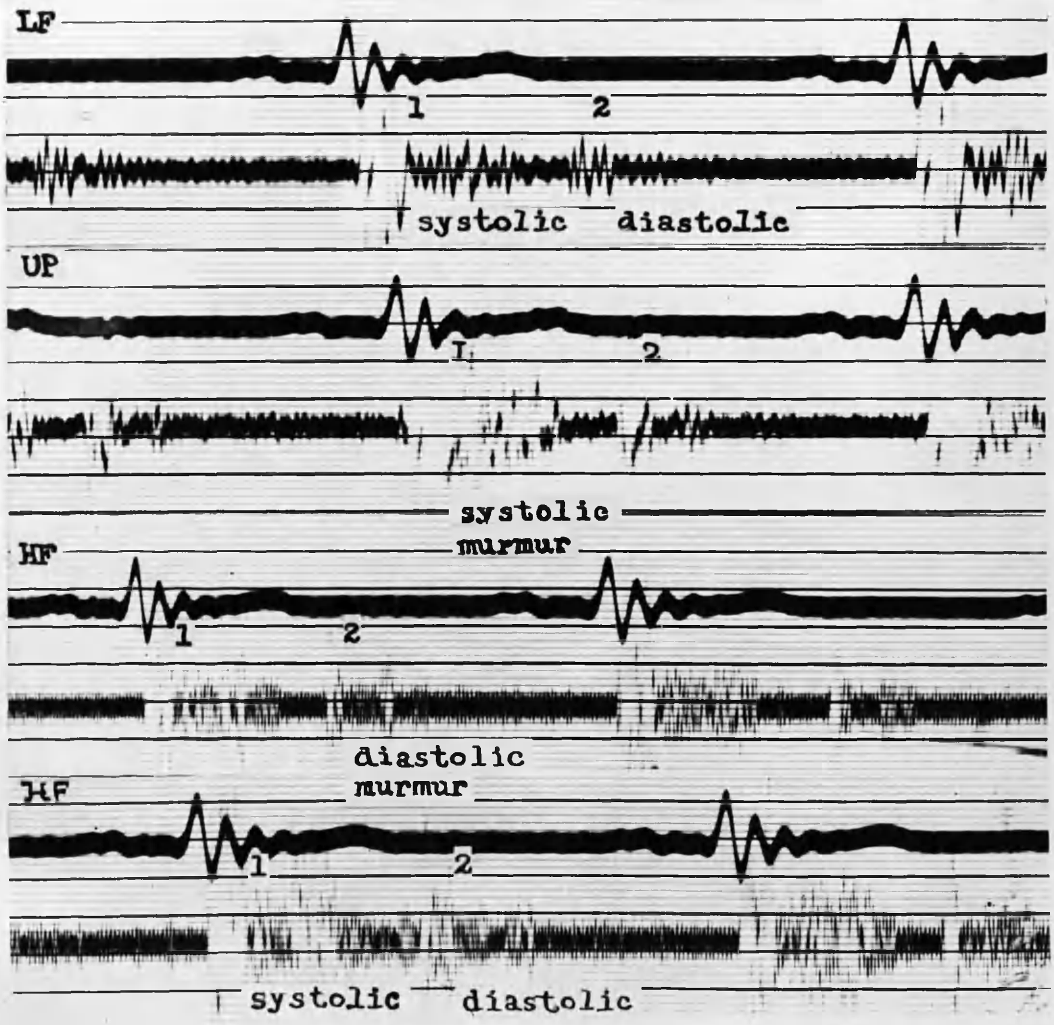


FIG. 23.

G.G., aet 20 yrs.

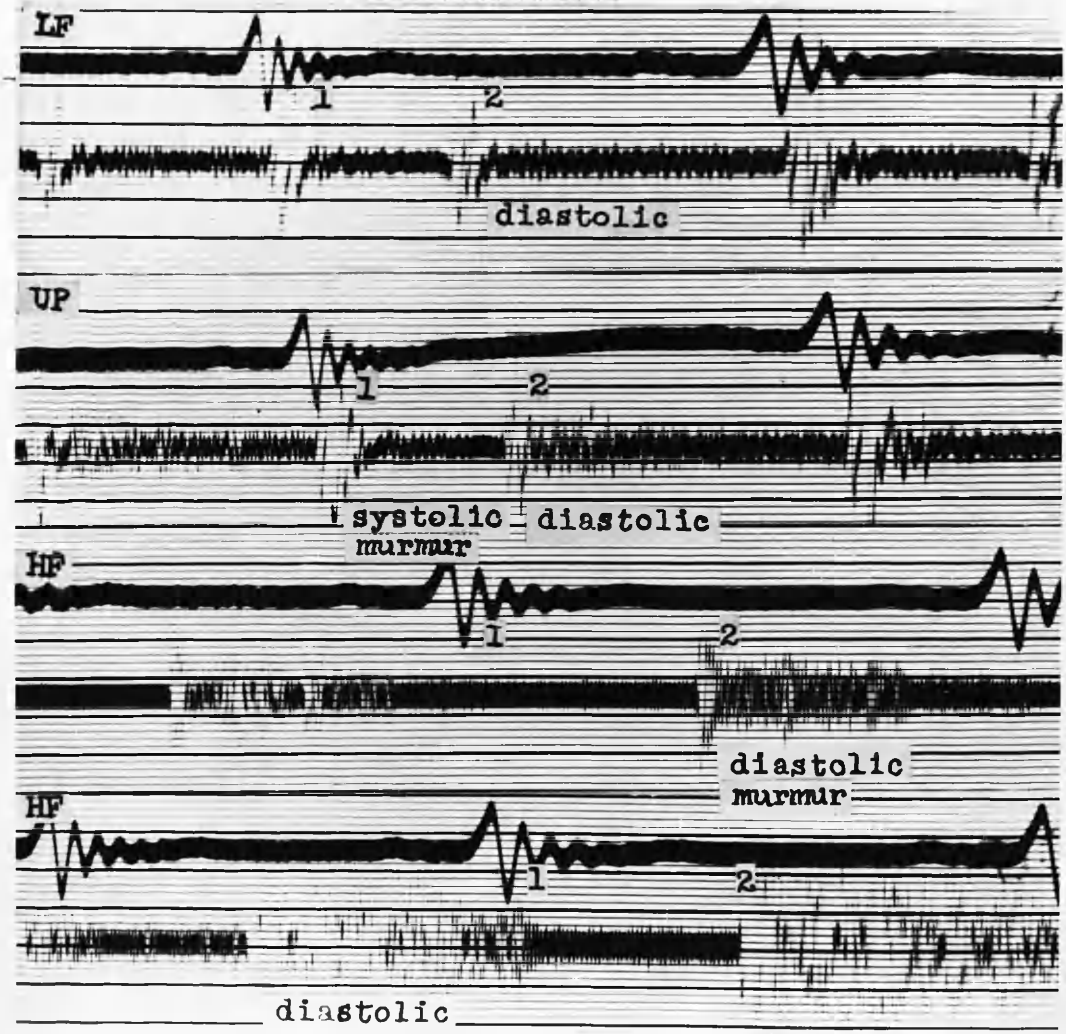
This record shows the degree of amplification of an aortic diastolic murmur which can be produced by the high frequency band of this instrument.

Aortic Stenosis and Incompetence.

Rheumatic.

Associated with Mitral Stenosis.

Basal Tracings.



E.O., aet 13 yrs.

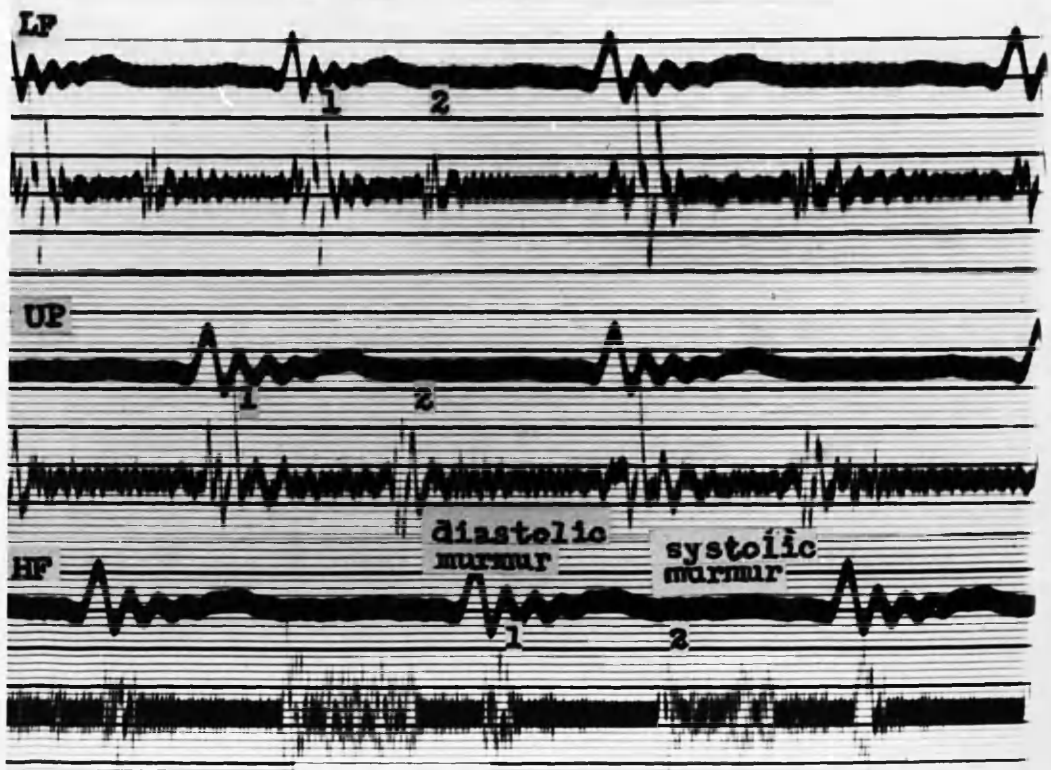
A further case in which the aortic diastolic murmur could be clearly demonstrated by an attenuation of lower frequency vibrations which confuse the picture in the low frequency and unfiltered phonocardiographs.

Aortic Incompetence.

Rheumatic.

Associated with Mitral Stenosis.

Basal Tracings.



diastolic

FIG. 25.

J.F., aet 35 yrs.

This is a case in which the mitral diastolic murmur is elicited by the low frequency band at the apex, and an aortic diastolic murmur, doubtful on auscultation, is visible in both the unfiltered, and high frequency band at the base.

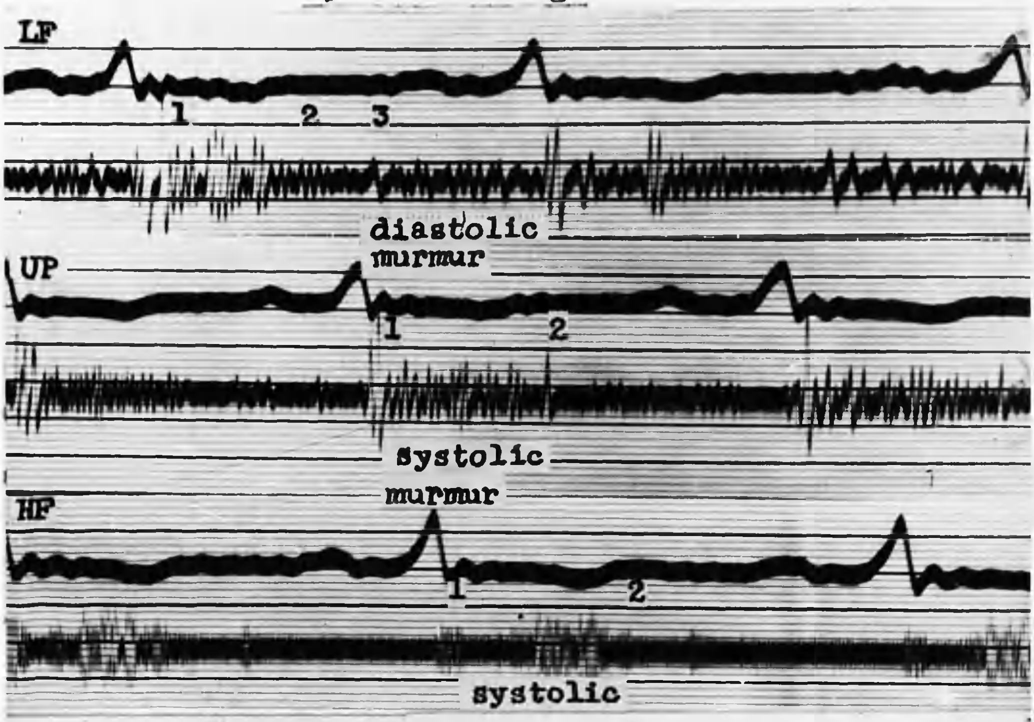
Fig 25.

Mitral Stenosis and Incompetence.

Aortic Stenosis and Incompetence.

Rheumatic.

Apical Tracings.



Basal Tracings.

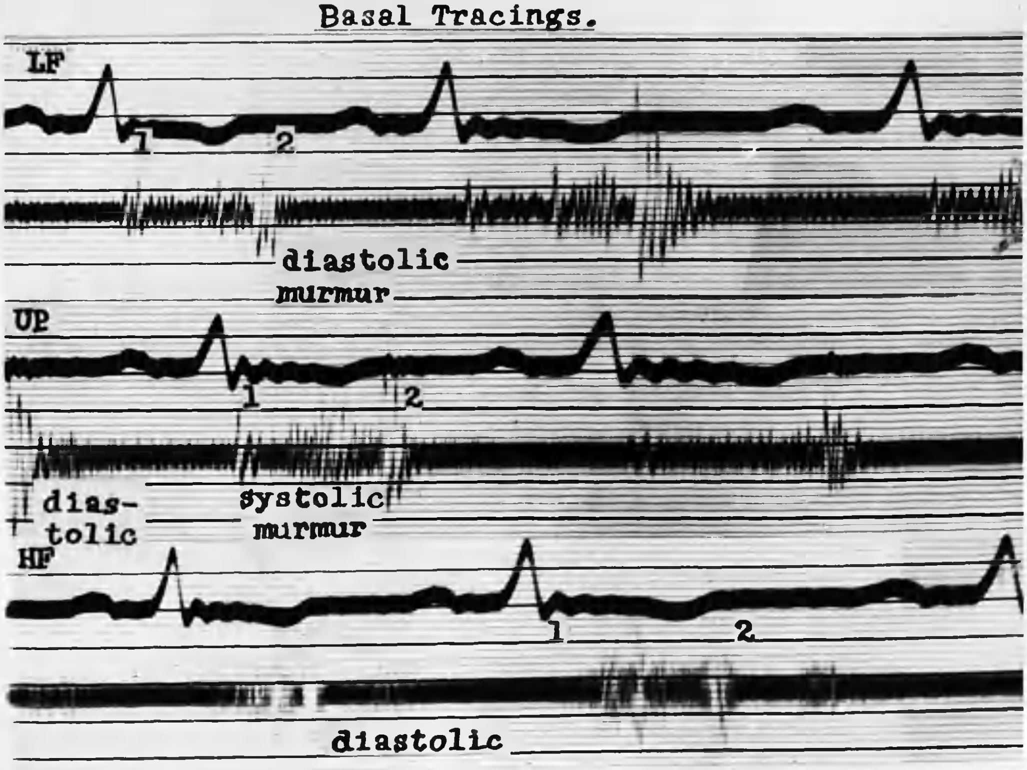


FIG. 26.

Both records were from cases thought to be of rheumatic origin, and in which no evidence of mitral stenosis could be elicited.

J.C., aet 40 yrs.

There is a well marked systolic murmur typical of aortic stenosis. The early diastolic is of relatively low frequency and is best seen in the unfiltered phonocardiogram. It is of low amplitude but long duration.

W.H., aet 31 yrs.

The appearances are very similar to those above. The very low amplitude, high frequency, short, early diastolic murmur is only seen in the high frequency band.

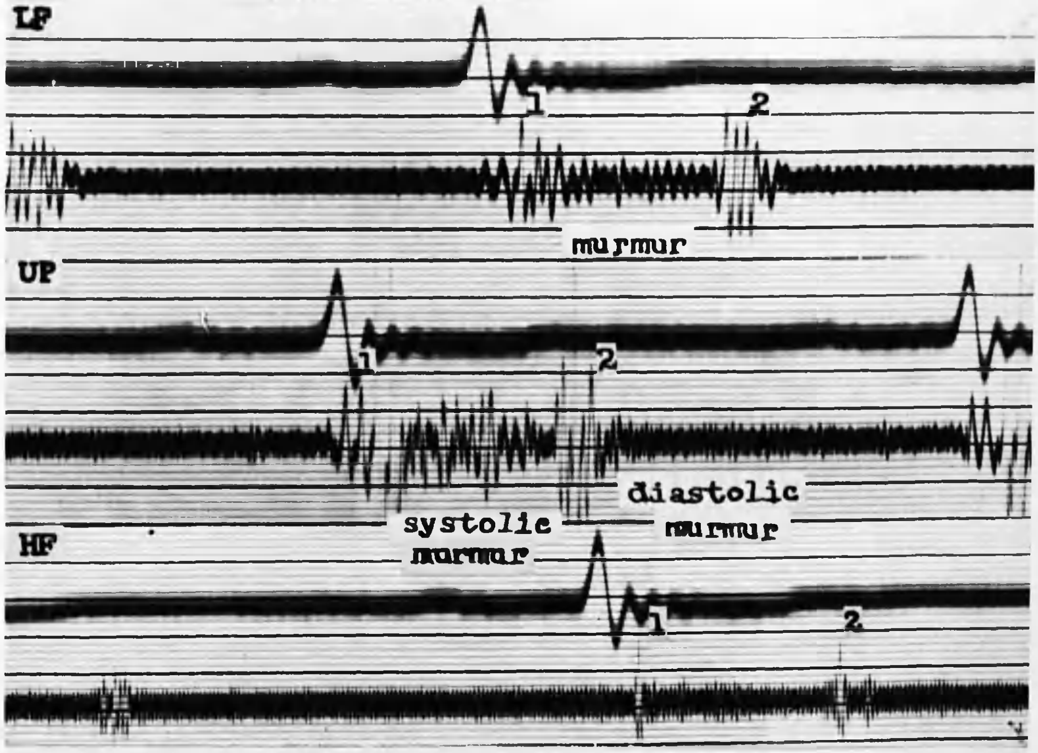
Fig 26.

Aortic Stenosis and Incompetence.

Rheumatic.

Without Mitral Stenosis.

Basal Tracings.



Basal Tracings.

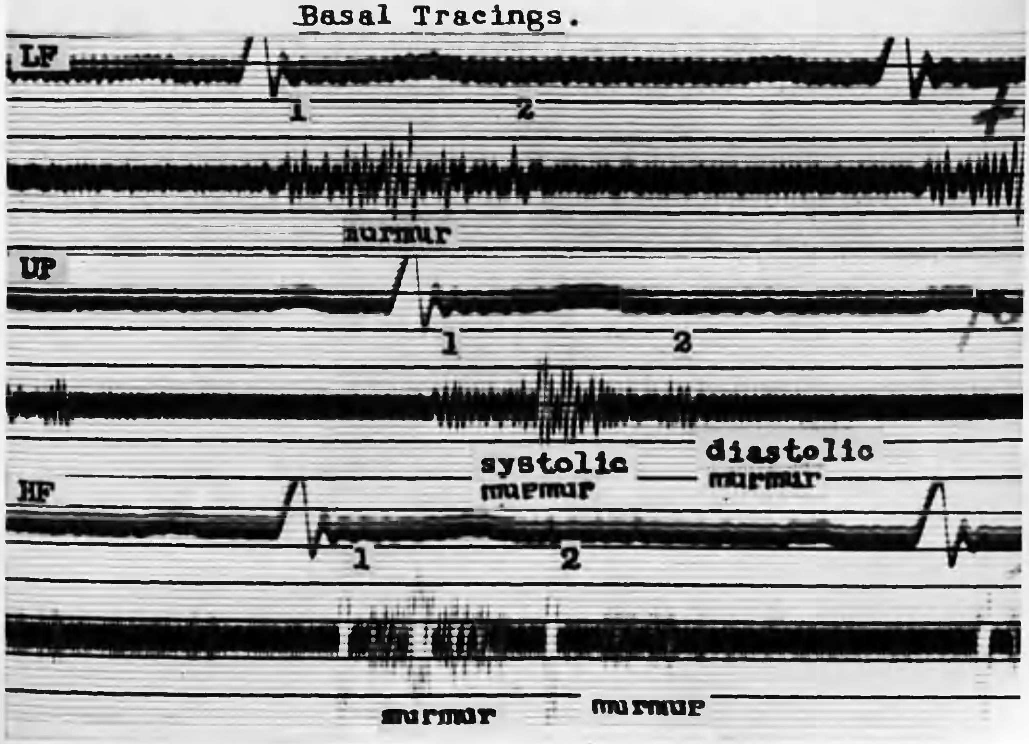


FIG. 27.

J.A., aet 18 yrs.

A case in which the only abnormality on auscultation was a doubtful aortic diastolic murmur at the 3rd left costal cartilage. The blood pressure was 128/60 mm. Hg.

Phonocardiogram demonstrates an early diastolic murmur, of high frequency, low amplitude, and short duration.

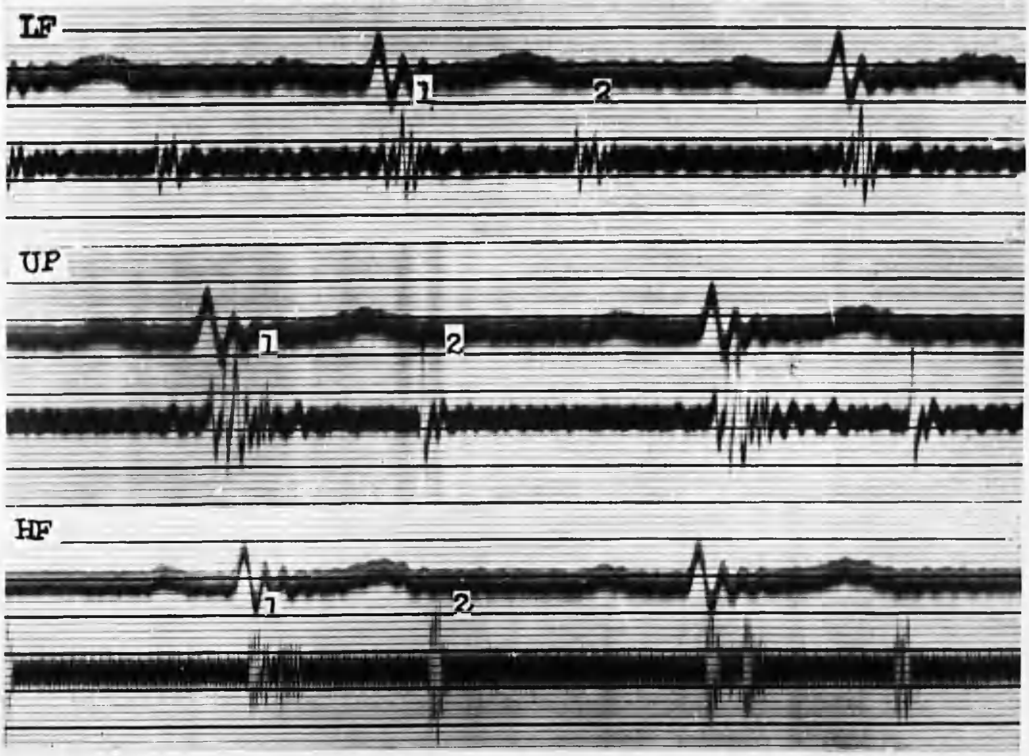
Fig 27.

Aortic Incompetence.

Rheumatic.

Without Mitral Stenosis.

Apical Tracings.



Basal Tracings.

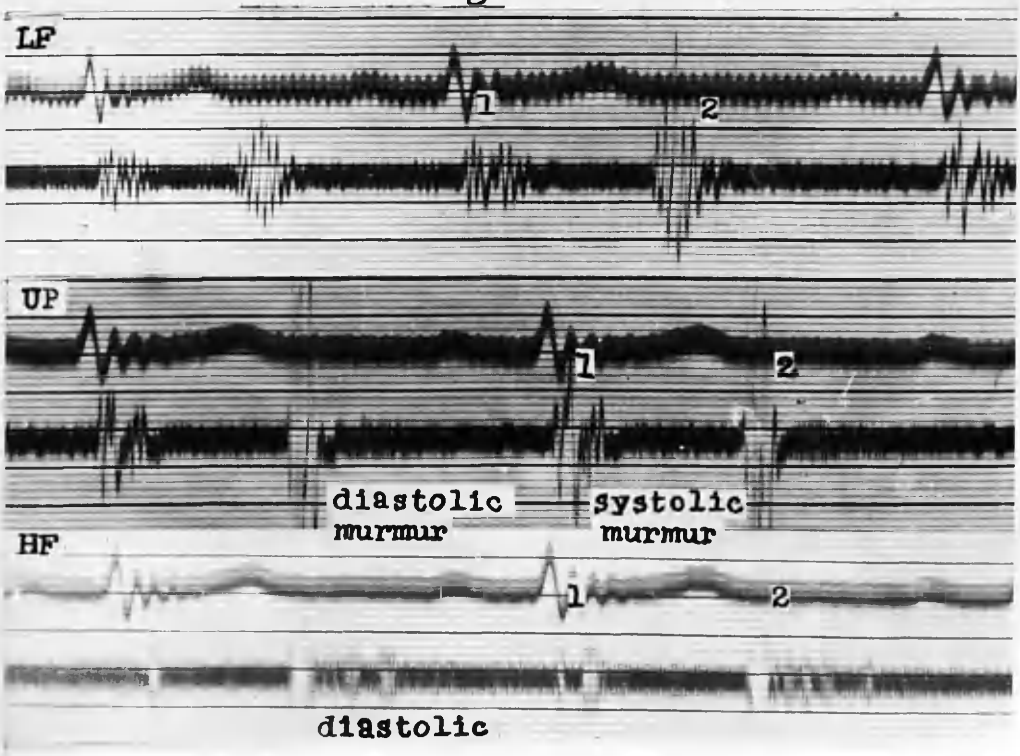


FIG. 28.

J.McG., aet 27 yrs.

The X Ray showed the presence of a calcified aortic valve. The typical murmur of aortic stenosis is well demonstrated to arise from the 3rd component of the 1st heart sound. There is no diastolic murmur.

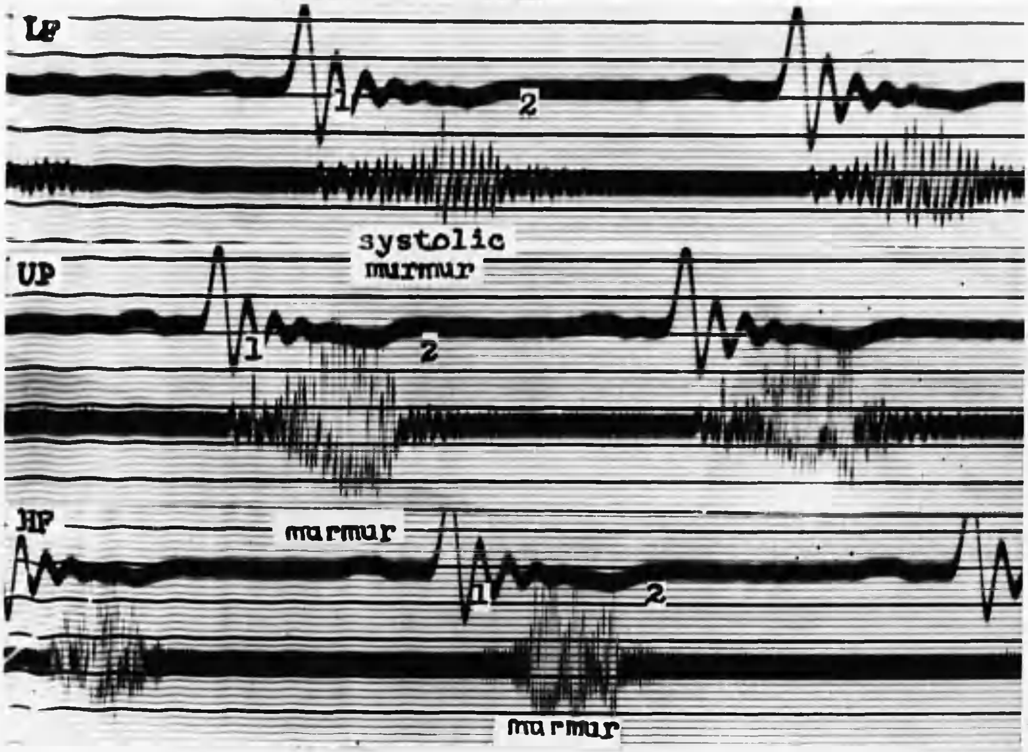
A.W., aet 65 yrs.

The systolic murmur is mid-systolic in timing though rather long, and may be due to aortic dilatation. The short, early diastolic is clearly visible. As a rule the diastolic murmur in cases of this aetiology tended to be of shorter duration.

Aortic Stenosis and Incompetence.

Aortic Sclerosis.

Basal Tracings.



Basal Tracings.

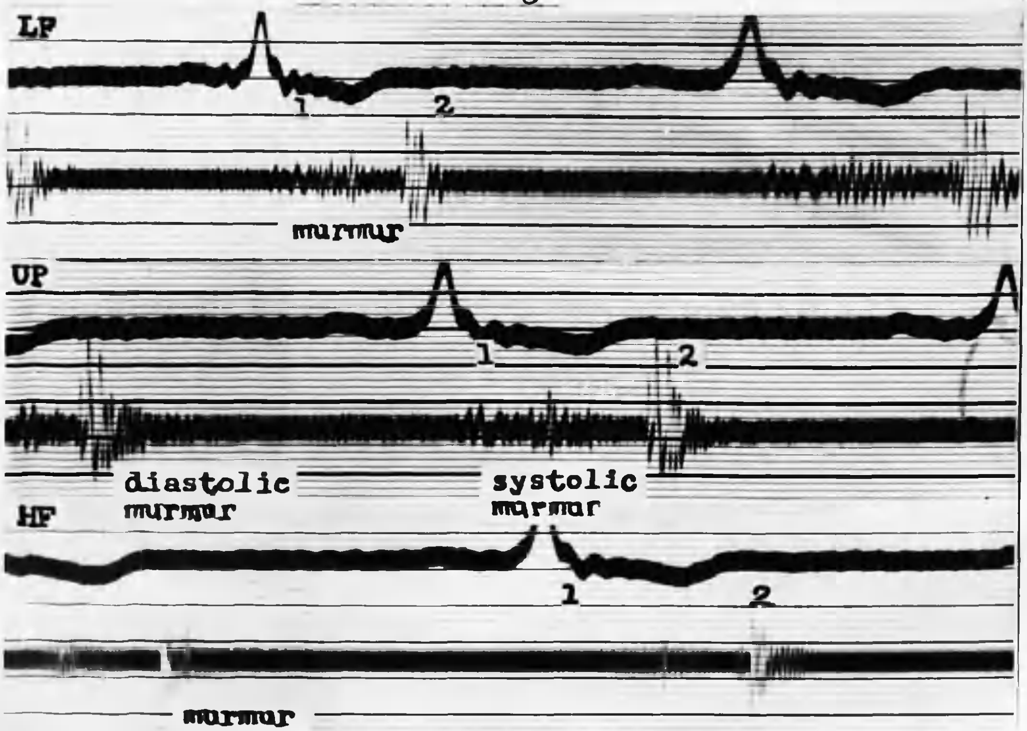


FIG. 29.

W.C., aet 51 yrs.

This tracing shows a late systolic murmur of relatively high frequency and high amplitude. There is doubt as to the cause of this murmur. Aortic dilatation, or more likely an aberrant chordae tendinae might be considered as possibilities. The diastolic murmur is of low amplitude and short duration.

C.E., aet 66 yrs.

The systolic murmur is typical of aortic stenosis. No definite diastolic can be distinguished.

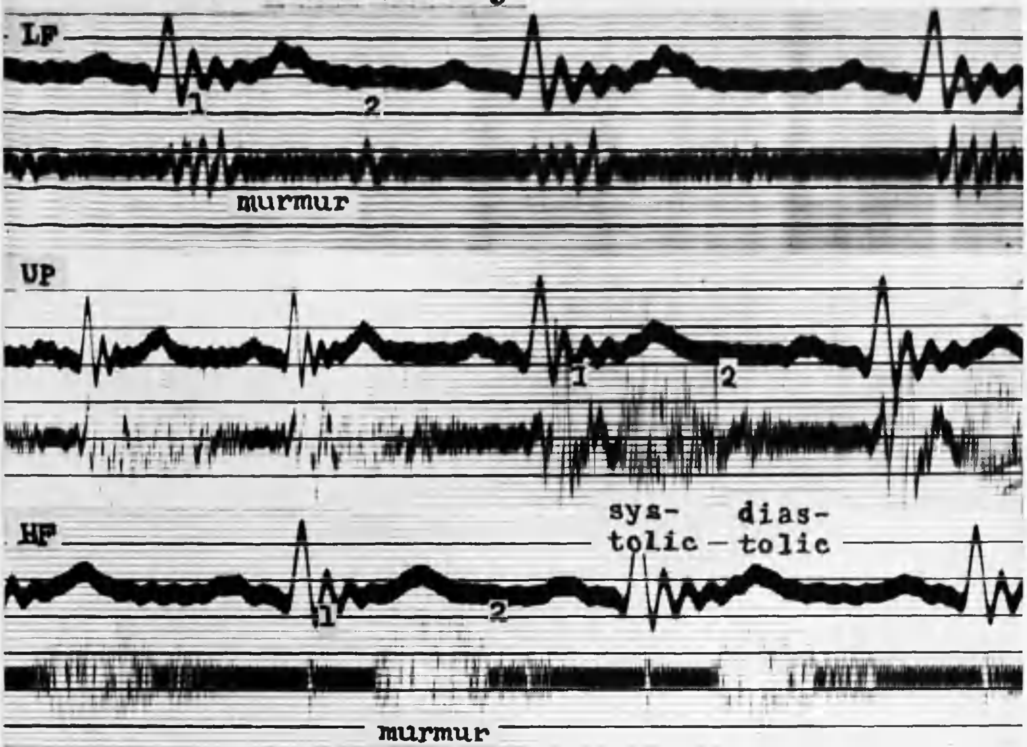
It is worthy of note that it would be difficult to distinguish the different timing of these systolic murmurs by auscultation.

Fig 29.

Aortic Valve Involvement.

Aortic Sclerosis.

Basal Tracings.



Basal Tracings.

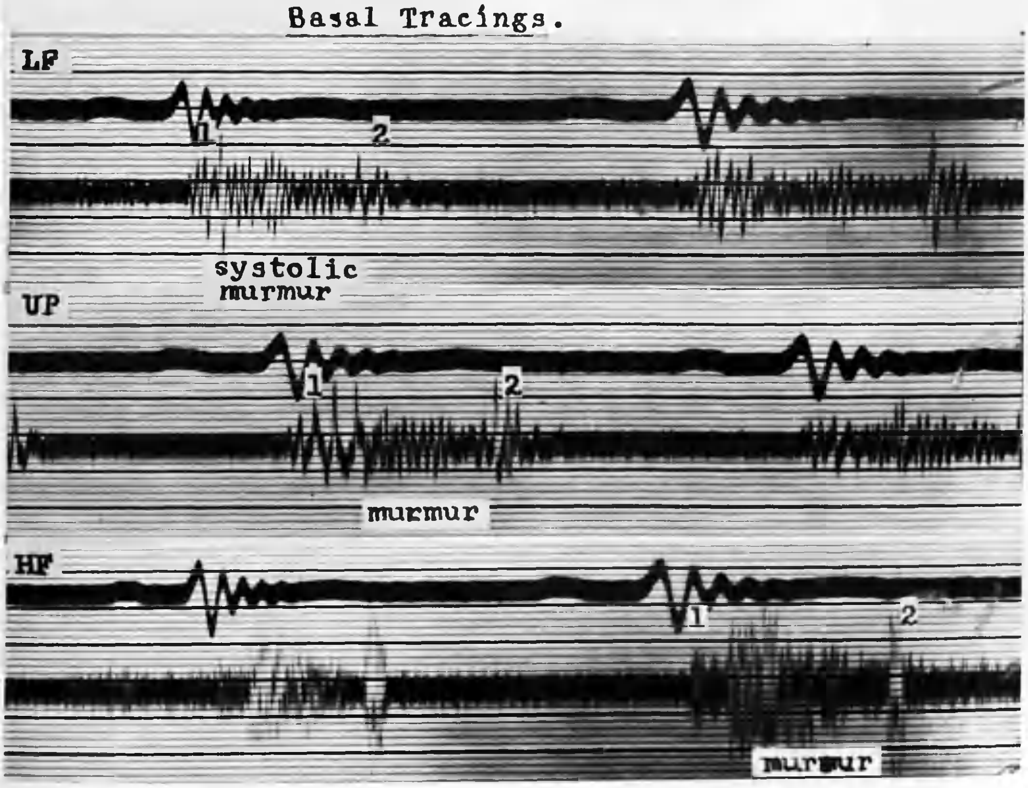


FIG. 30.

A.G., aet 71 yrs.

The apical tracings show a mid-systolic murmur of short duration thought to originate in ventricular hypertrophy. There are some vibrations of medium and high frequency in early diastole which form a "Foster's Murmur".

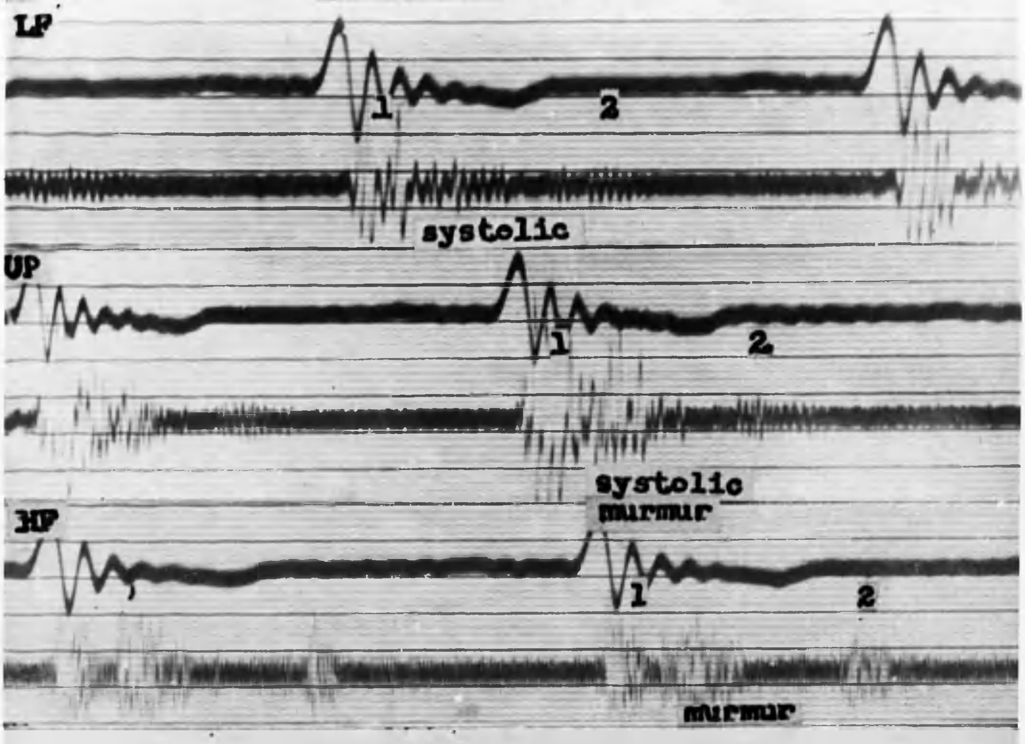
The basal tracings show continuous systolic and diastolic bruits. It was unusual to find such a prominent diastolic murmur with aortic sclerosis but no other aetiology could be ascertained.

Fig 30.

Aortic Stenosis and Incompetence.

Aortic Sclerosis.

Apical Tracings.



Basal Tracings.

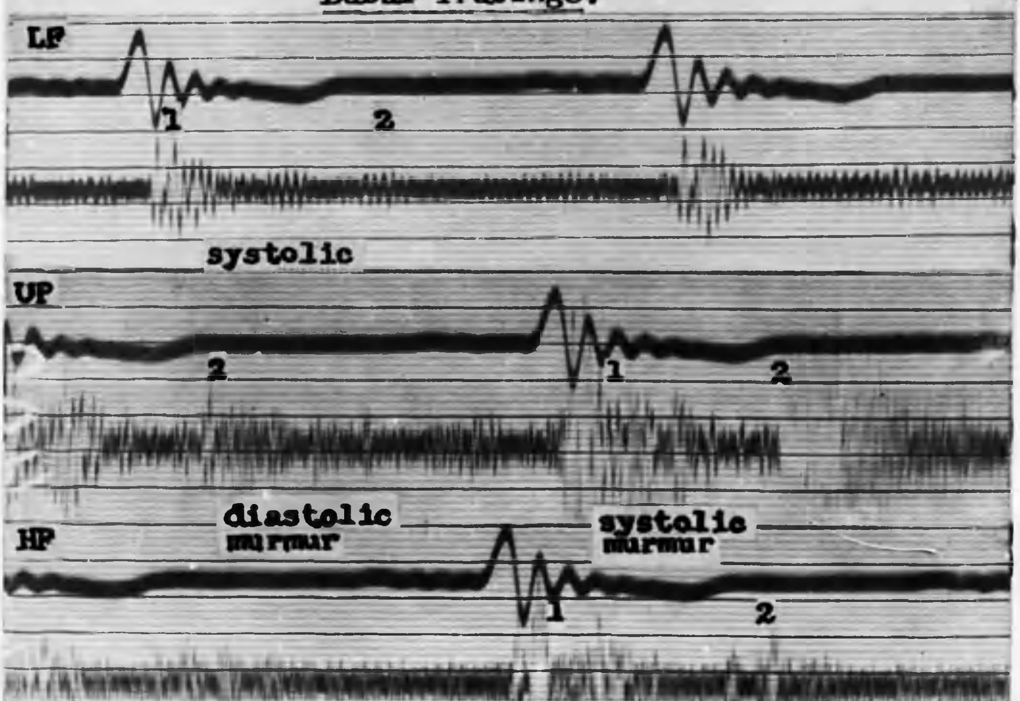


FIG. 31.

W.B., aet 48 yrs.

The clinical picture was that of typical aortic incompetence. The Wasserman reaction was positive. No history of rheumatism could be elicited. There is an apical mid-systolic murmur of a type referable to ventricular hypertrophy. The "3rd" sound is visible, and a definite mid-diastolic murmur of low frequency, low amplitude and long duration is clearly seen.

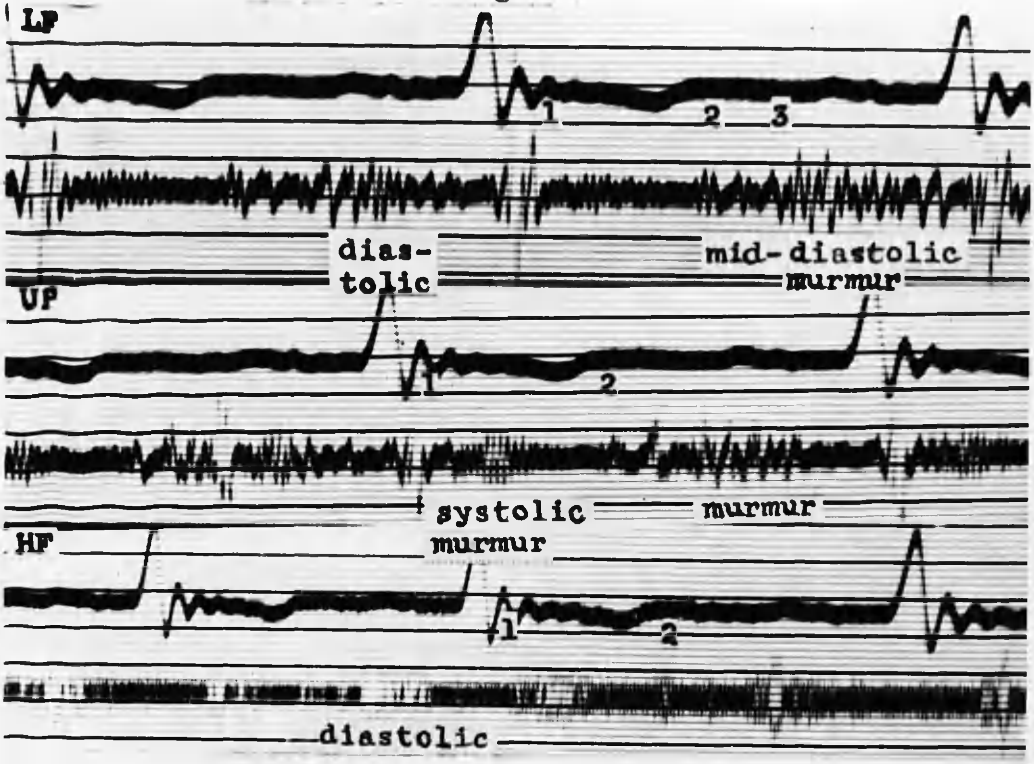
The basal murmurs are similar to those already described as being due to aortic stenosis or dilatation and to aortic incompetence.

Fig 31.

The Austin Flint Murmur.

Aortic Incompetence, Syphilitic.

Apical Tracings.



Basal Tracings.

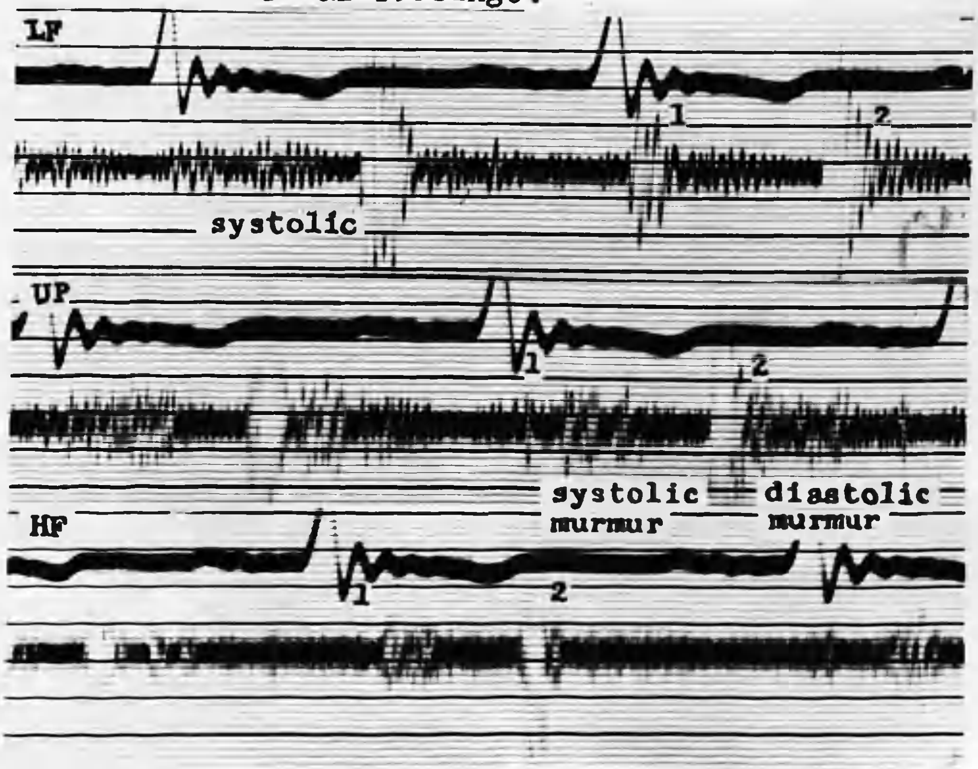


FIG. 32.

R.Y., aet 59 yrs.

A further example of a case similar to that illustrated in the previous figure. This is the case which came to post-mortem examination and in which no mitral valve pathology could be discerned.

The murmurs at the apex are a mid-systolic; and a long, low amplitude, low frequency mid-diastolic. The basal murmurs are those of aortic incompetence and dilatation.

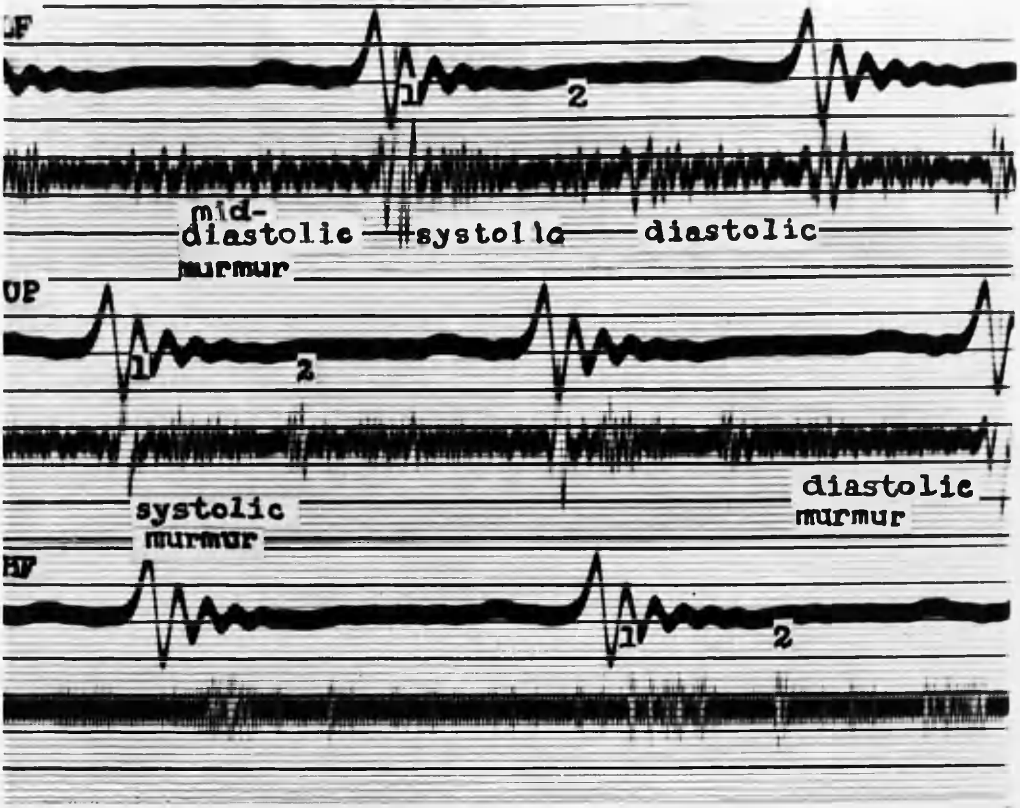
Comparison with the diastolic murmurs of rheumatic mitral stenosis show a remarkable similarity.

Fig 32.

The Austin Flint Murmur.

Aortic incompetence, Syphilitic.

Apical Tracings.



Basal Tracings.

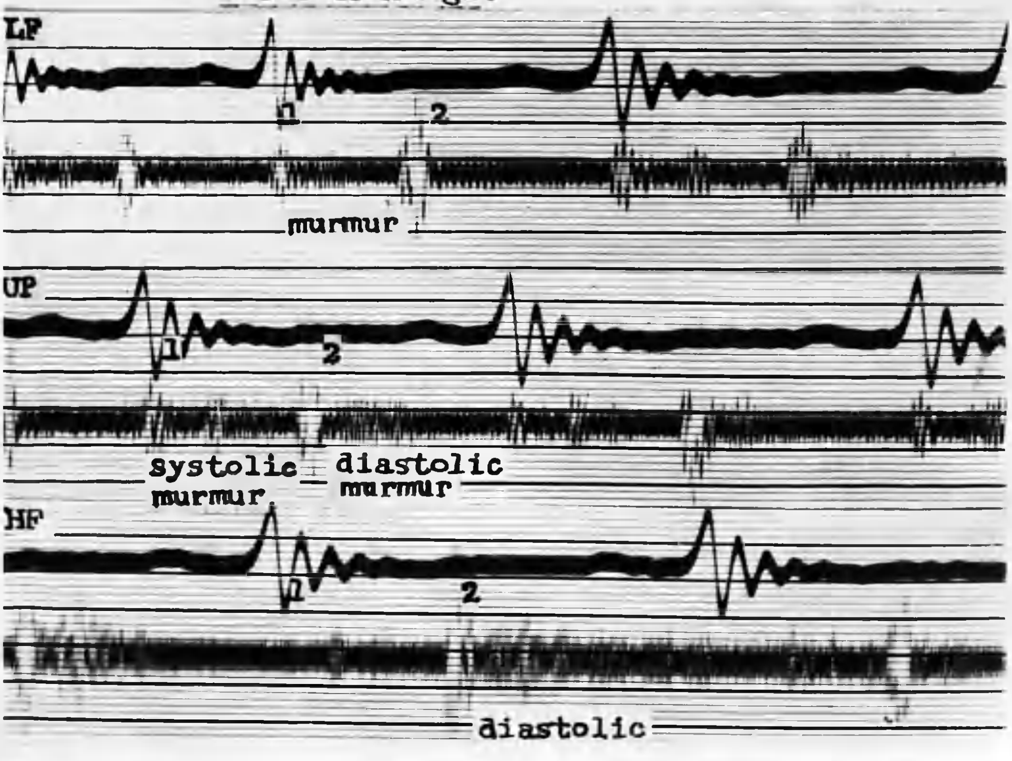


FIG. 33.

J.S., aet 63 yrs.

Another typical Austin Flint murmur with syphilitic mesa-aortitis and aortic incompetence. In this case the early systolic murmur at the apex demonstrates a relative mitral incompetence.

The Austin Flint Murmur.

Aortic Incompetence, Syphilitic.

Apical Tracings.

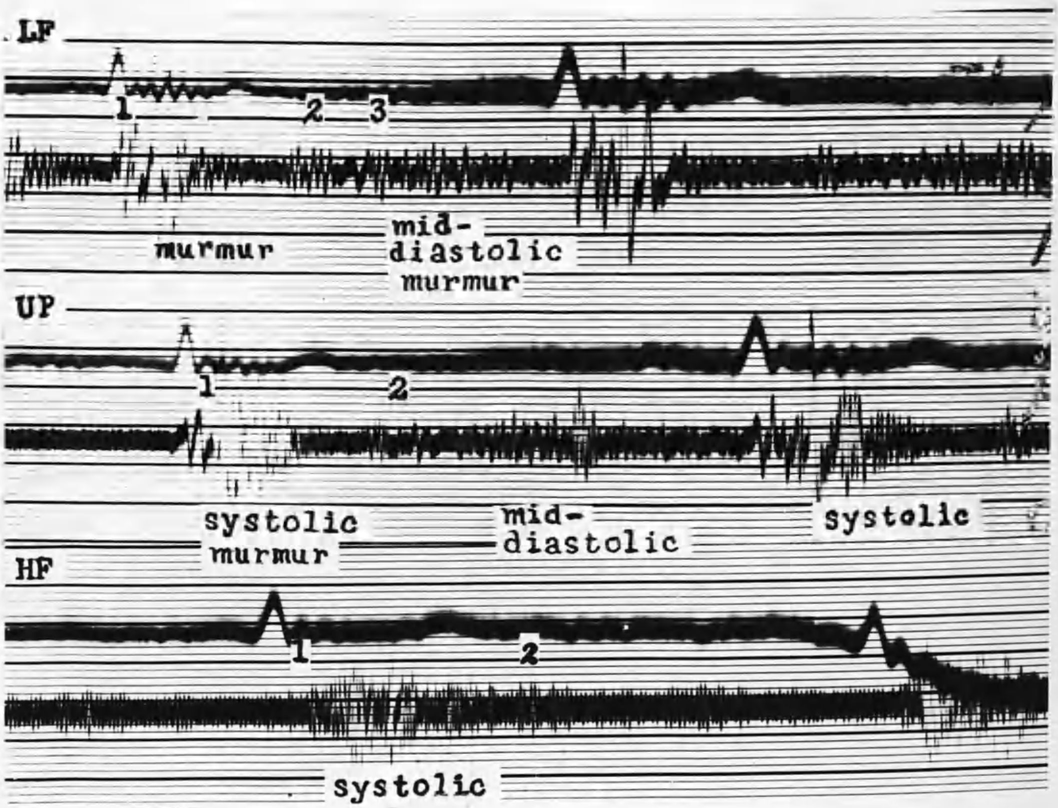
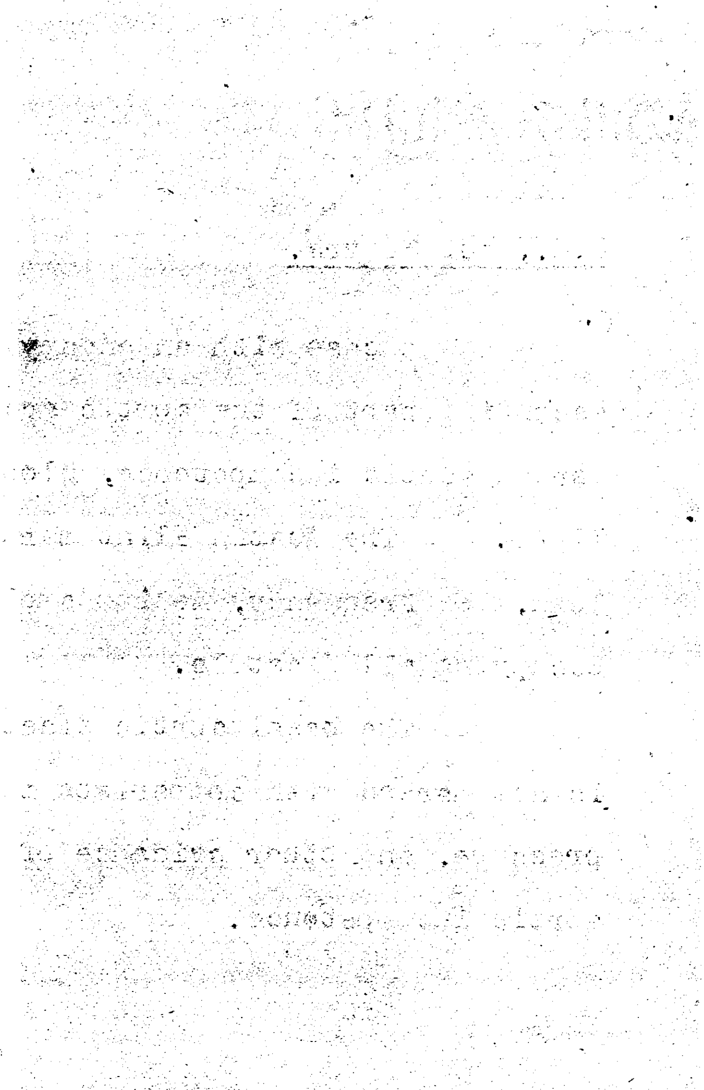


FIG. 34.



J.R., aet 30 yrs.

A case with an aneurysm of the ascending part of the aortic arch, and marked aortic incompetence, blood pressure 110/0. The Austin Flint murmur is a long, low frequency, medium amplitude murmur occupying all diastole.

The basal aortic diastolic murmur is not marked with comparison to the blood pressure, and other evidence of considerable aortic incompetence.

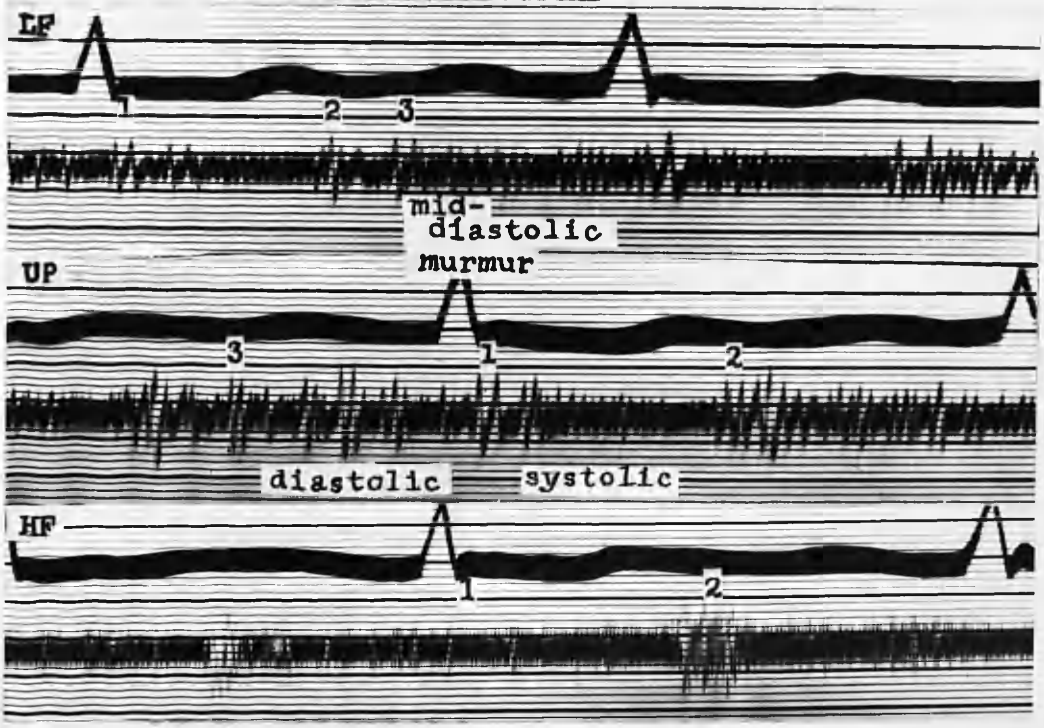
Fig 34.

The Austin Flint Murmur.

Aortic Incompetence, Syphilitic.

Aortic Aneurysm.

Apical Tracings.



Basal Tracings.

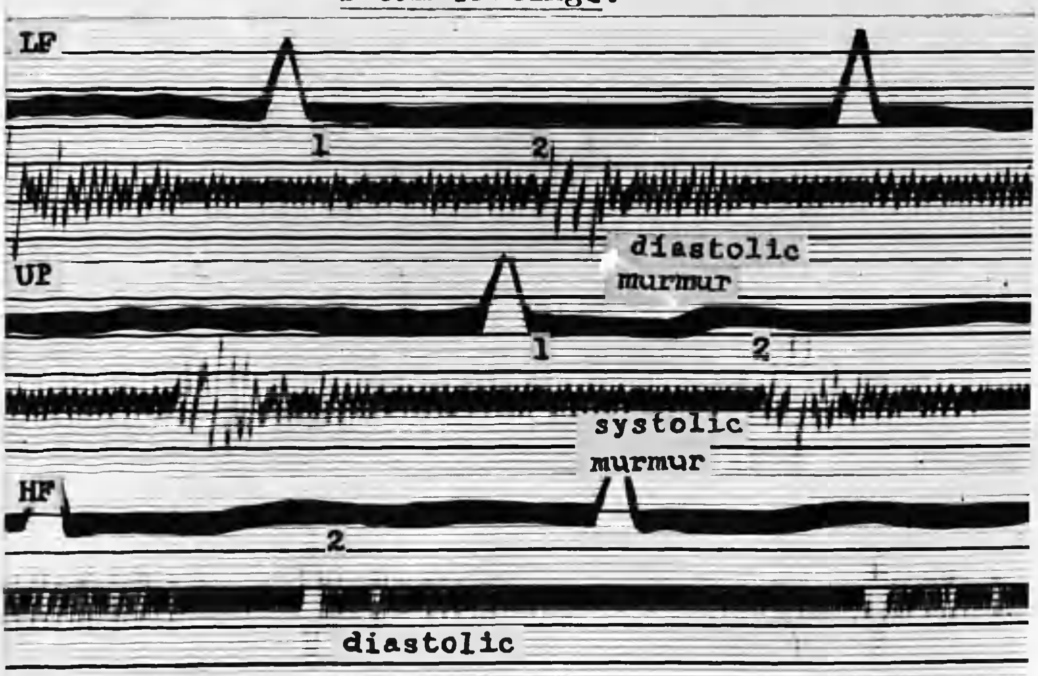


FIG. 35.

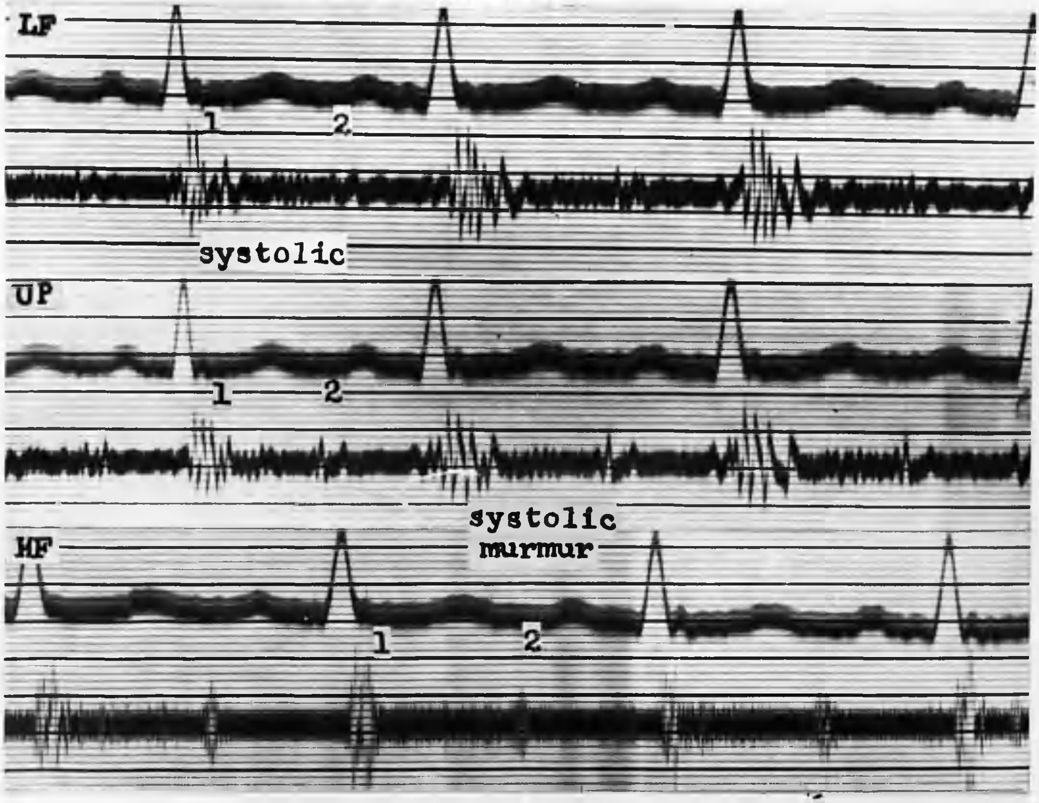
C.O'S., aet 51 yrs.

These tracings are demonstrated in conjunction with those in the following illustration. The case is that of an aneurysm of syphilitic origin situated on the aortic arch. The systolic and diastolic bruit from the aneurysm is conducted to the base of the heart.

Fig 35.

Aortic Aneurysm.

Apical Tracings.



Basal Tracings.

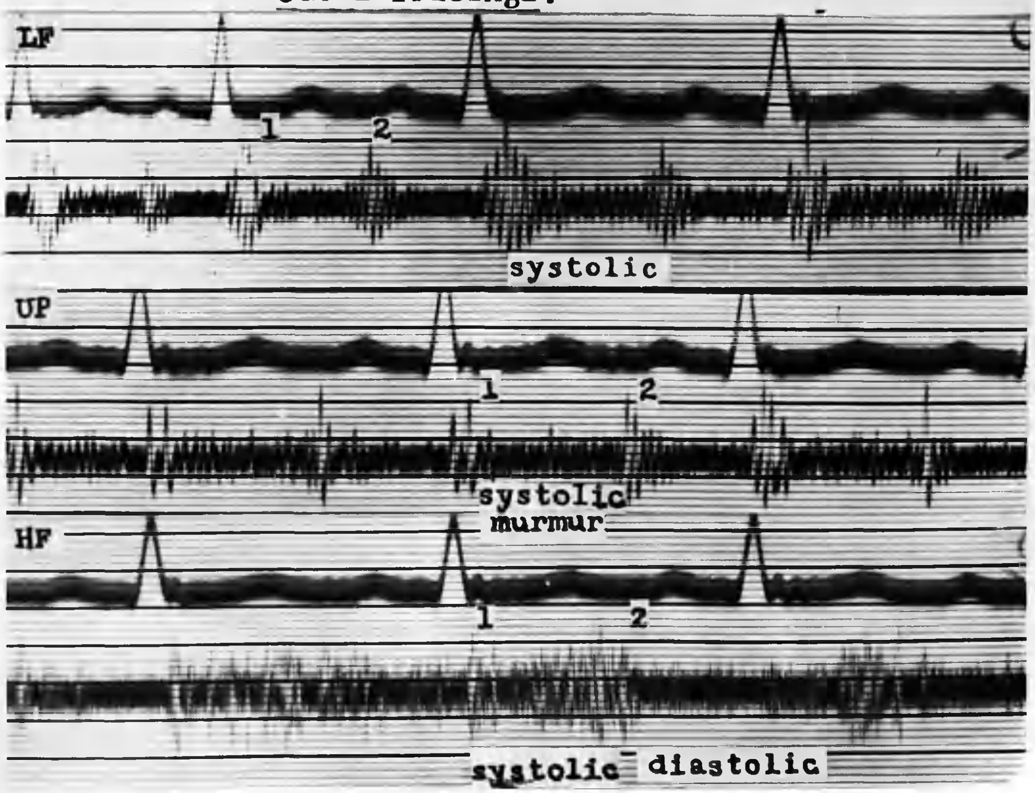


FIG. 36.

C.O'S., aet 51 yrs.

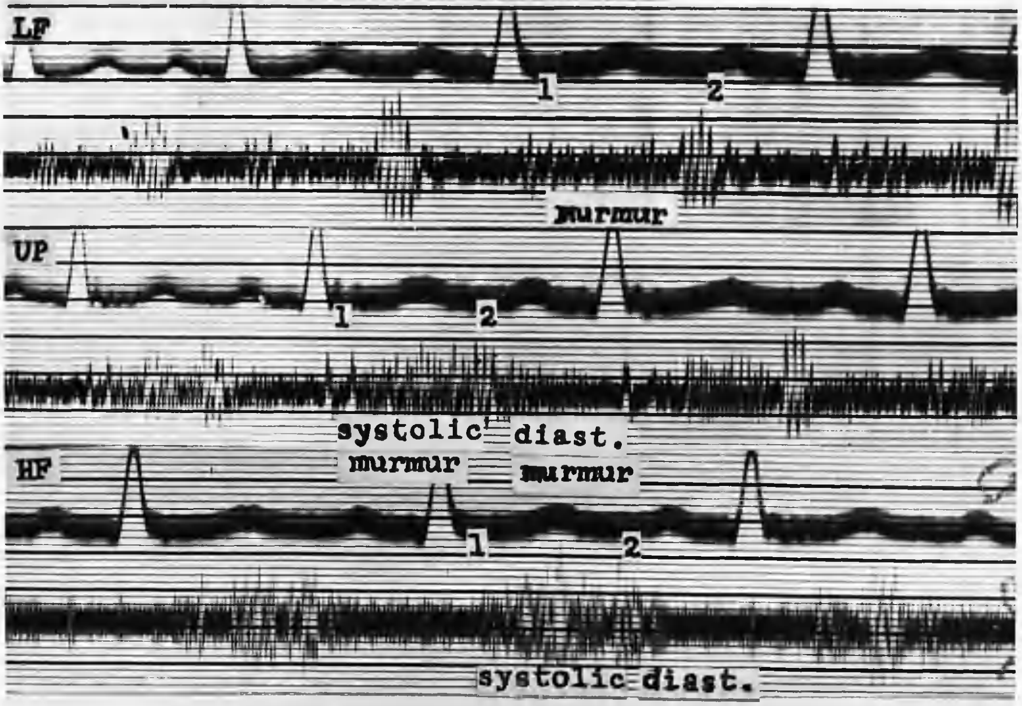
Records from the aneurysm described on the previous page. The bruit is continuous throughout systole and diastole, with the emphasis on the systolic phase, and particularly in late systole. The frequency is in the higher ranges.

J.R., aet 30 yrs.

Tracings from the aneurysm of the case shown in Fig. 34. The bruit is again continuous throughout systole and diastole but the emphasis is on the early diastolic phase. The frequency is again mainly in the higher ranges.

Aortic Aneurysm.

Records from the Aneurysm.



Records from the Aneurysm.

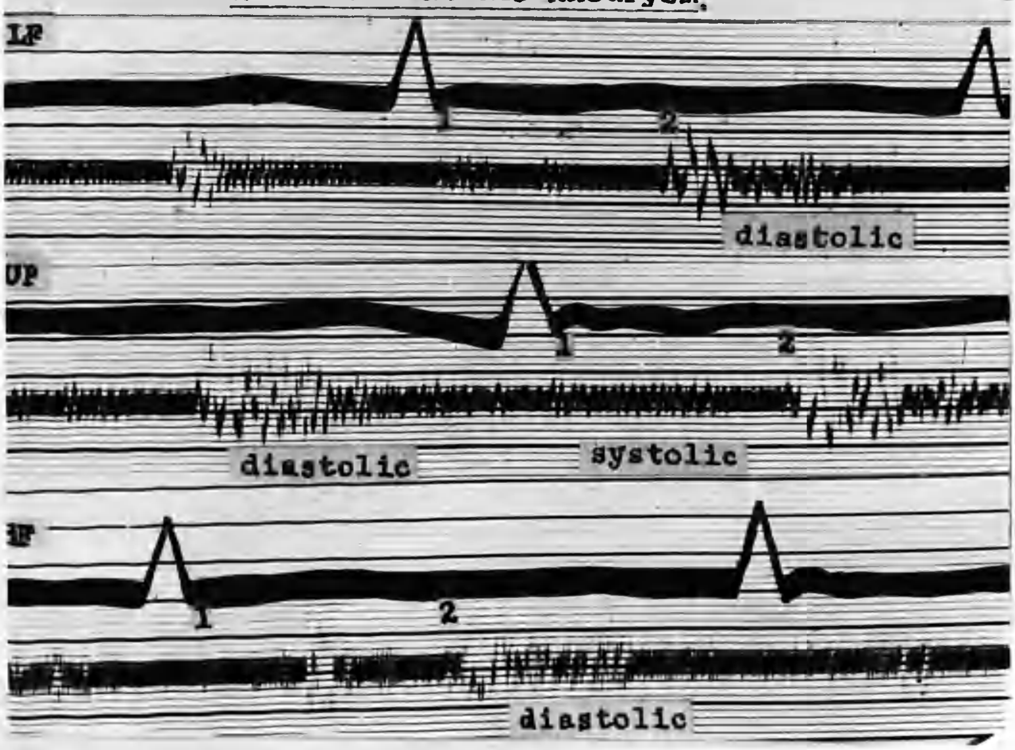


FIG. 37.

A.D., aet 25 yrs.

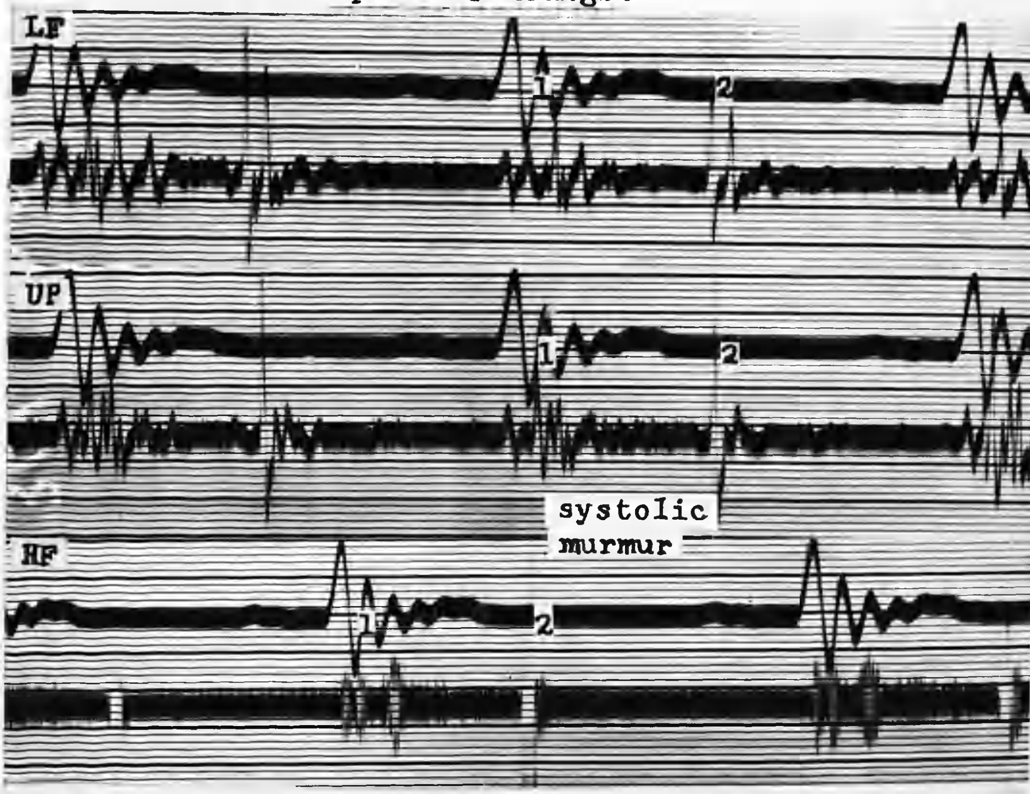
A member of an R.A.F. air crew who was crushed in an aircraft accident, and whose symptoms and signs dated from the accident. The apical systolic murmur is considered to be conducted from the aortic area. The basal systolic and diastolic murmurs are typical of aortic stenosis and incompetence. The phonocardiogram would suggest that an initial rheumatic infection was possible.

Fig 37.

Aortic Incompetence.

Traumatic.

Apical Tracings.



Basal Tracings.

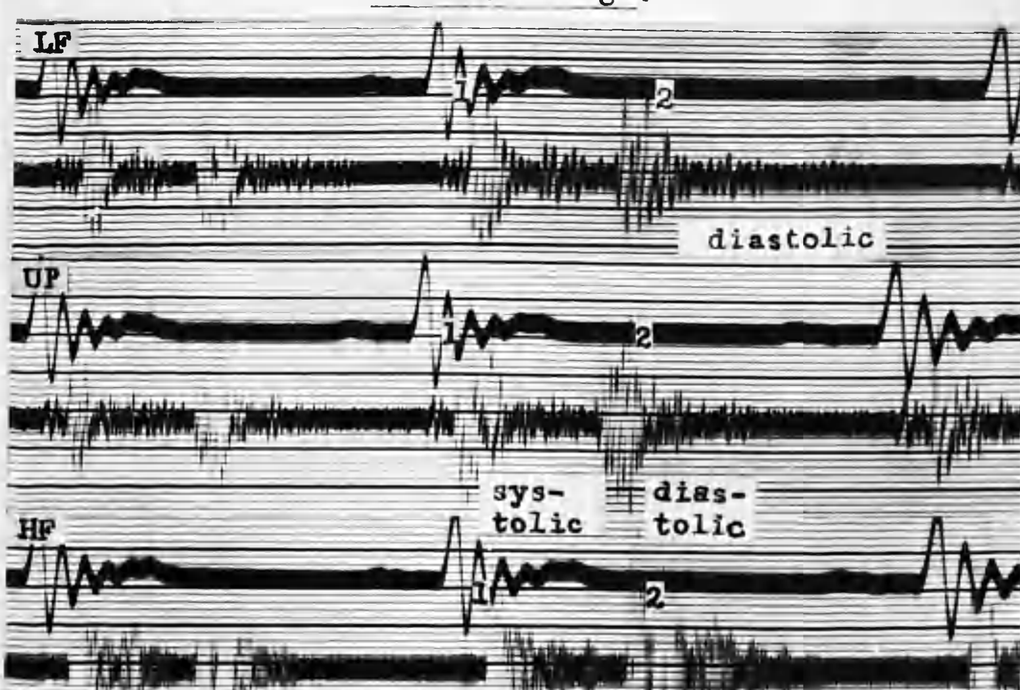
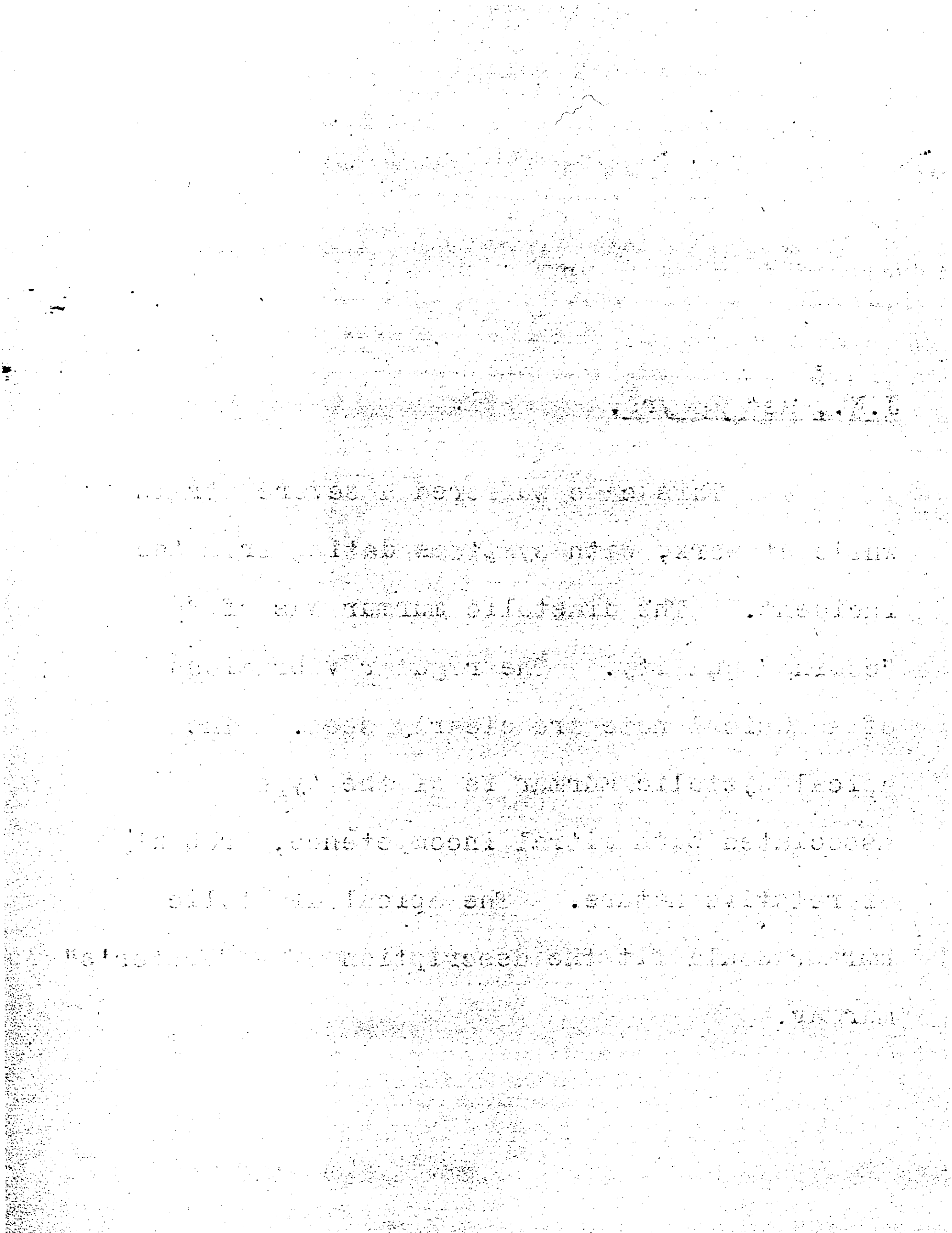


FIG. 38.



J.N., aet 34 yrs.

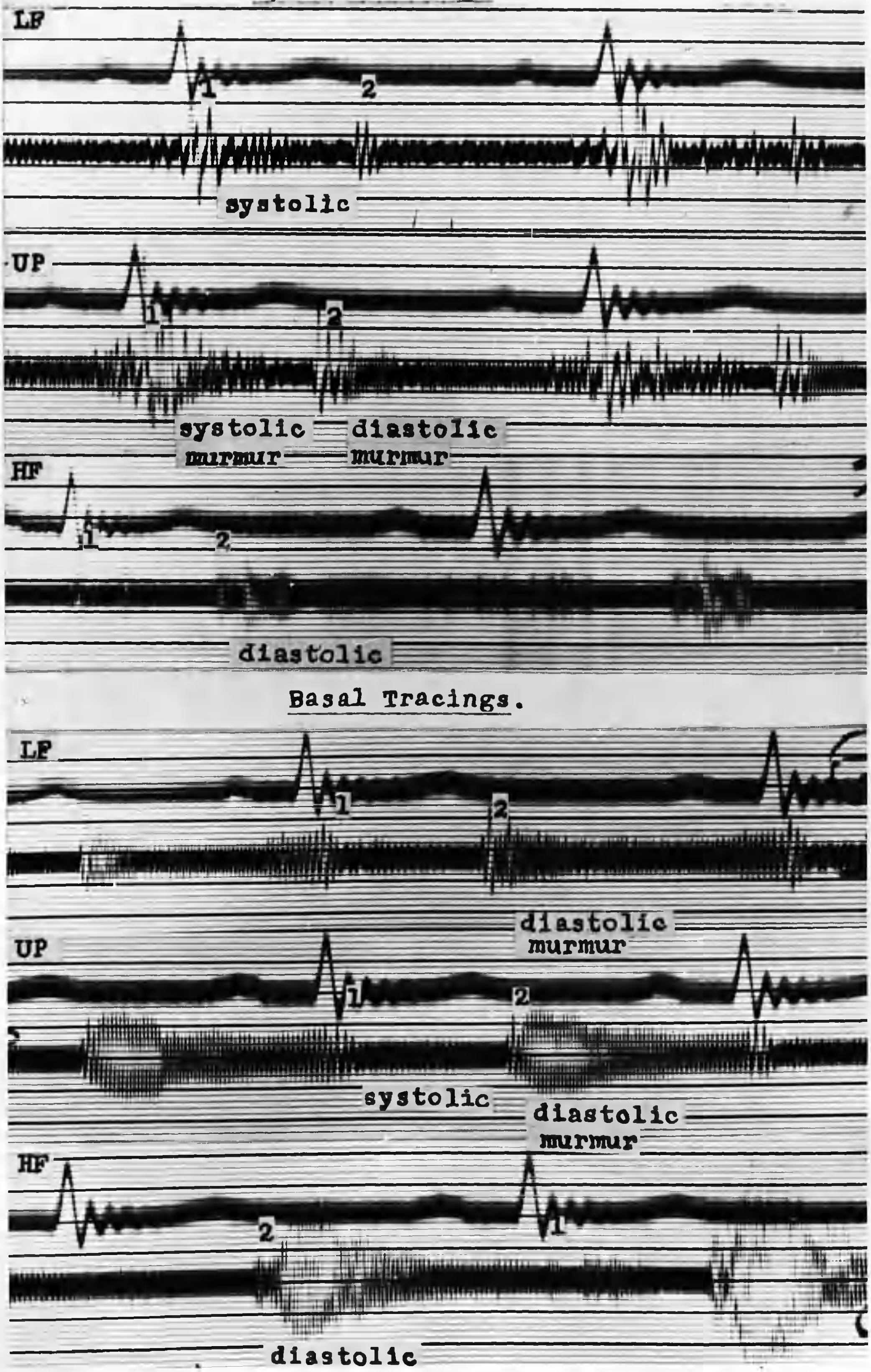
This case suffered a severe strain while at work, with symptoms dating from the incident. The diastolic murmur was of "cooing" quality. The regular vibrations of a musical note are clearly seen. The apical systolic murmur is of the type associated with mitral incompetence, probably of relative nature. The apical diastolic murmur would fit the description of a "Foster's" murmur.

Fig 38

Aortic Incompetence.

Traumatic.

Apical Tracings.



ILLUSTRATIONS

INNOCENT SYSTOLIC MURMURS

These two cases illustrate the apical mid-systolic murmur.

Mrs. A.C., aet 57 yrs.

The low amplitude, medium and high frequency, short mid-systolic murmur was seen.

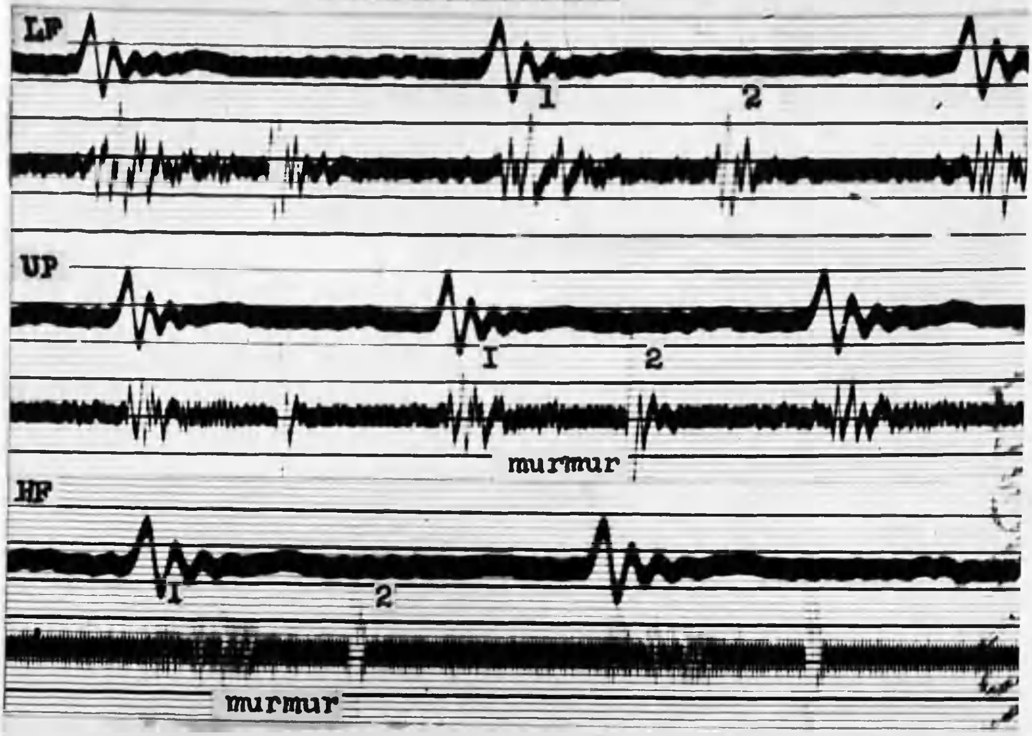
H.B., aet 14 yrs.

The systolic murmur was of typical innocent type. The 3rd sound was prominent.

The Innocent Murmur.

The Apical Mid-systolic Murmur.

Apical Tracings.



Apical Tracings.

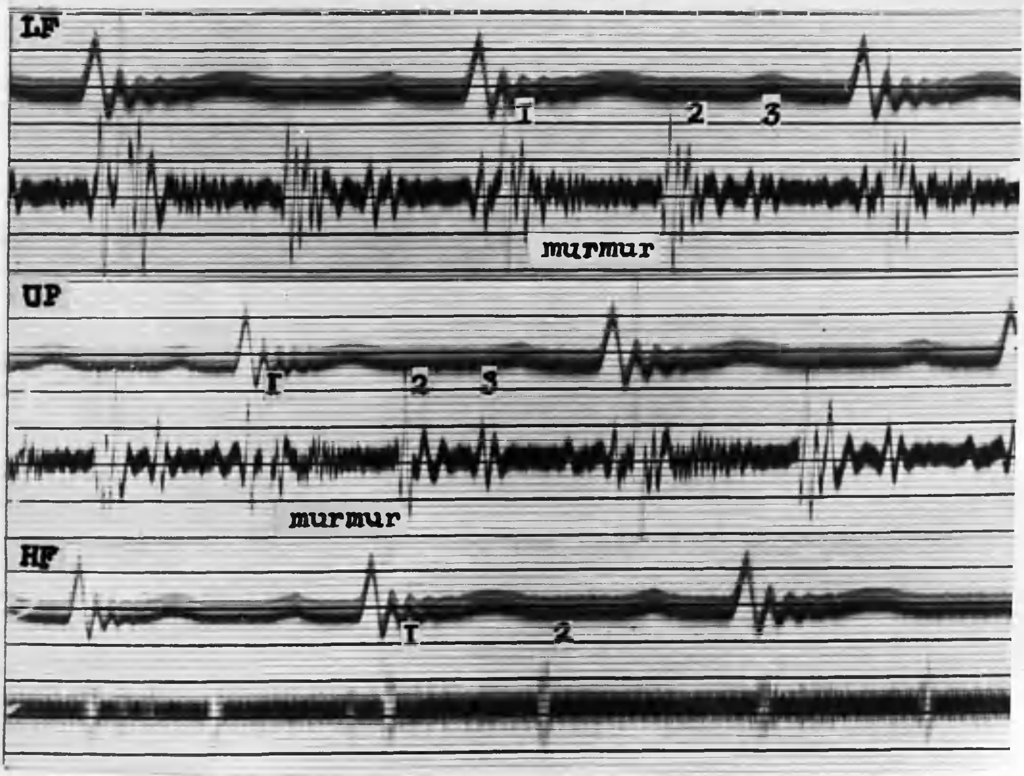
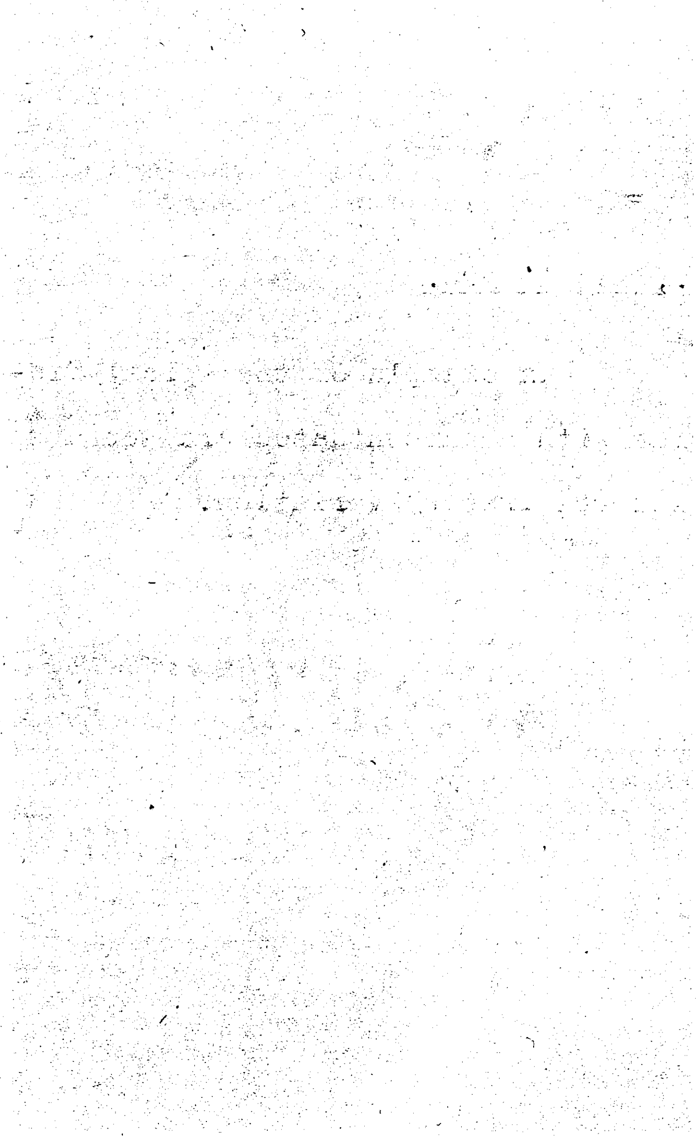


FIG. 40.



T.H., aet 15 yrs.

An example of the apical mid-systolic murmur with an accentuated 3rd sound showing marked respiratory variation.

The Innocent Murmur.

The Apical Mid-systolic Murmur.

Apical Tracings.

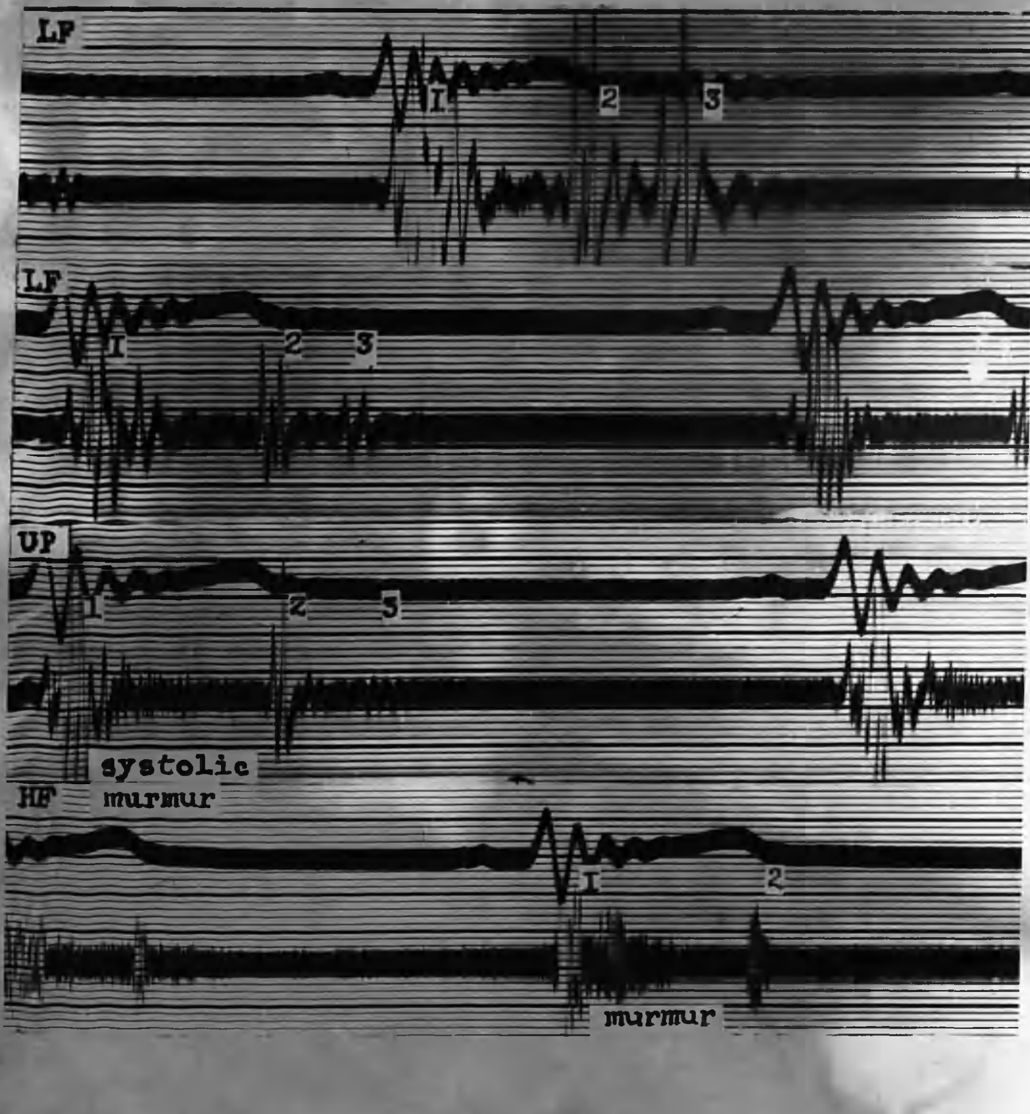
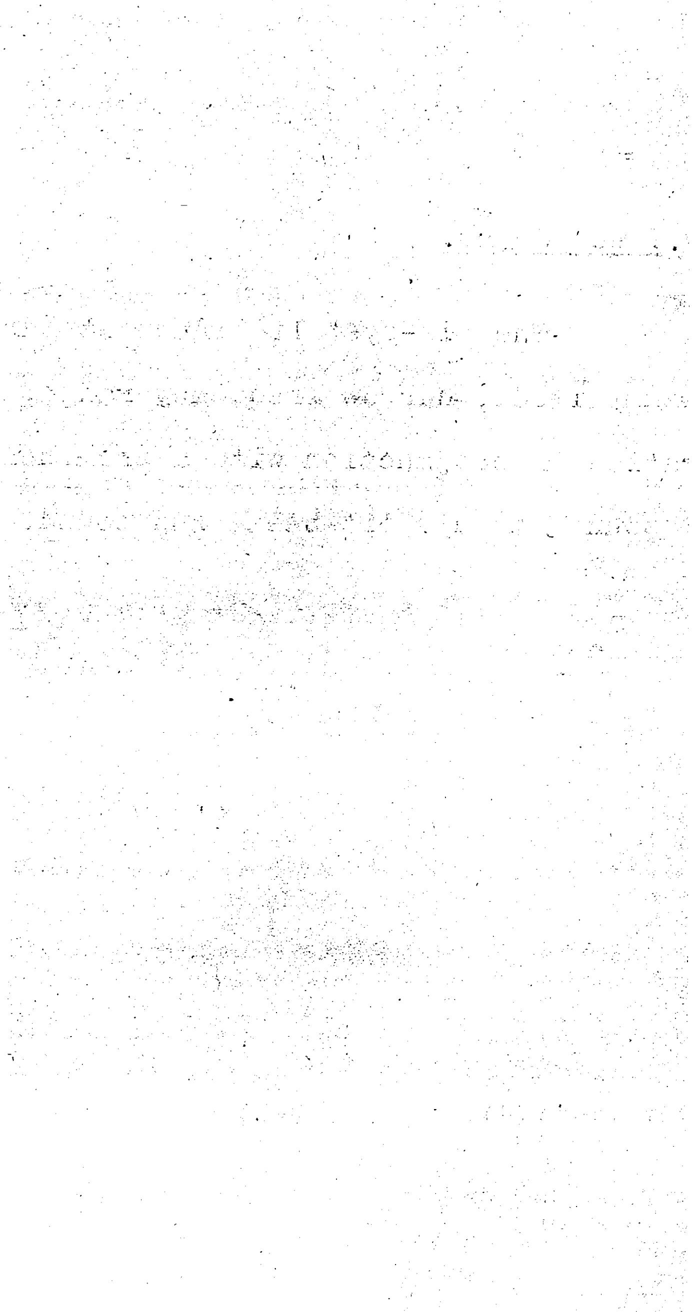


FIG. 41.



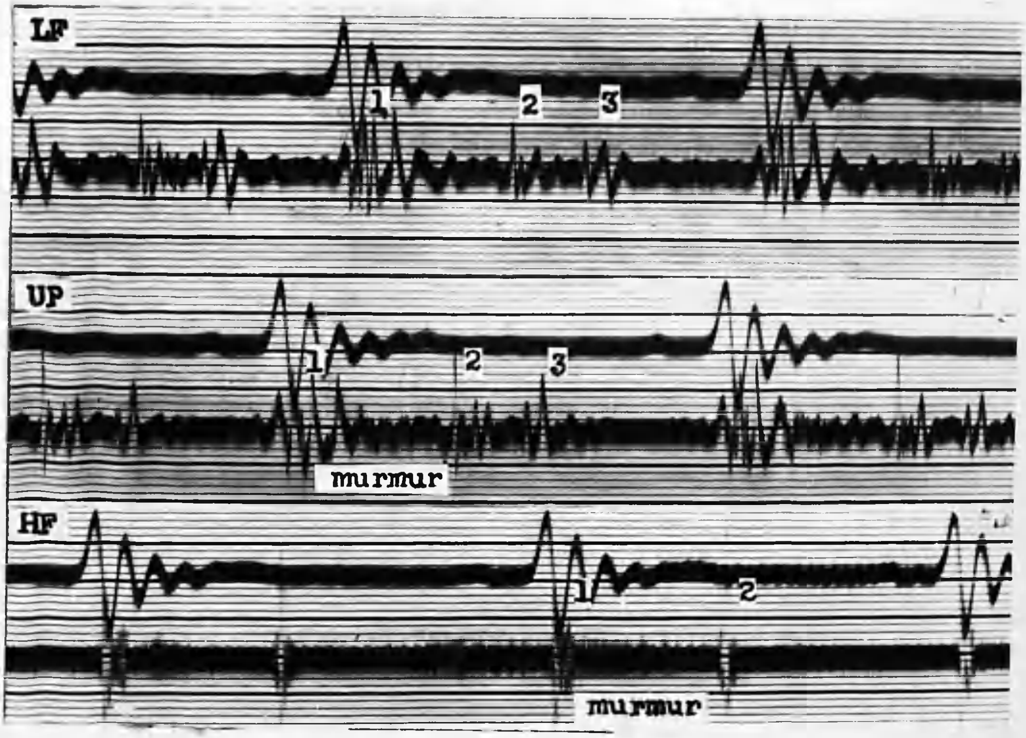
R.T., aet 8 yrs.

The mid-systolic innocent murmur of low amplitude, narrow frequency range, and short duration in conjunction with a prominent apical 3rd sound and a split basal 2nd sound.

Fig 41.

The Innocent Mid-systolic Murmur.

Apical Tracings.



Basal Tracings.

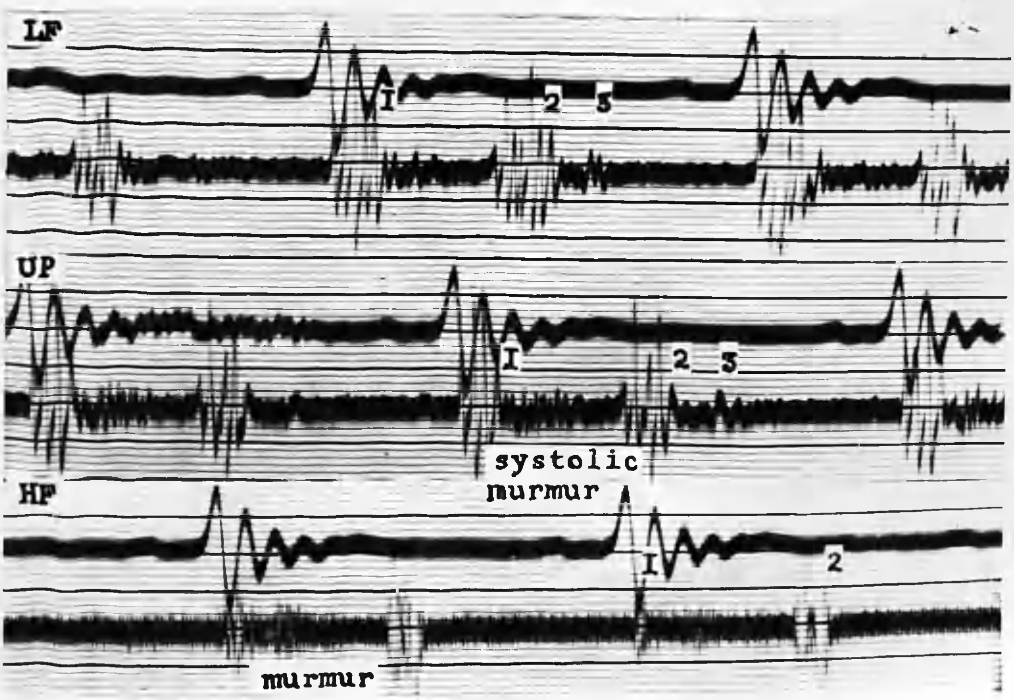


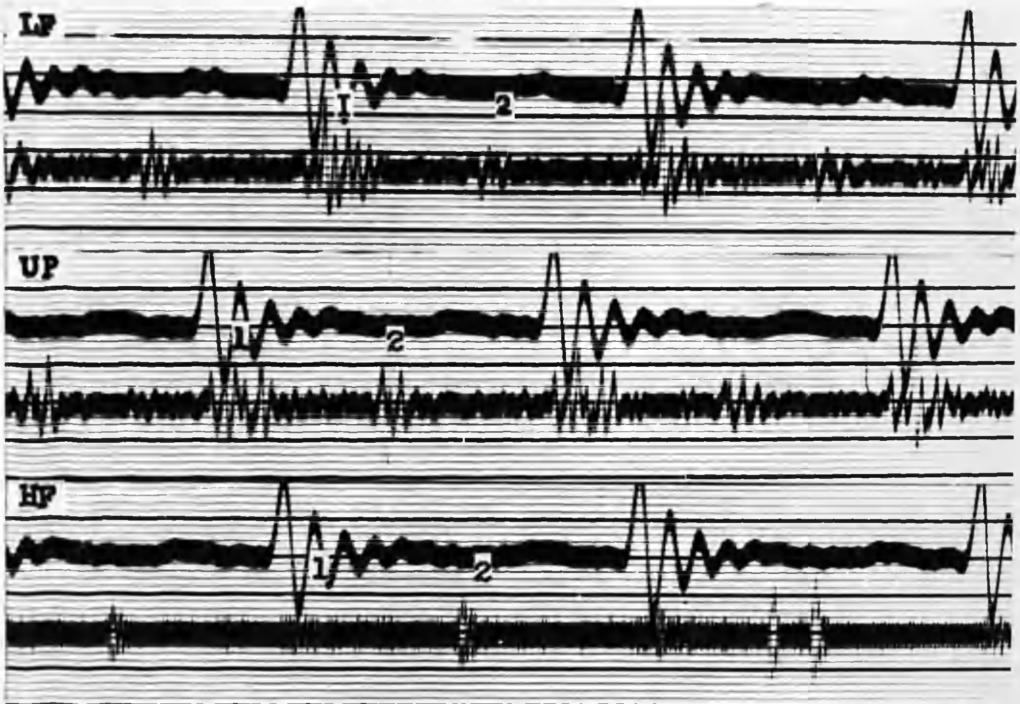
FIG. 42.

M.D., aet 27 yrs.

An example of the basal mid-systolic murmur of narrow frequency range, low amplitude, and short duration. The 2nd basal sound was narrowly split.

The Basal Mid-systolic Murmur.

Apical Tracings.



Basal Tracings.

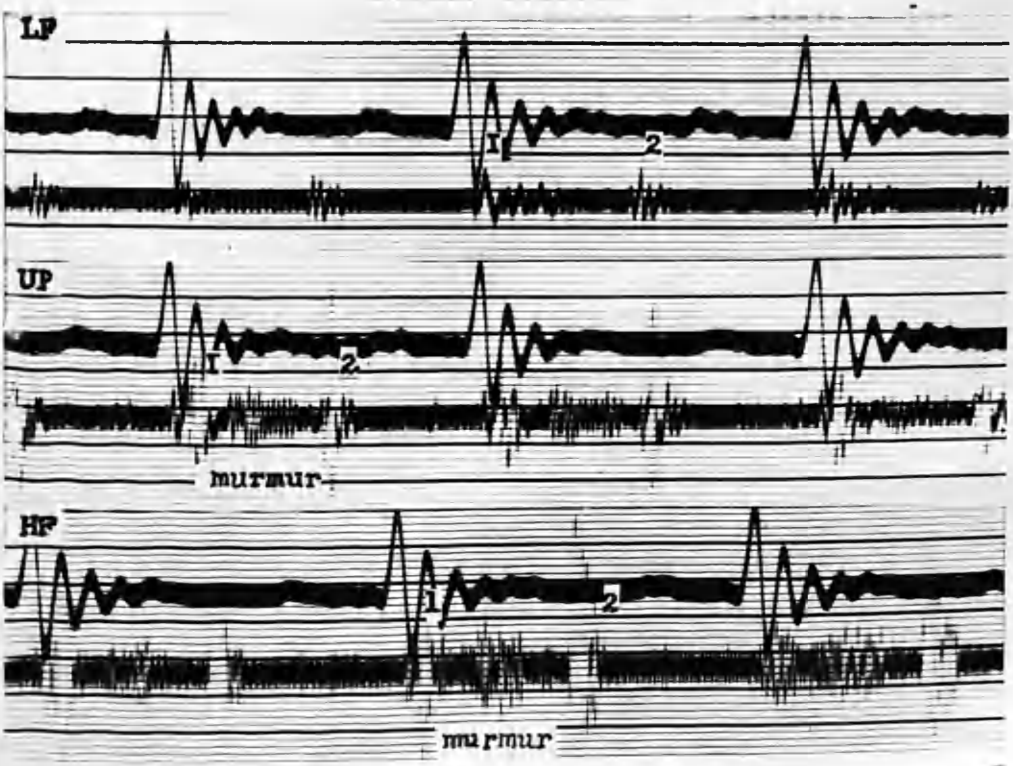


FIG. 43.

G.G., aet 22 yrs.

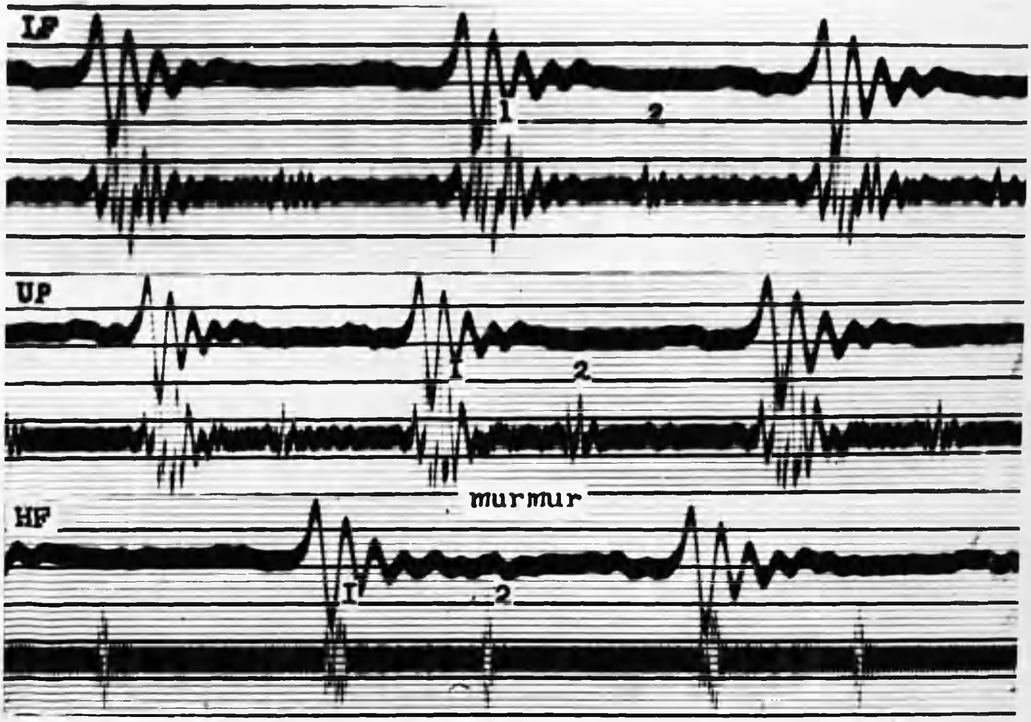
A further example of the basal mid-systolic murmur of somewhat wider frequency range than was usually found.

Fig 43.

The Innocent Murmur.

The Basal Mid-systolic Murmur.

Apical Tracings.



Basal Tracings.

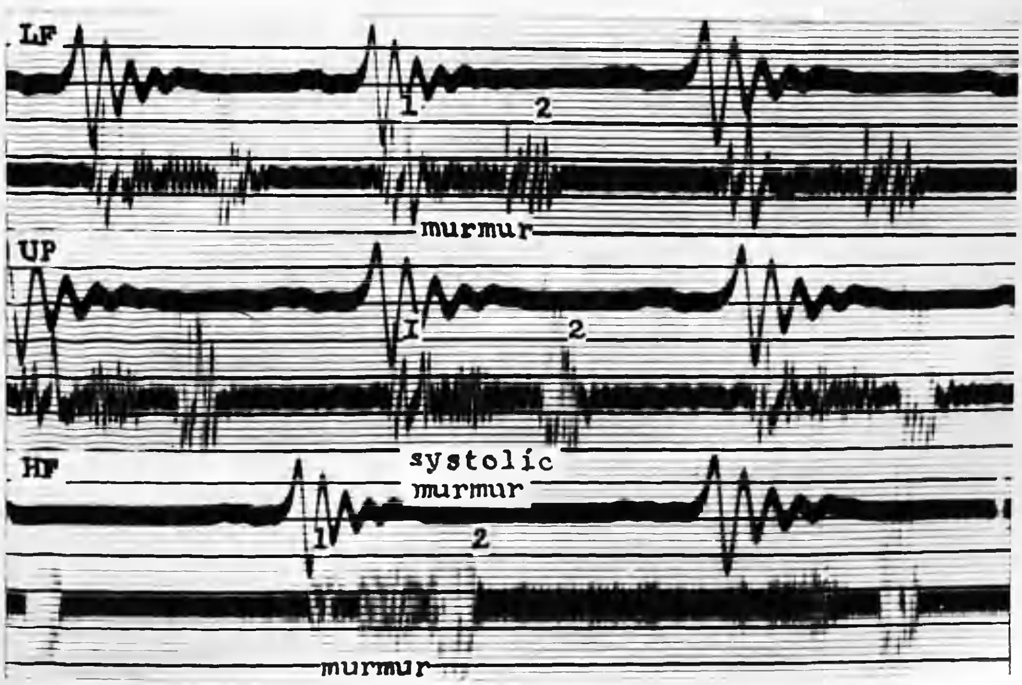


FIG. 44.

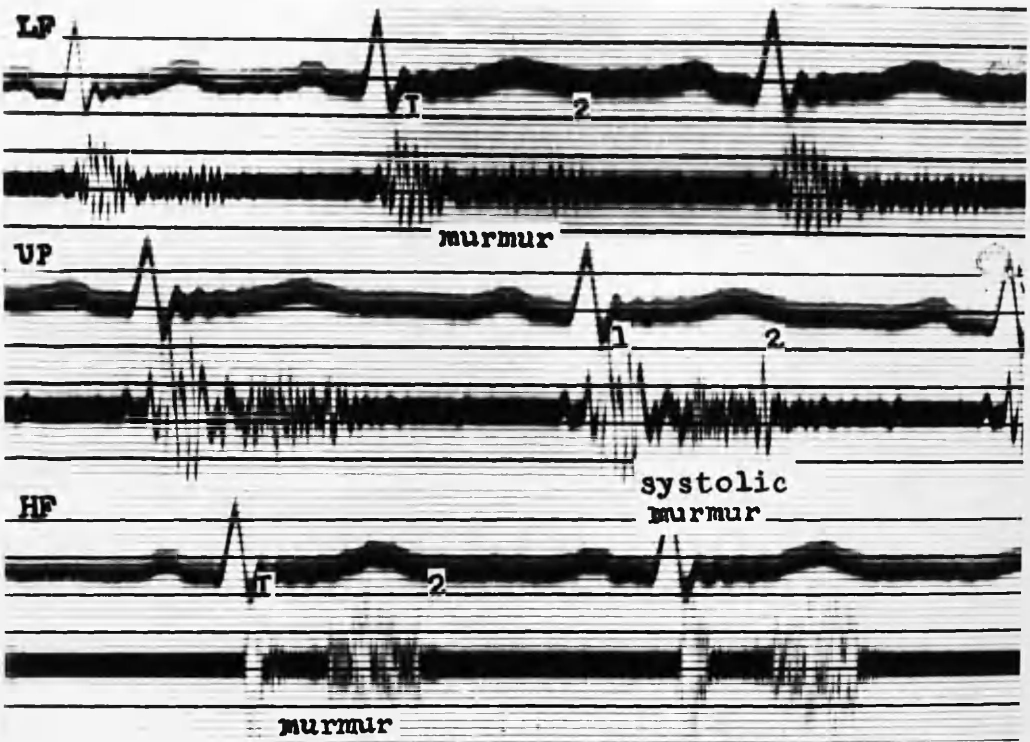
T.T., aet 47 yrs.

The murmur was noticably late systolic in it's onset, and was more prominent at the apex. It is well elicited by the high frequency band.

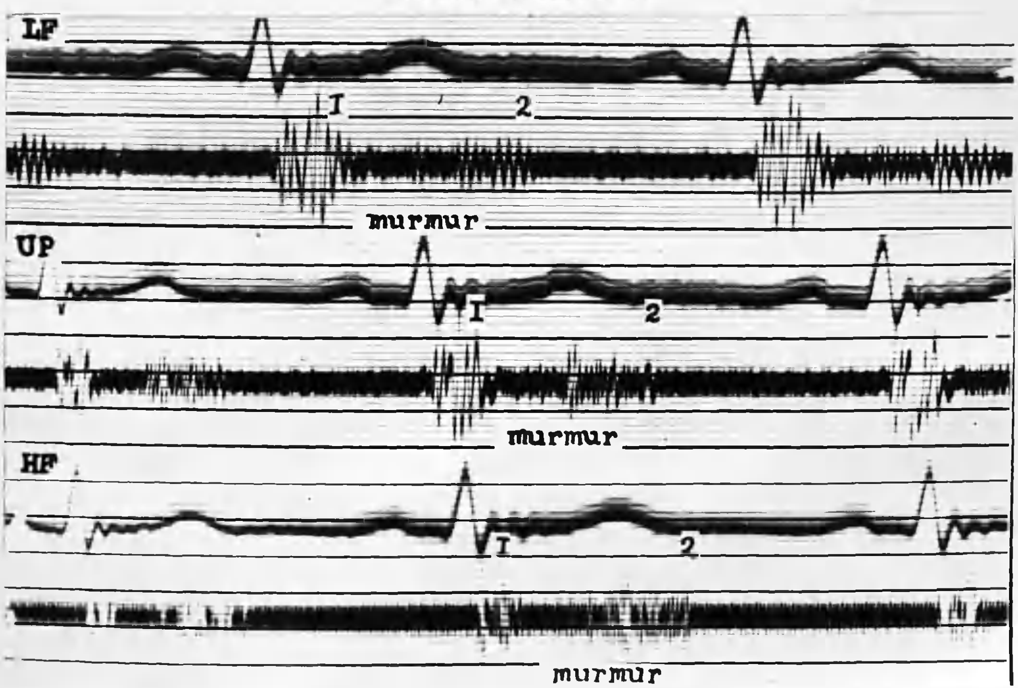
Fig 44.

The Innocent Late Systolic Murmur.

Apical Tracings.



Basal Tracings.



ILLUSTRATIONS

EQUIVOCAL PHONOCARDIOGRAMS

FIG. 45.

O.H., aet 8 yrs.

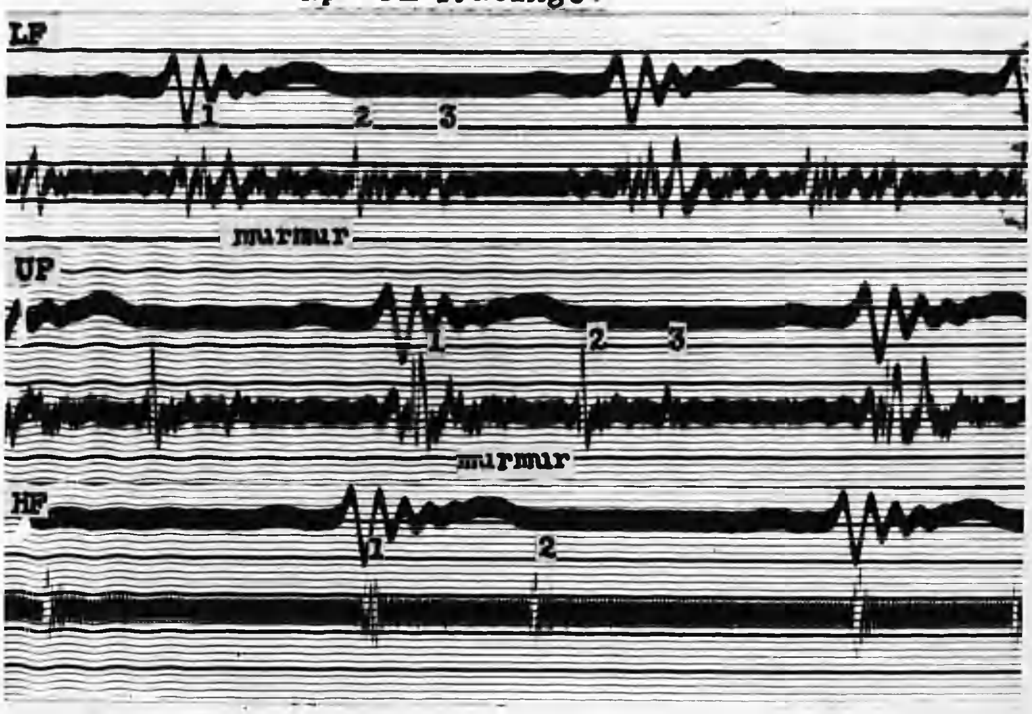
This case was considered to be in the probable innocent group. The systolic murmur was of low and medium frequency, low amplitude, short duration and mid-systolic in timing. The 3rd sound was followed by a few doubtful low frequency vibrations. The 2nd basal sound was split.

Fig 45.

Equivocal Phonocardiogram.

Probably Innocent.

Apical Tracings.



Basal Tracings.

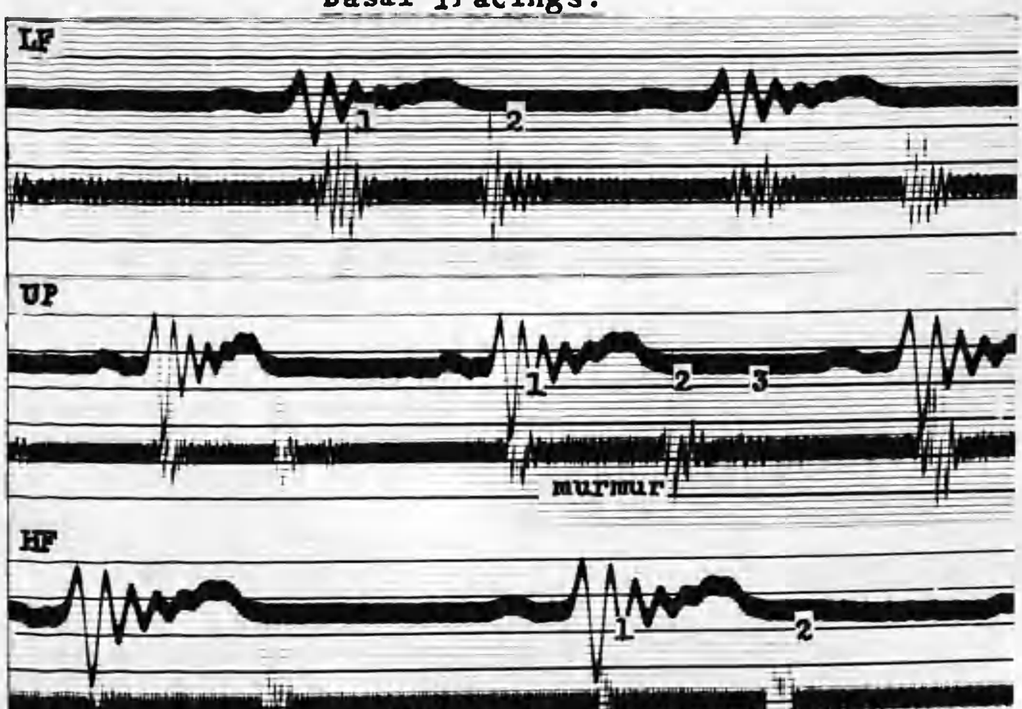
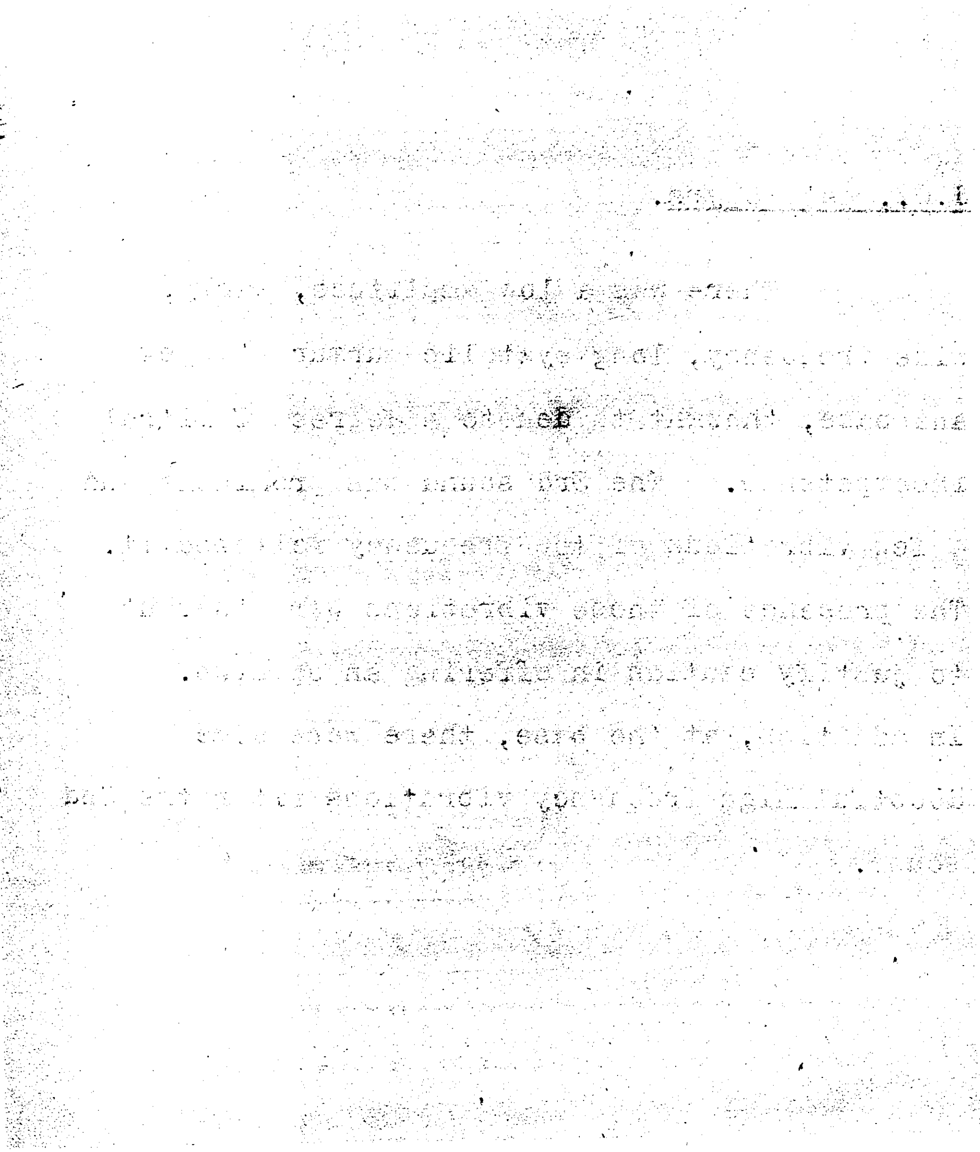


FIG. 46.



J.O., aet 15 yrs.

There was a low amplitude, early, wide frequency, long systolic murmur at apex and base, thought to denote a degree of mitral incompetence. The 3rd sound was prominent and a few vibrations of low frequency followed it. The presence of those vibrations were thought to justify caution in offering an opinion. In addition, at the base, there were some doubtful high frequency vibrations after the 2nd sound.

Fig 46.

Equivocal Phonocardiogram.

? Mitral Incompetence.

? Aortic Diastolic Murmur.

Apical Tracings.

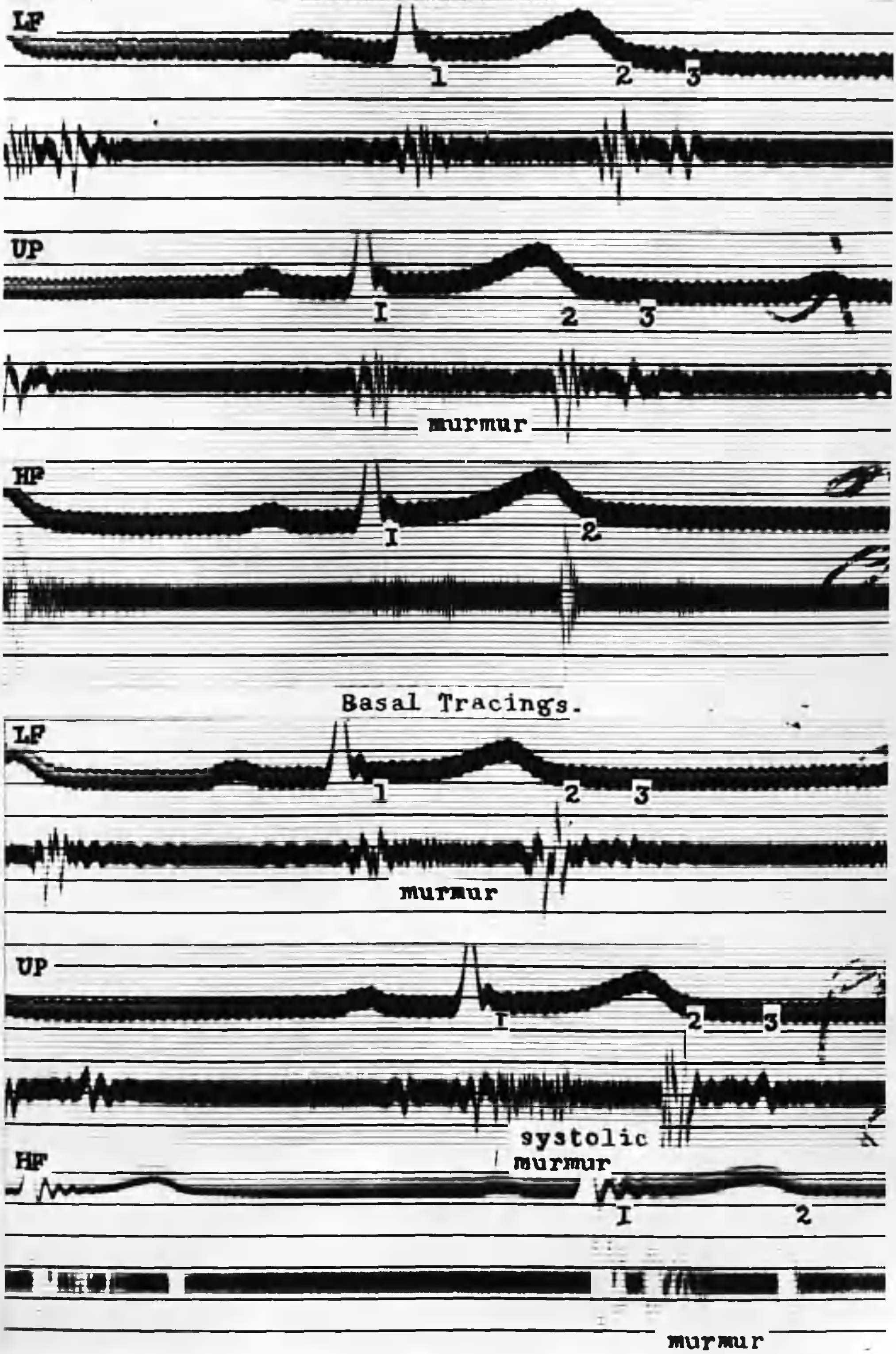


FIG. 47.

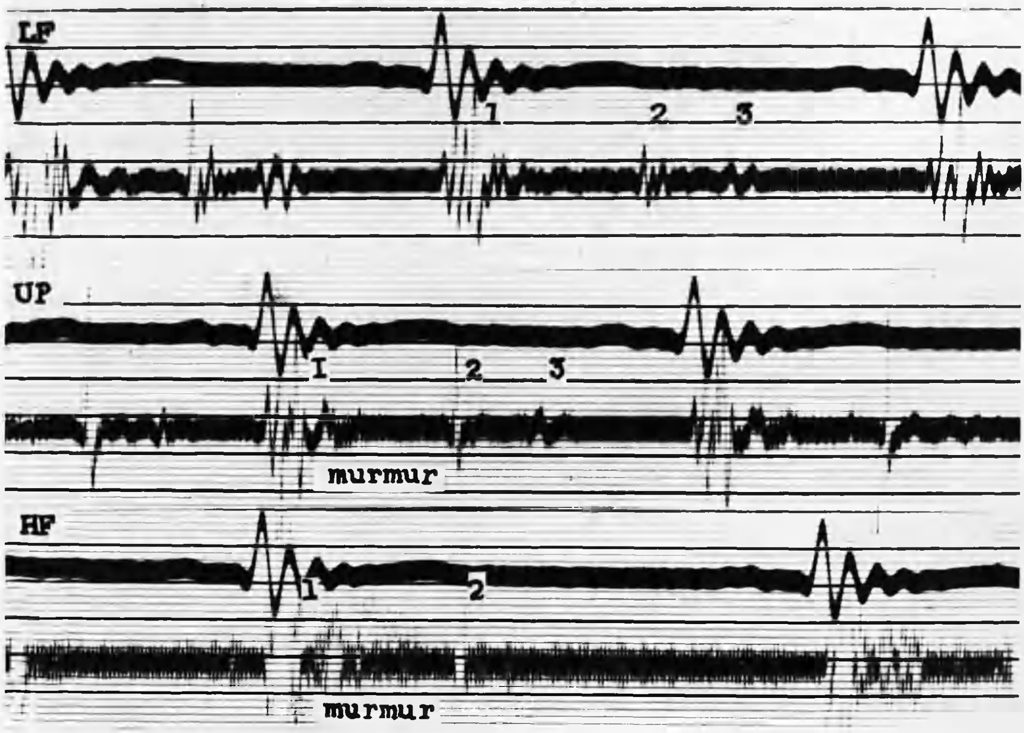
J.McC., aet 14 yrs.

An example of a probable innocent murmur in association with a prominent apical 3rd sound and a split basal 2nd sound. The mid-systolic nature of the murmur was clear and it was more prominent at the base.

Equivocal Phonocardiogram.

Probably Innocent.

Apical Tracings.



Basal Tracings.

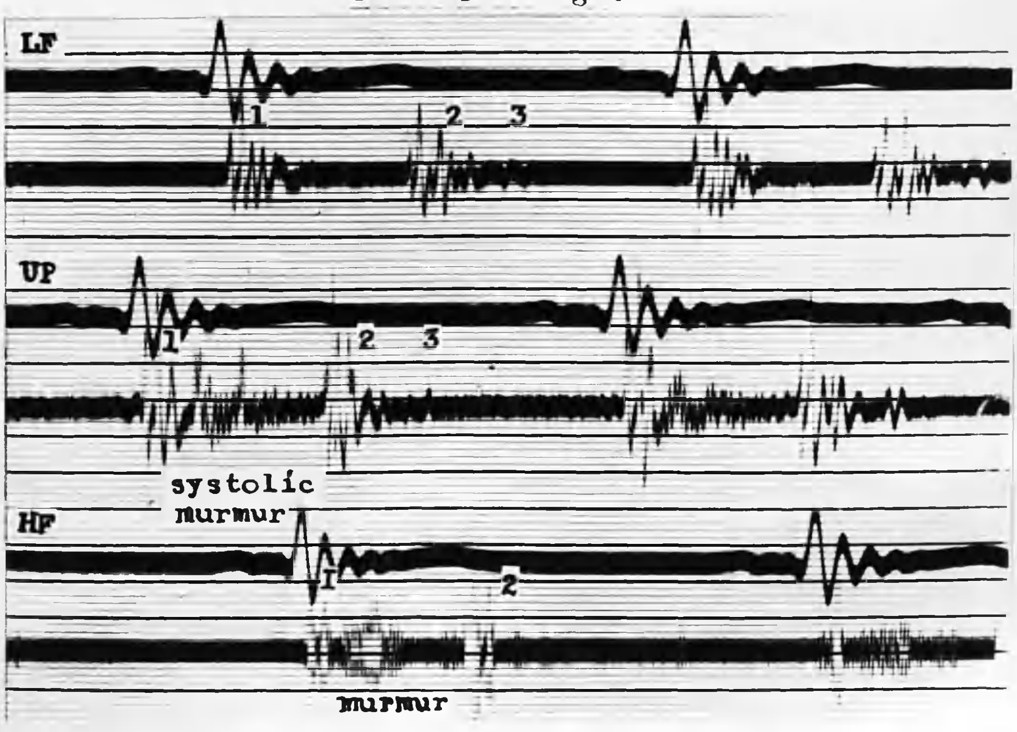
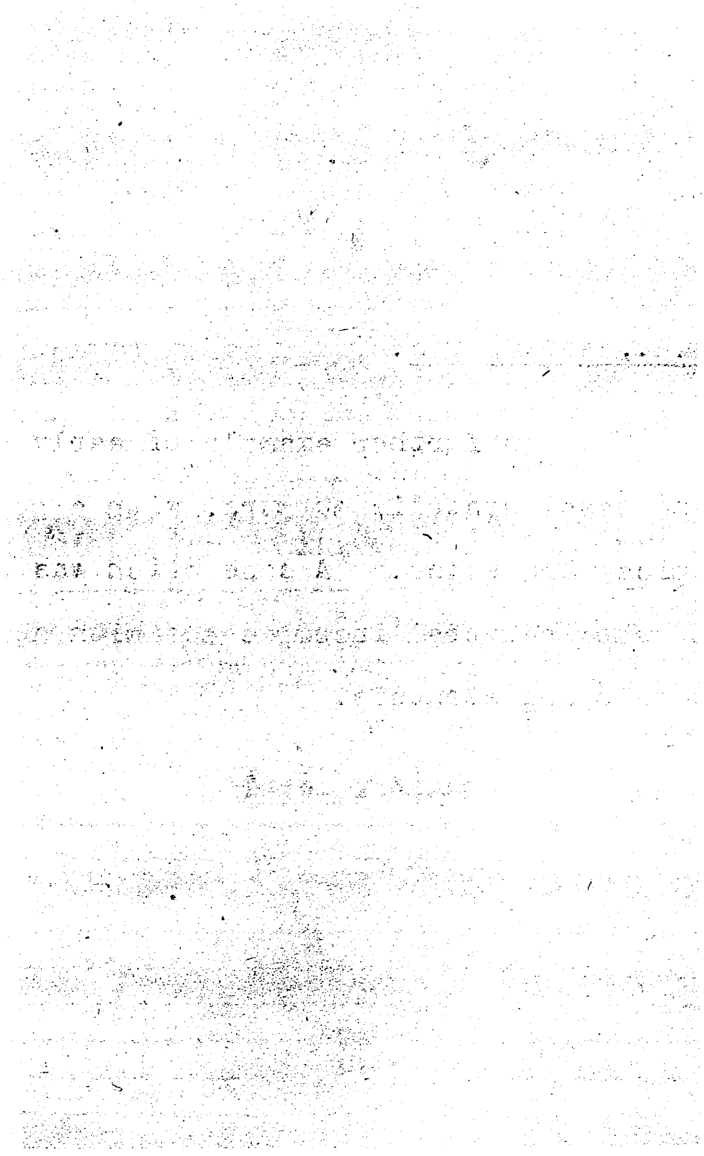


FIG. 48.



S.R., aet 20 yrs.

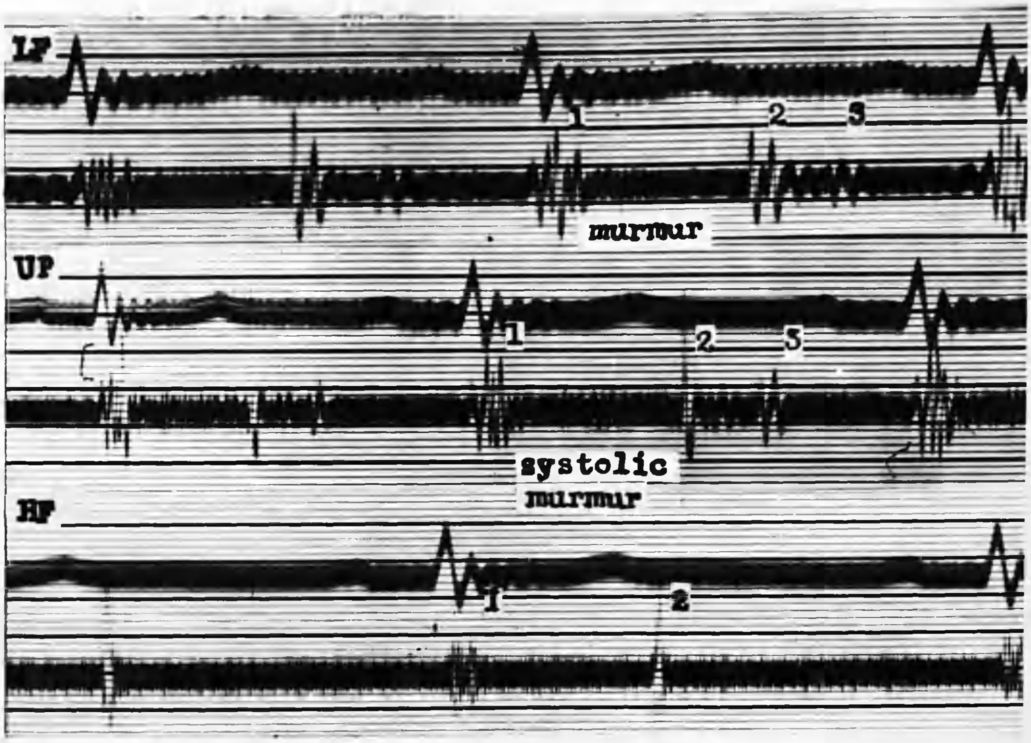
A further example of early apical and basal systolic murmurs, with a prolonged apical 3rd sound. A case which was considered to show a mitral incompetence with doubtful developing stenosis.

Fig 48.

Equivocal Phonocardiogram.

Probably of Organic Valvular Origin.

Apical Tracings.



Basal Tracings.

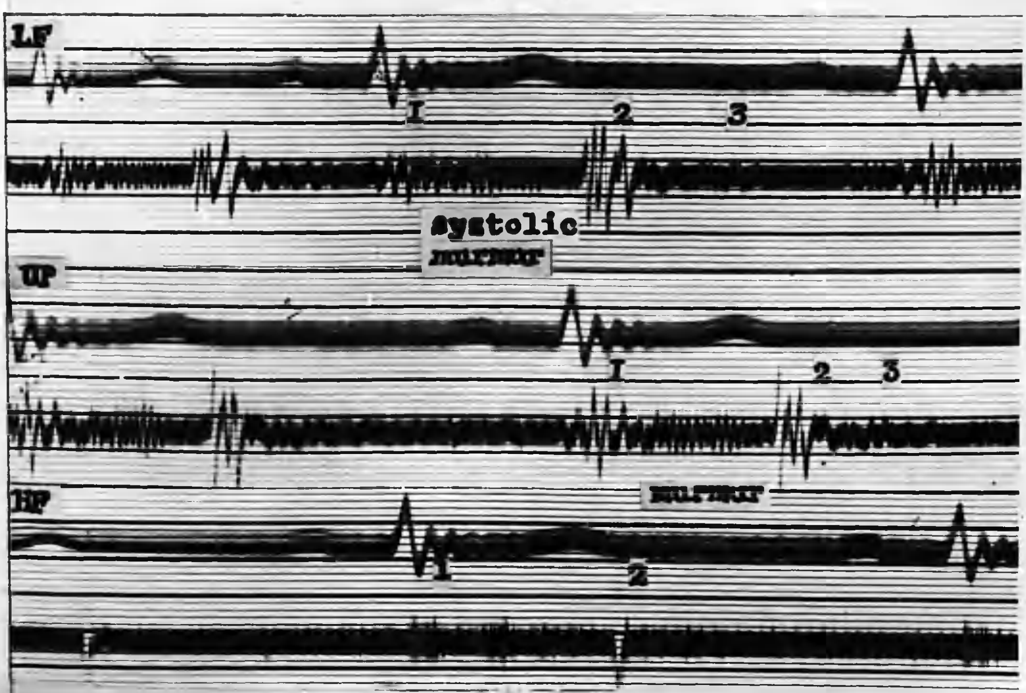


FIG. 49.

J.L., aet 7 yrs.

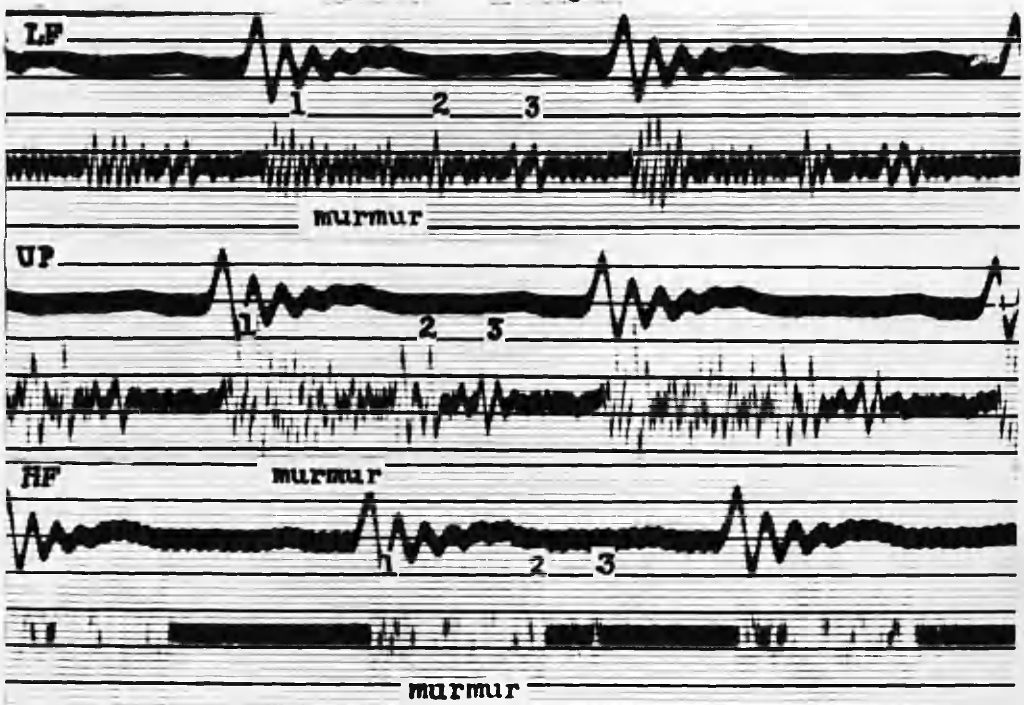
A striking example of a murmur of mitral incompetence associated with an accentuated apical 3rd sound followed by some low frequency vibrations, and a split, accentuated basal 2nd sound.

Fig 49.

Equivocal Phonocardiogram.

Probably of Organic Valvular Origin.

Apical Tracings.



Basal Tracings.

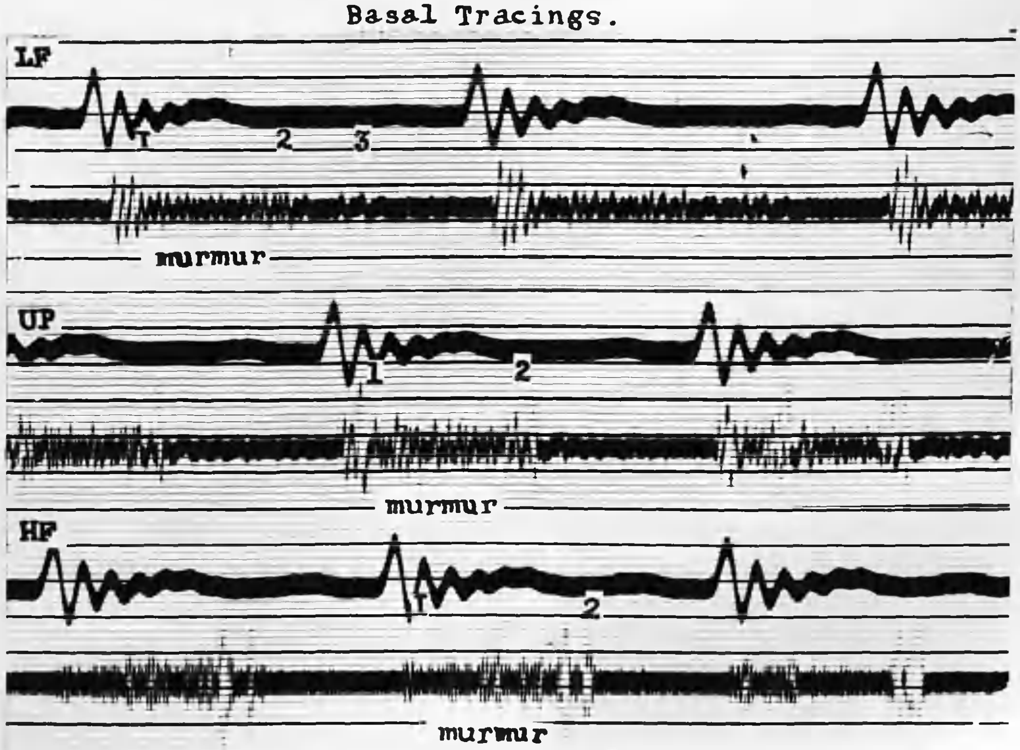


FIG. 50.

H.M., aet 20 yrs.

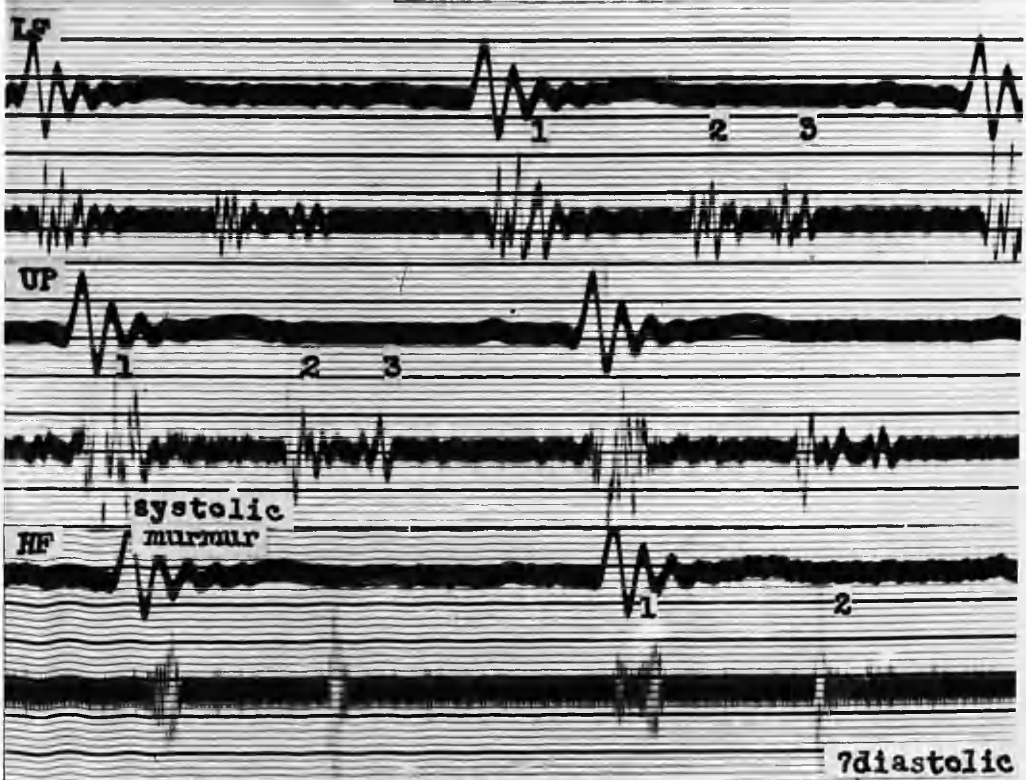
The apical systolic murmur, mid-systolic in timing, of very low amplitude, was seen only in the unfiltered phonocardiogram. The apical 3rd sound was visible.

The basal systolic murmur was of long duration, and the onset could not be defined with certainty. The amplitude was low and it was visible in all three records. At both apex and base there was high frequency vibrations in early diastole, but not obvious enough to justify a definite diagnosis.

Equivocal Phonocardiogram.

Probable Innocent Group.

Apical Tracings.



Basal Tracings.

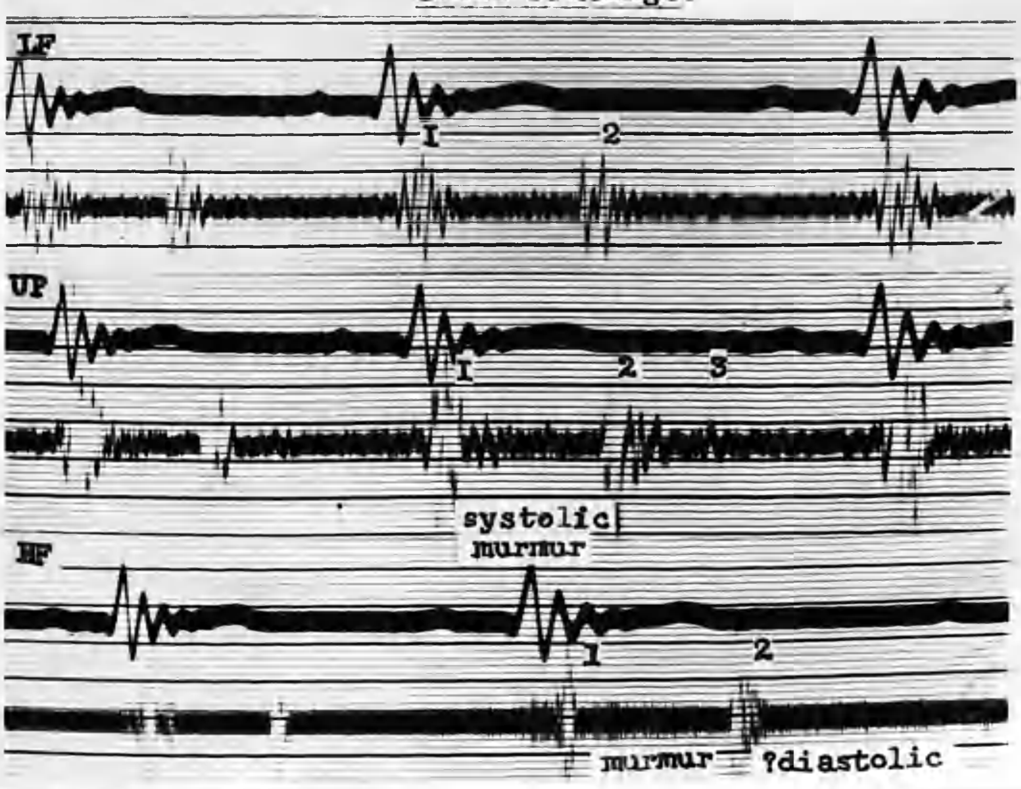


FIG. 51.

J.R., aet 15 yrs.

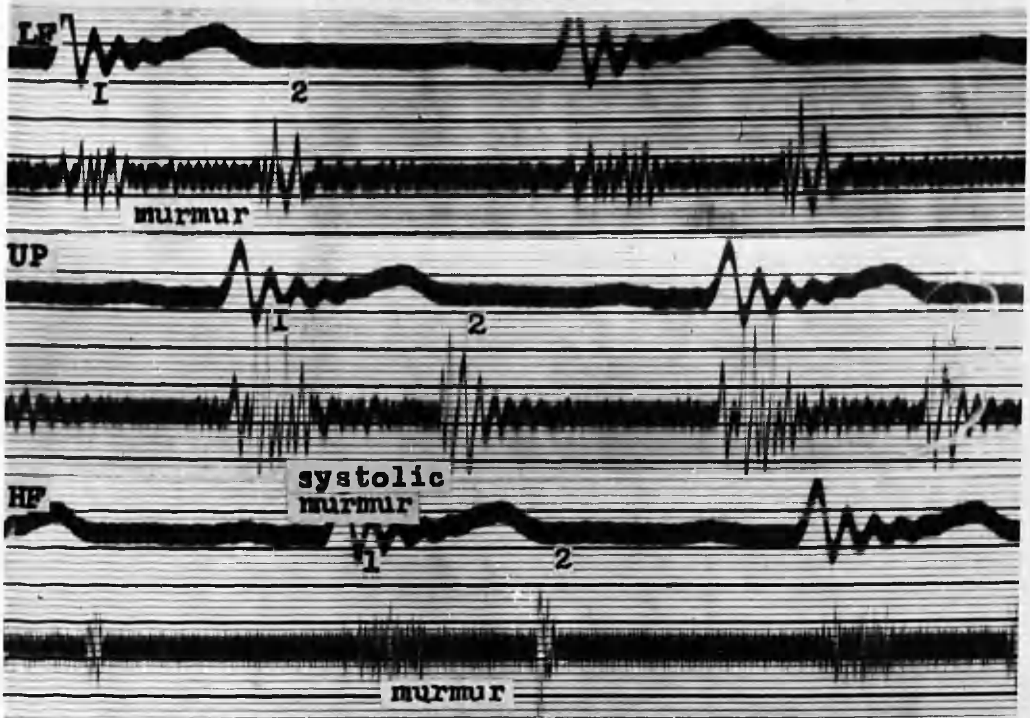
This case showed a short apical systolic murmur of indeterminate beginning. At the base was a similar murmur, and with high amplification some high frequency vibrations in early diastole became visible but not in a sufficiently definite fashion to warrant a diagnosis.

Fig 51.

Equivocal Phonocardiogram.

? Aortic Diastolic.

Apical Tracings.



Basal Tracings.

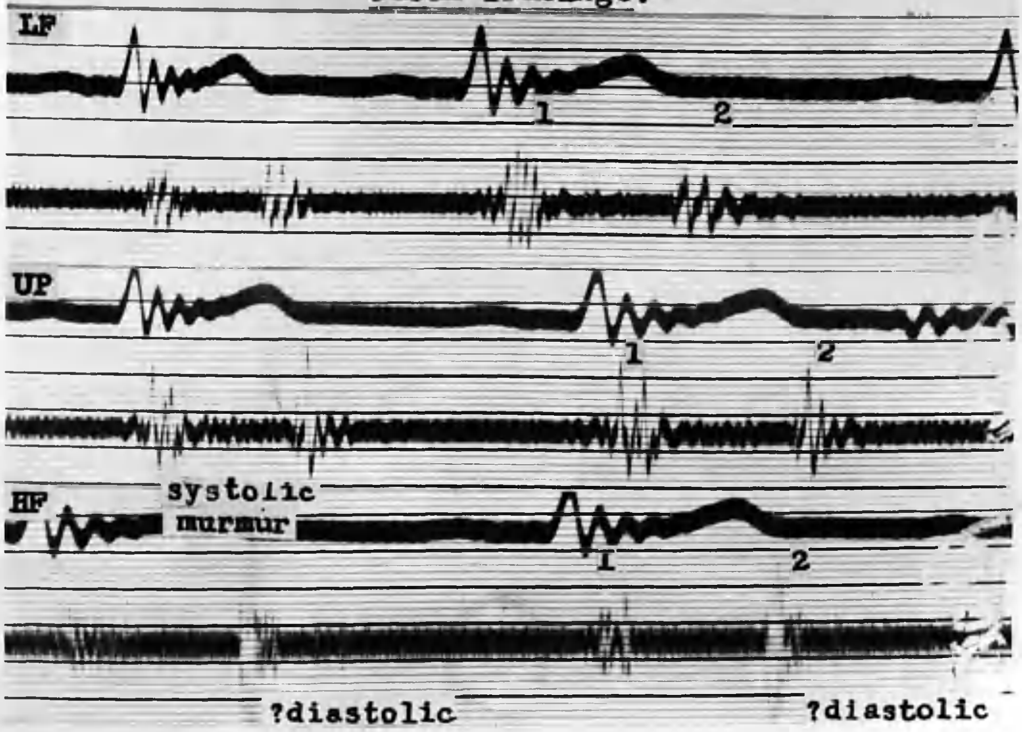


FIG. 52.

E.A., aet 16 yrs.

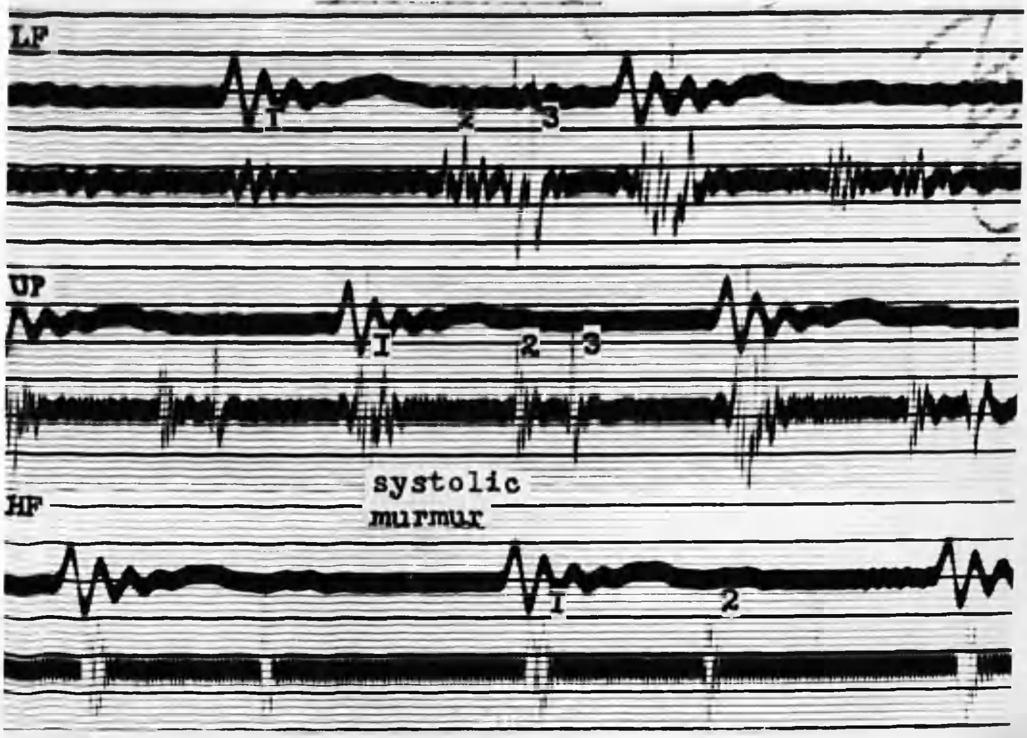
This case is described in the text. The striking feature was the grossly accentuated 3rd sound, seen in one complex at the apex as a short, low frequency, mid-diastolic murmur. It was thought that in conjunction with the history the changes indicated an active carditis.

Fig 52.

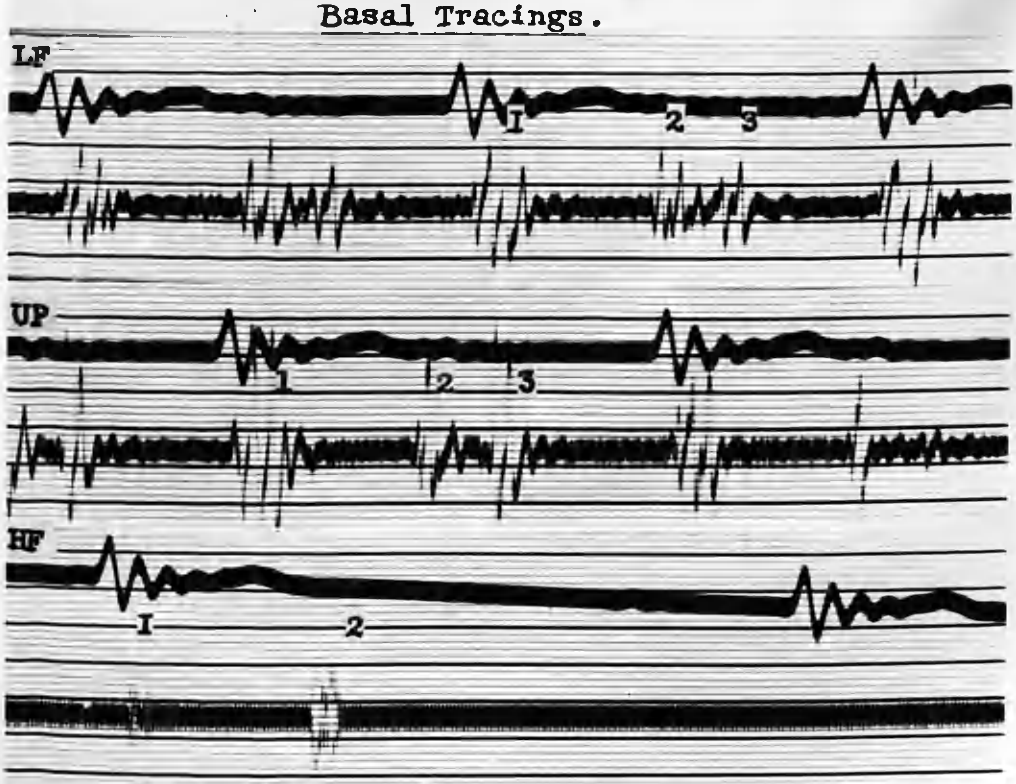
Equivocal Phonocardiogram.

With greatly accentuated 3rd sound.

Apical Tracings.



Basal Tracings.



MURMURS IN ANAEMIA

FIG. 53.

W.L., aet 40 yrs.

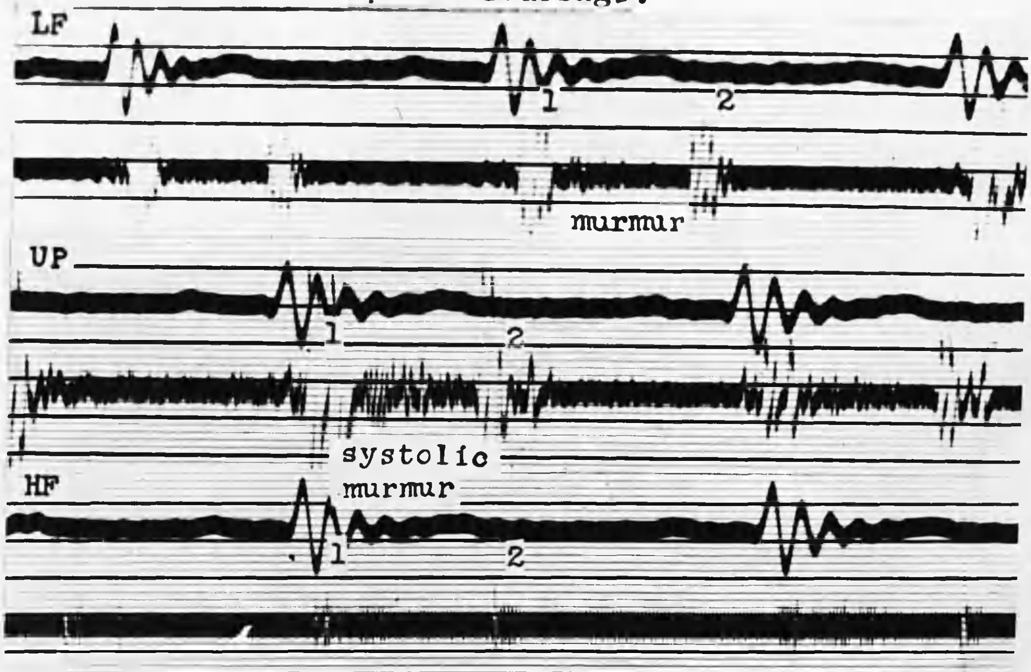
This was a case of the nephrotic syndrome, without hypertension, which developed a considerable anaemia. Hb. - 40% of 14 grams, RBC. - 1.99 million/cu.mm., WBC. - 10,200/cu.mm.

There was a well marked mid-systolic murmur, of low and medium frequency, low amplitude and short duration. This murmur was considered to be essentially non-valvular in origin. A flabby myocardium, diminished blood viscosity, and increased rate of the circulation may have been factors involved.

Murmurs in Anaemia.

A Mid-systolic Murmur.

Apical Tracings.



Basal Tracings.

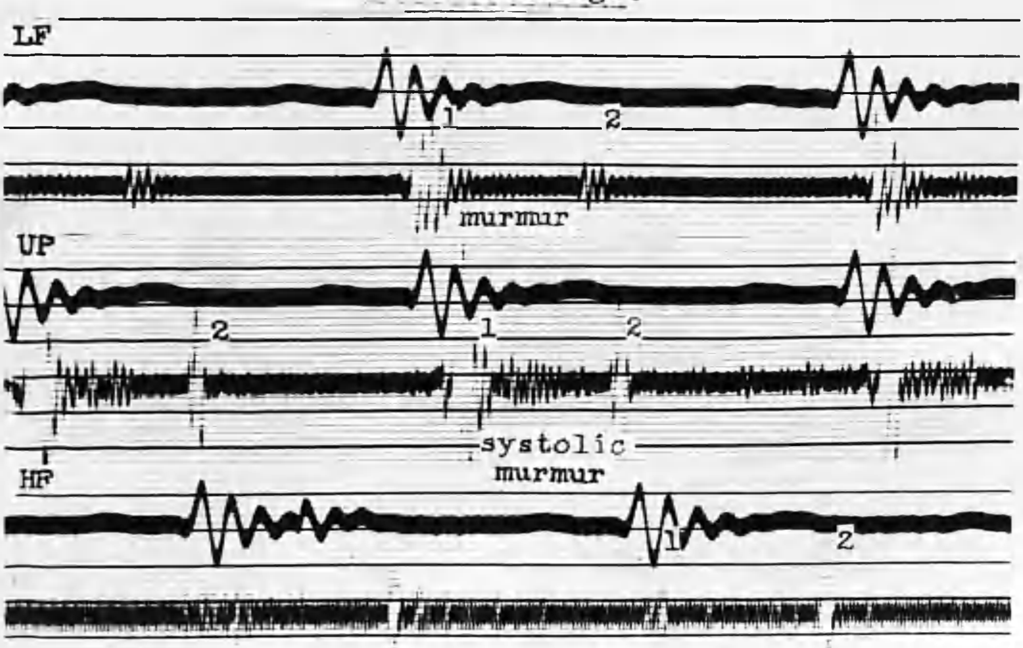


FIG. 54.

Mrs A.McK. aet 26 yrs.

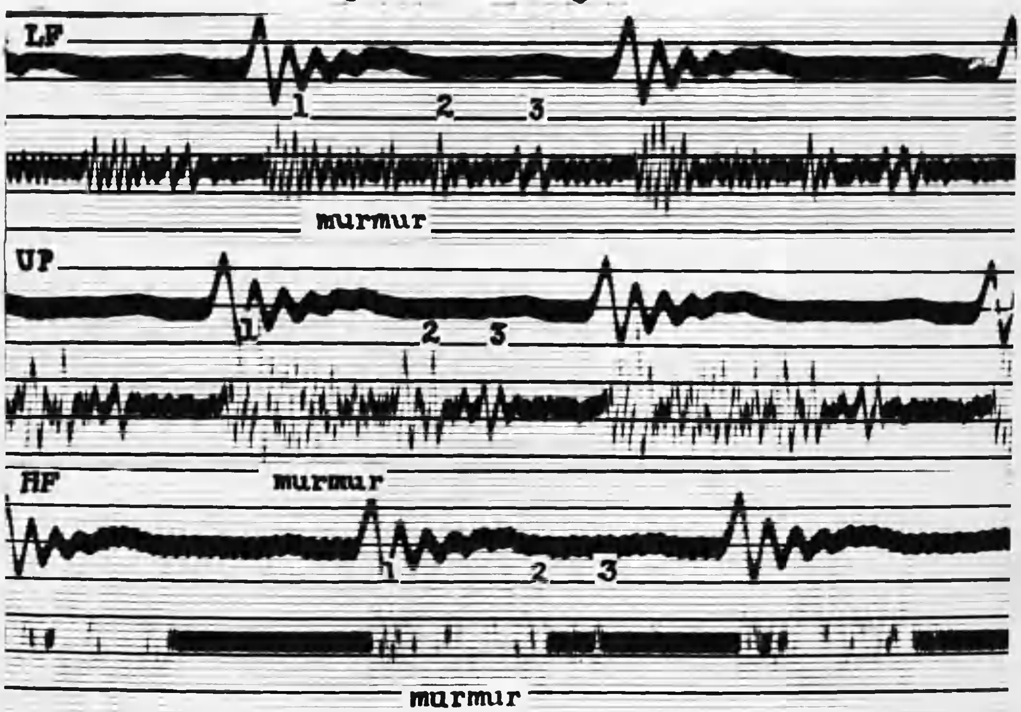
A typical mid-systolic murmur in a case of anaemia of the puerperium; Hb. - 50% of 14 grams, RBC. 3.7 Million/cu.mm. WBC. 4.600/cu.mm. In this case the murmur was seen with equal facility at apex and base.

Fig 49.

Equivocal Phonocardiogram.

Probably of Organic Valvular Origin.

Apical Tracings.



Basal Tracings.

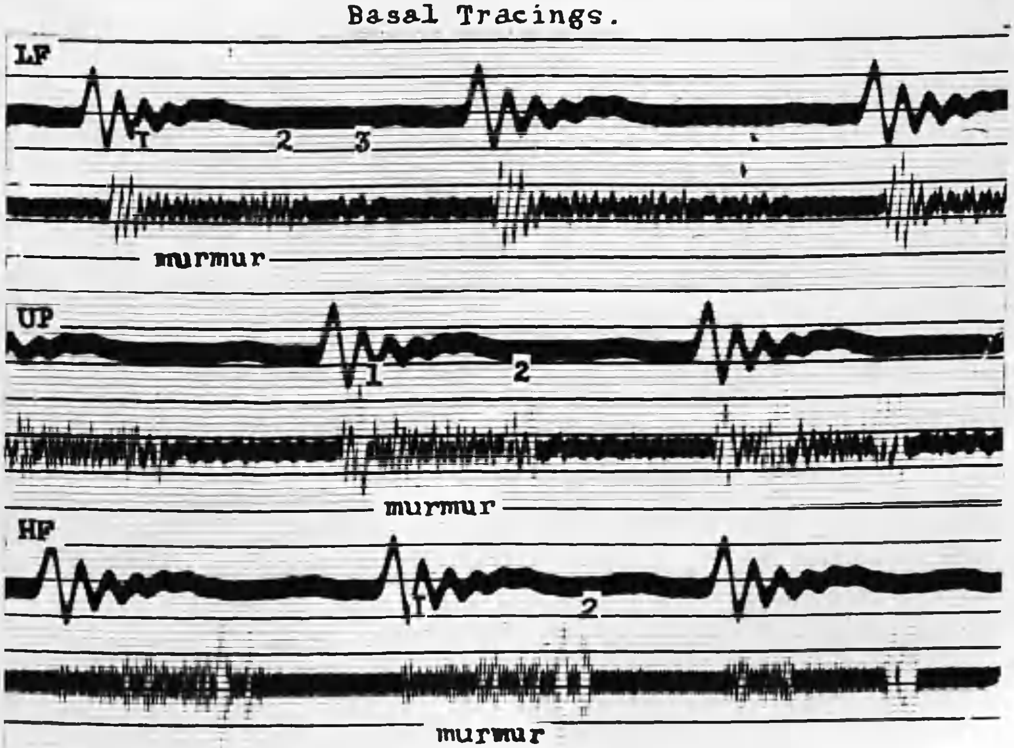


FIG. 50.

H.M., aet 20 yrs.

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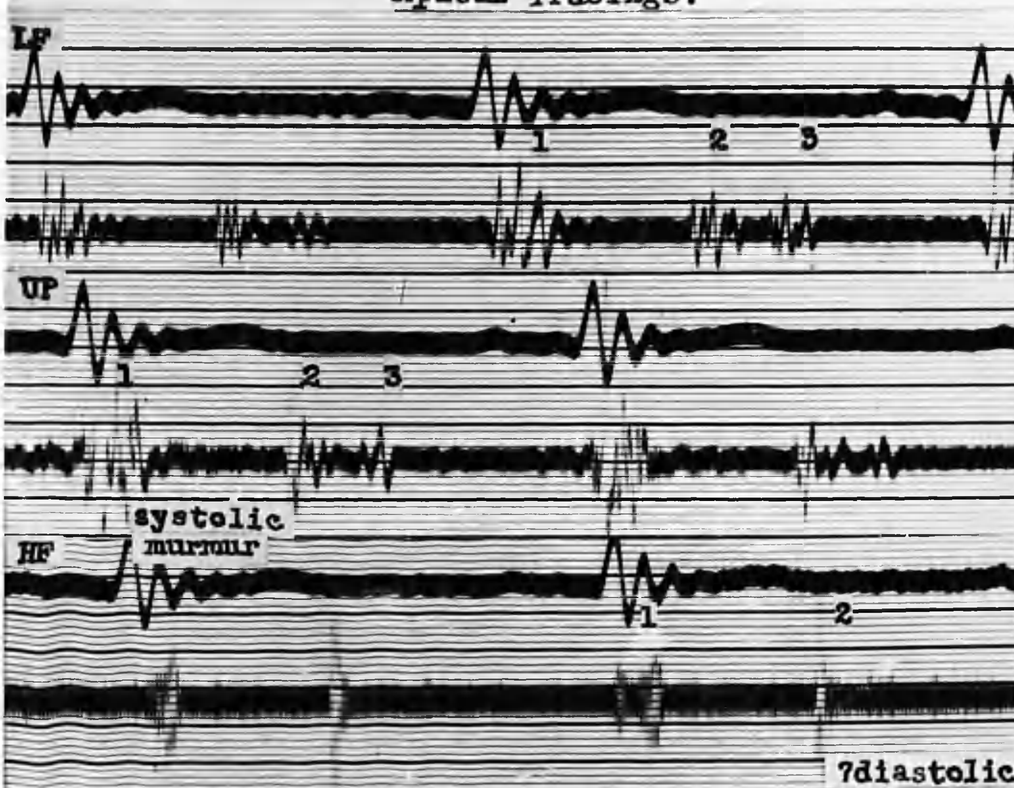
Fig 50.

Equivocal Phonocardiogram.

Probable Innocent Group.

Apical Tracings.



Basal Tracings.

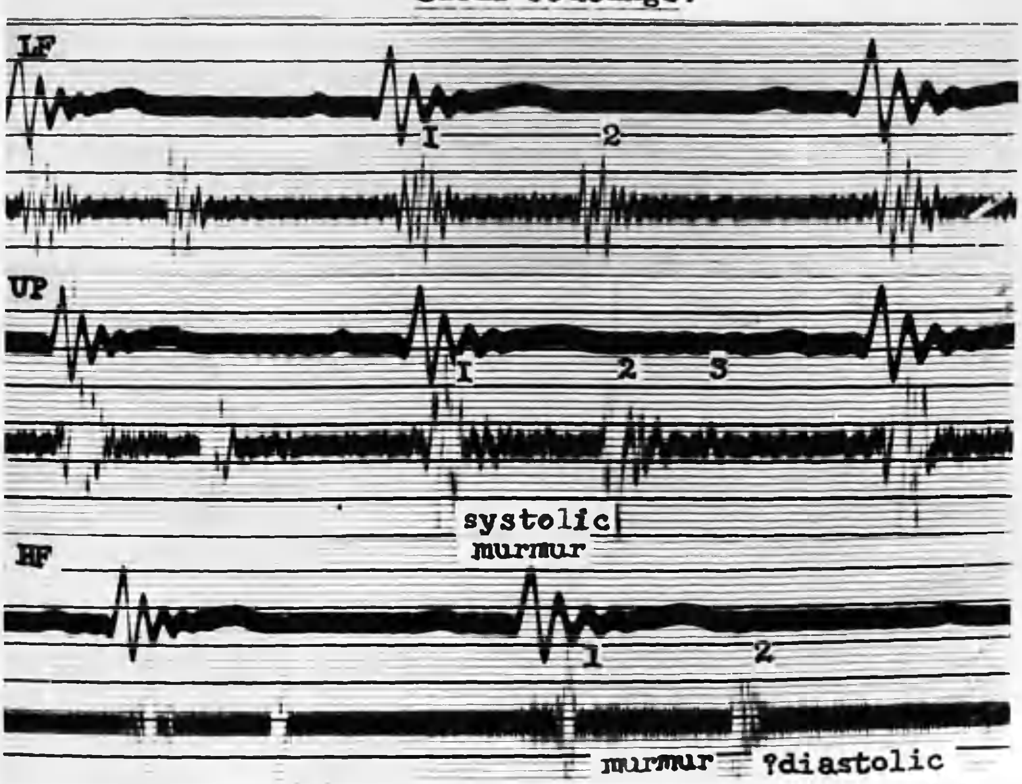


FIG. 51.

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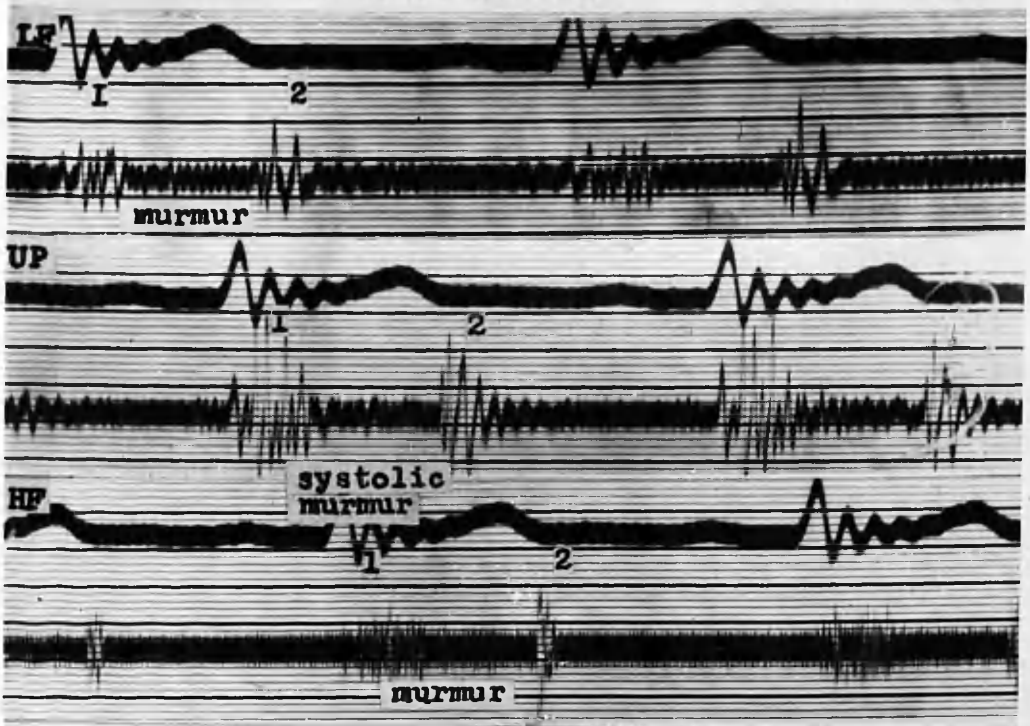
Fig 51.

Equivocal Phonocardiogram.

? Aortic Diastolic.

Apical Tracings.



Basal Tracings.

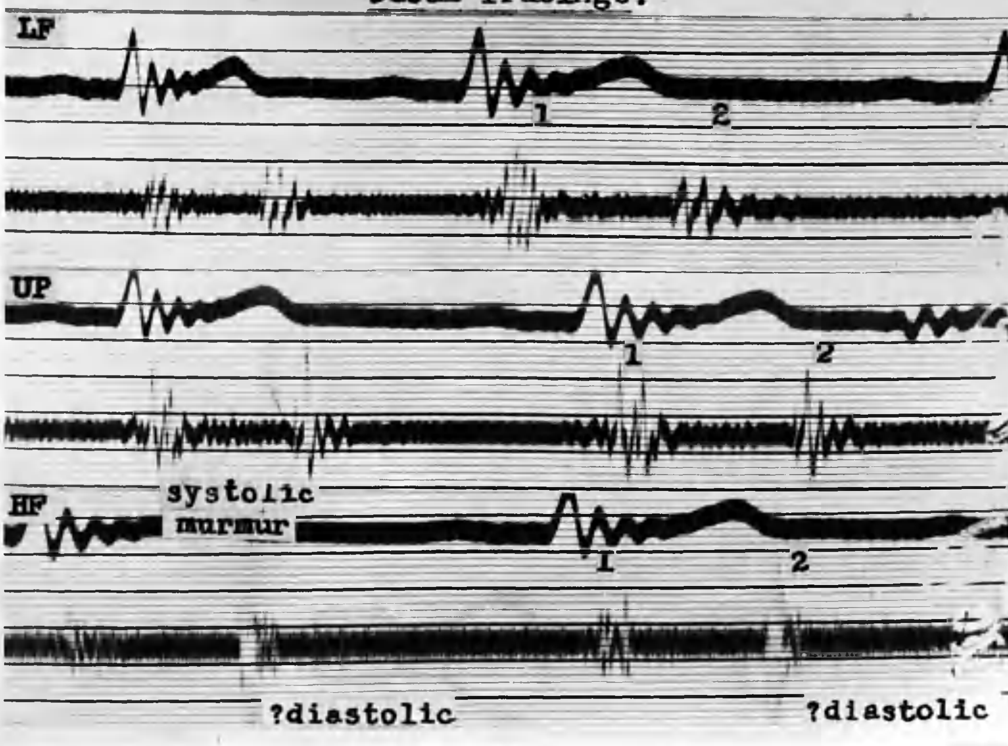


FIG. 52.

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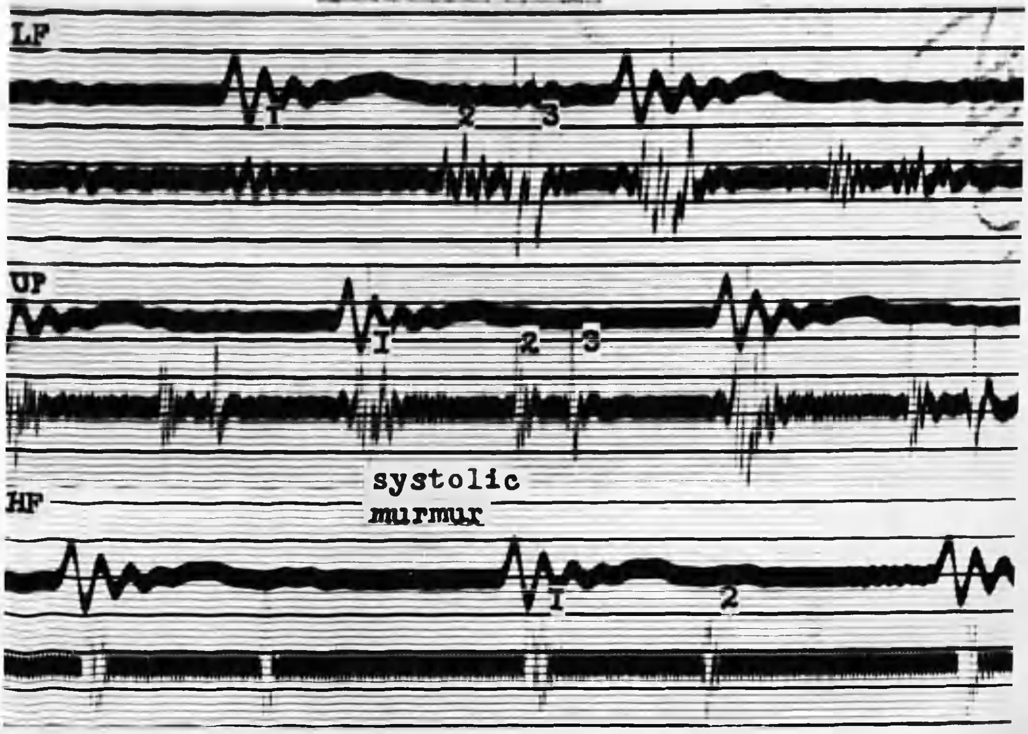
Fig 52.

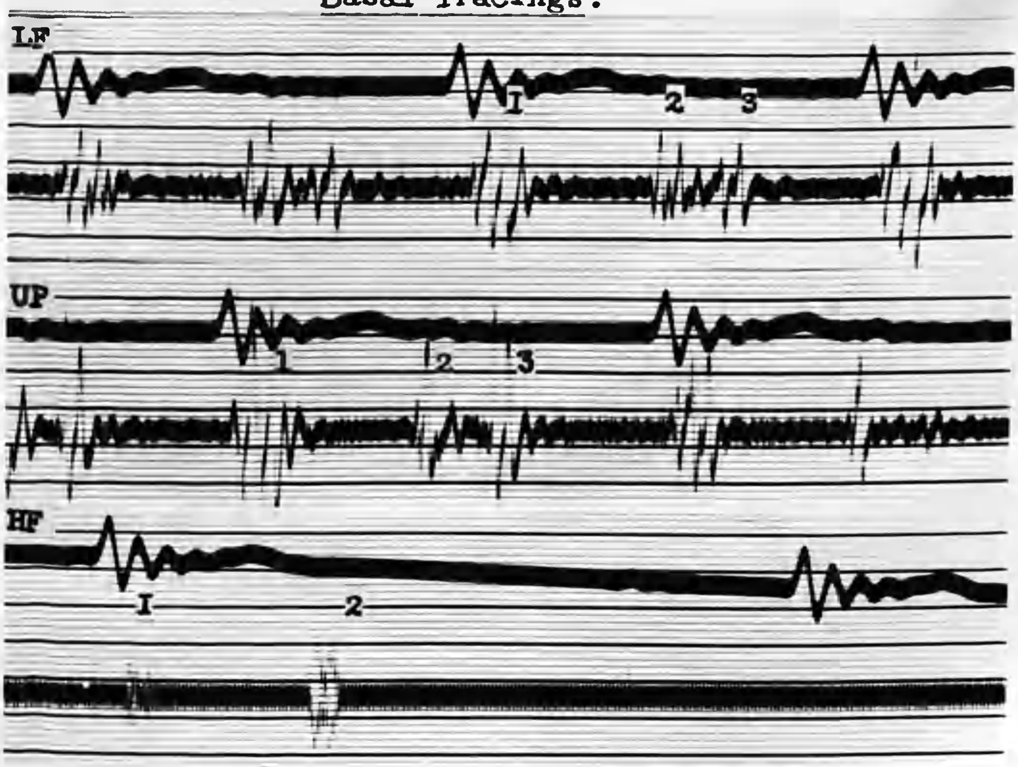
Equivocal Phonocardiogram.

With greatly accentuated 3rd sound.

Apical Tracings.



Basal Tracings.



MURMURS IN ANAEMIA

FIG. 53.

W.L., aet 40 yrs.

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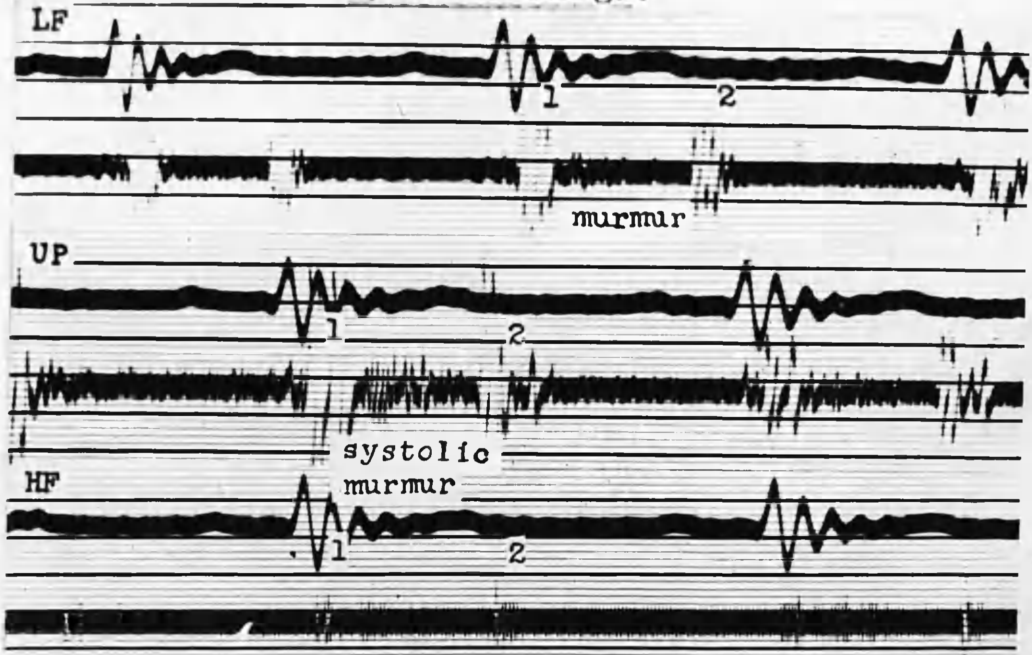
Murmurs in Anaemia.

A Mid-systolic Murmur.

Apical Tracings.



Basal Tracings.

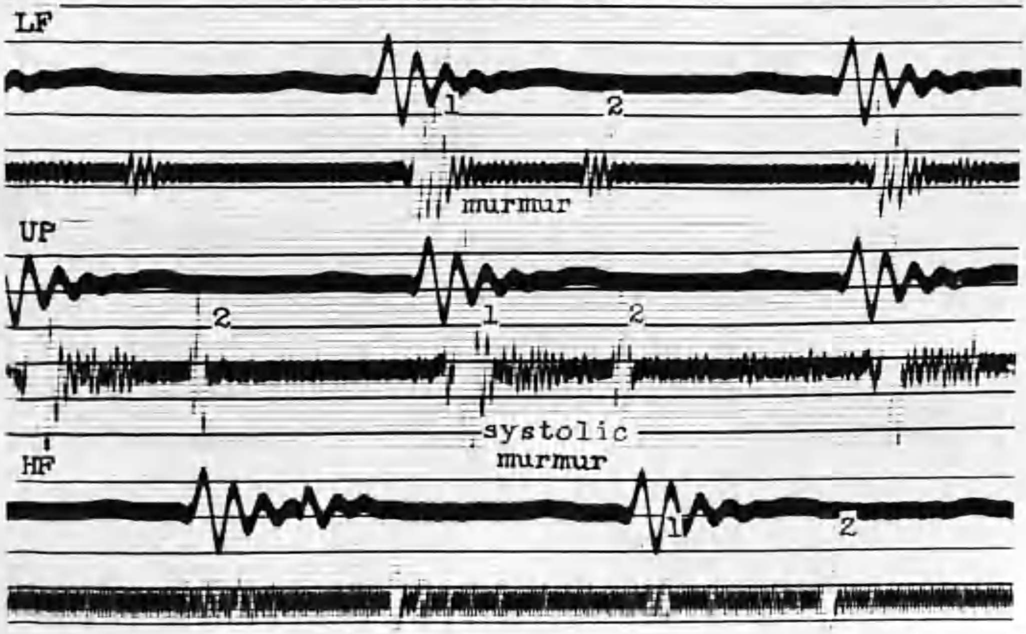
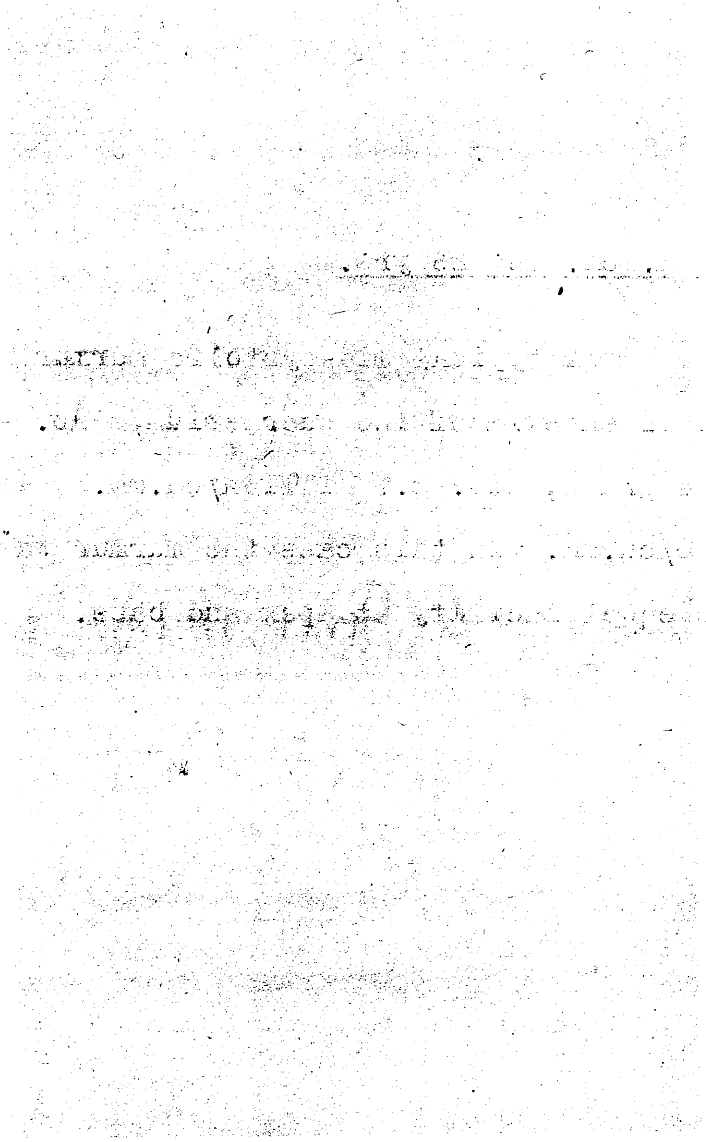


FIG. 54.



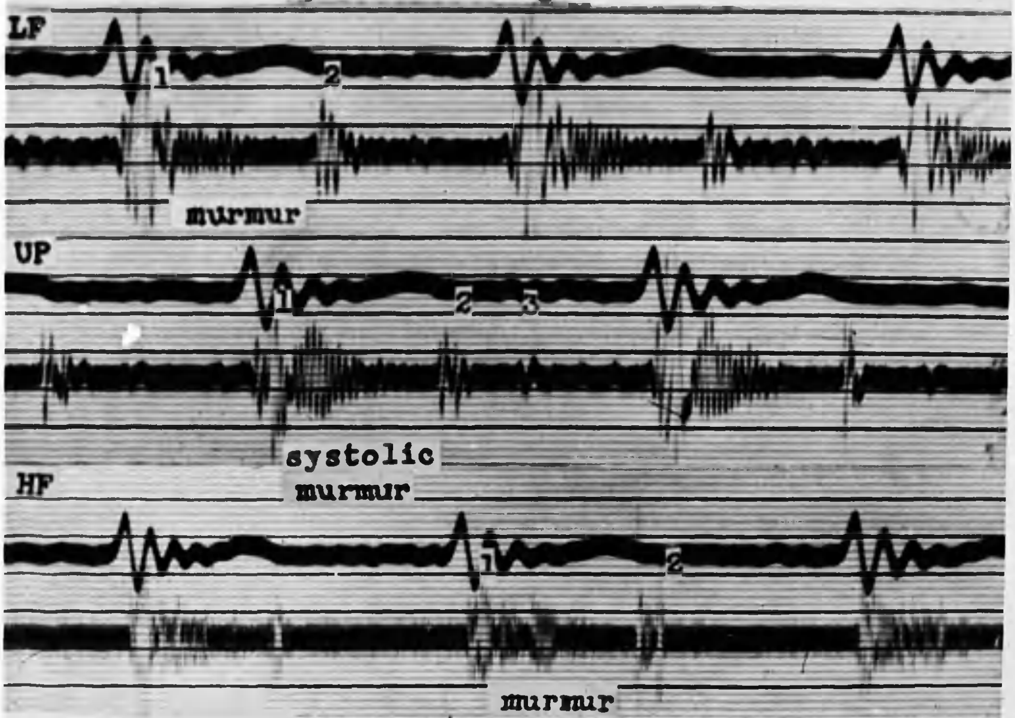
Mrs A.McK. aet 26 yrs.

A typical mid-systolic murmur in a case of anaemia of the puerperium; Hb. - 50% of 14 grams, RBC. 3.7 Million/cu.mm. WBC. 4.600/cu.mm. In this case the murmur was seen with equal facility at apex and base.

Murmurs in Anaemia.

A Mid-systolic Murmur.

Apical Tracings.



Basal Tracings.

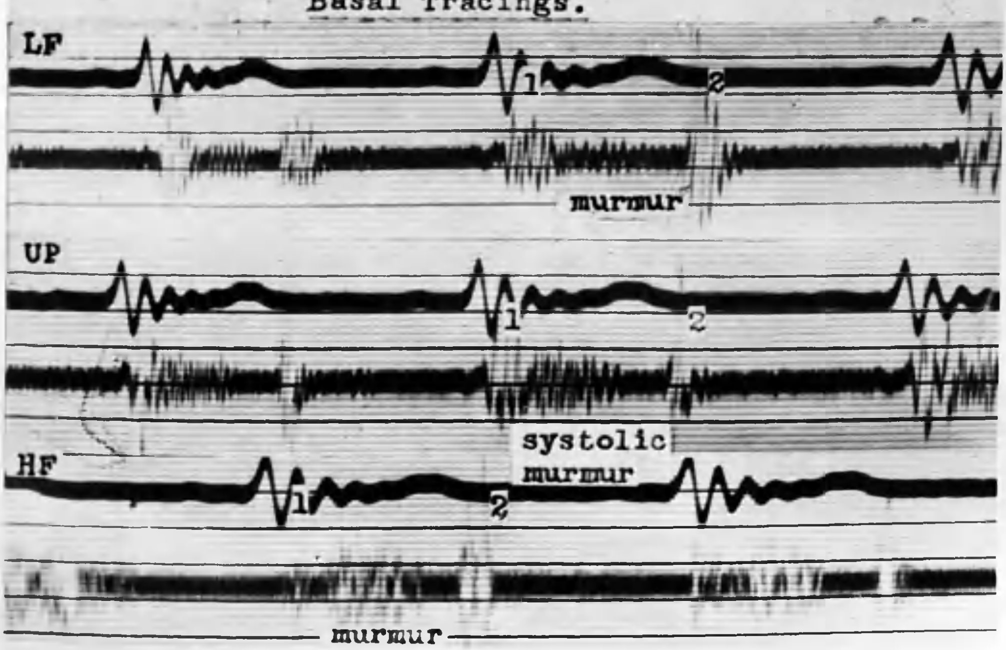


FIG.55.

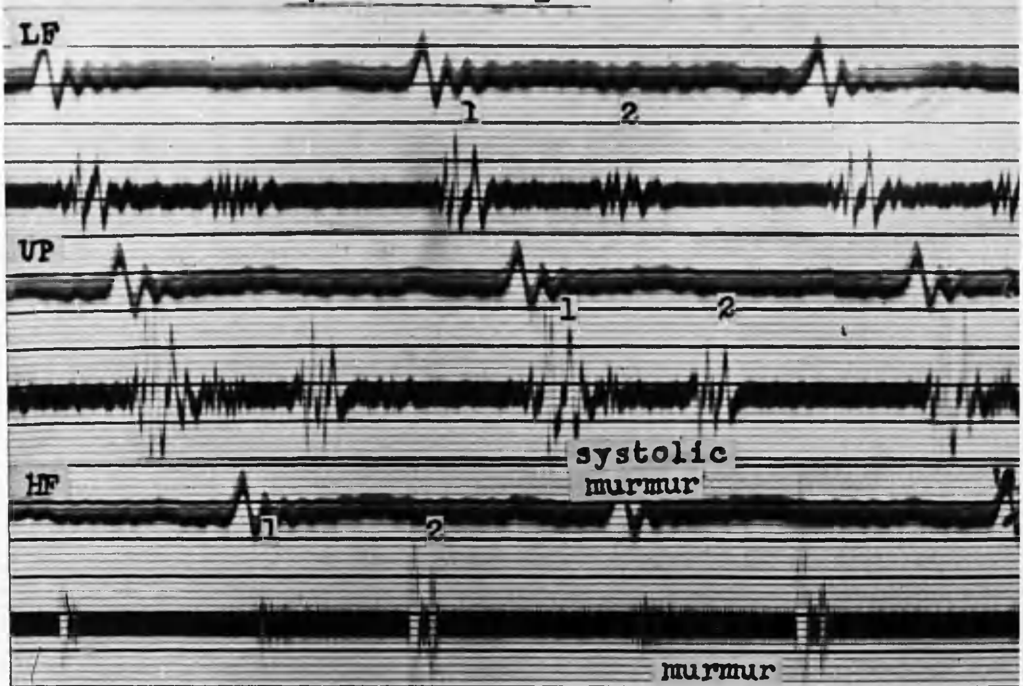
Mrs. A.C., aet 30 yrs.

An iron deficiency anaemia due to repeated pregnancies. Hb. - 68% of 14 grams, RBC. - 3.5 Million/cu.mm. WBC. 5000/cu.mm. There was a mid-systolic murmur of medium frequency, very low amplitude and short duration at the apex, and a late systolic murmur of similar characteristics at the base.

Murmurs in Anaemia.

A Late-systolic Murmur.

Apical Tracings.



Basal Tracings.

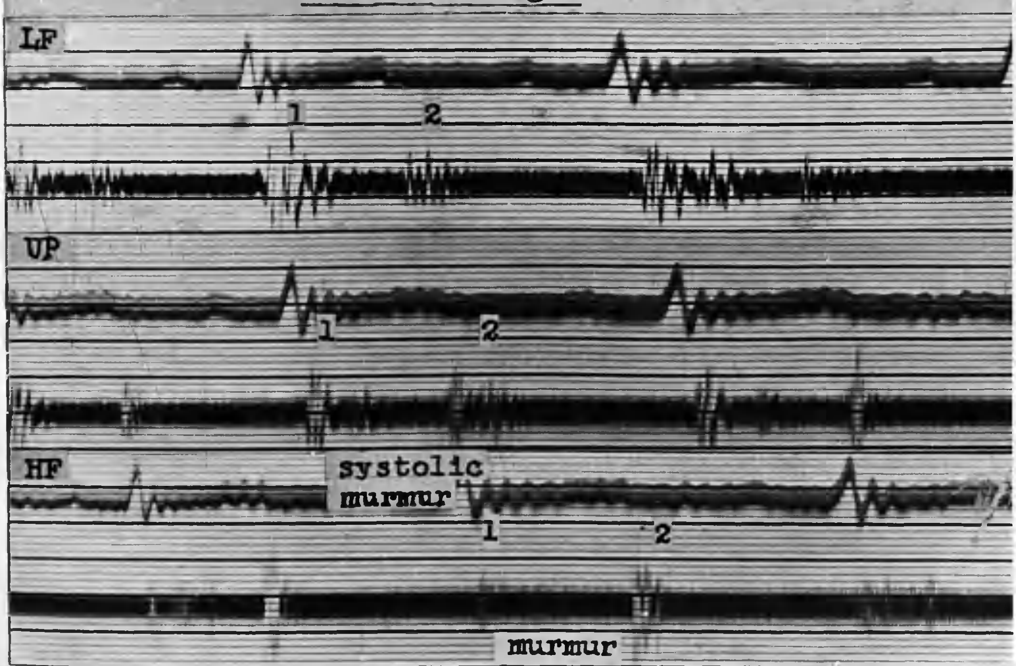


FIG. 56.

Mrs. A.S., aet 79 yrs.

This case was one of Pernicious Anaemia of severe degree. Hb. - 38% of 14 grams, RBC. - 1.75 million/cu.mm. WBC. 6,000/cu.mm. There was moderate cardiac enlargement.

There was an early systolic murmur at the apex suggestive of probable functional mitral incompetence.

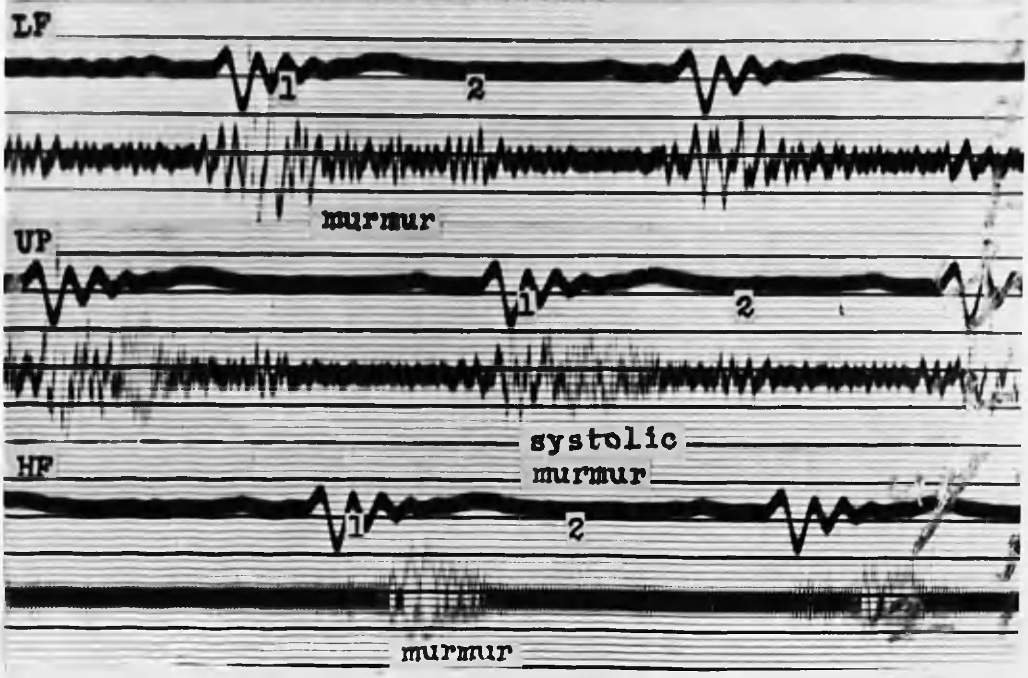
There was an early systolic murmur at the base slightly later than the above, and the 2nd sound was followed by an indefinite, medium frequency, early diastolic murmur. The latter two murmurs suggested aortic dilatation and regurgitation. There was no radiological evidence of aortic sclerosis.

Fig 56.

Murmurs in Anaemia.

An Early-Systolic Murmur.

Apical Tracings.



Basal Tracings.

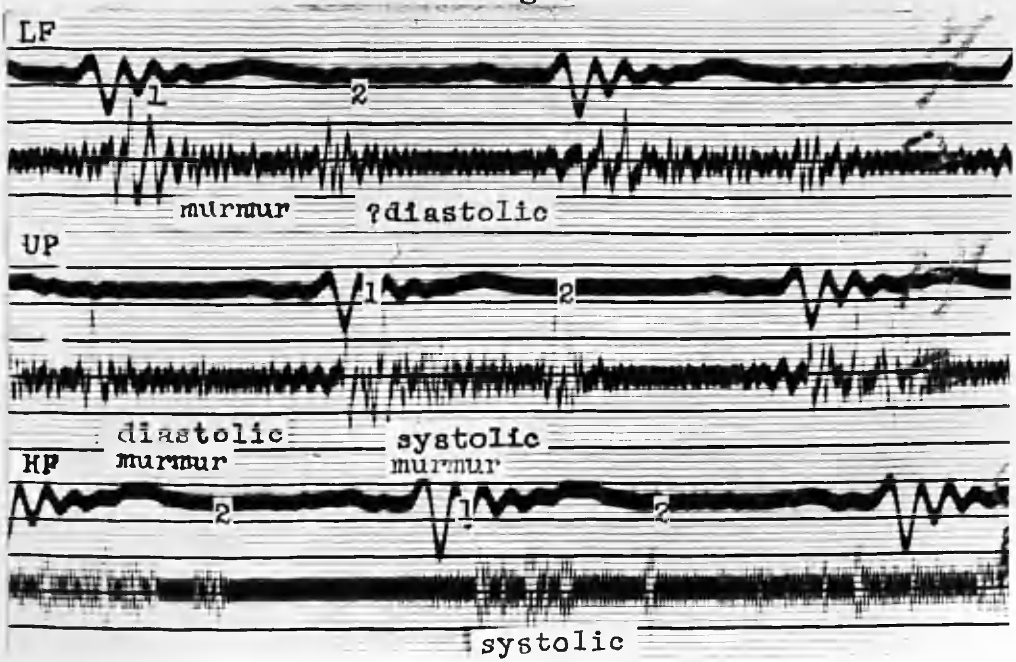


FIG. 57.

Mrs. E.T., aet 46 yrs.

A case of myeloid leukaemia in the terminal stages. Hb. - 28% of 14 grams, RBC. 1.31 million/cu.mm. WBC. 13.500/cu.mm.

An early systolic murmur of mitral incompetence type was preceded by a "presystolic" murmur seen in the low frequency band and the unfiltered phonocardiograph.

A fatty, flabby myocardium was found at autopsy. No mitral lesions were visible.

Murmurs in Anaemia.

A "Presystolic" Murmur.

Apical Tracings.

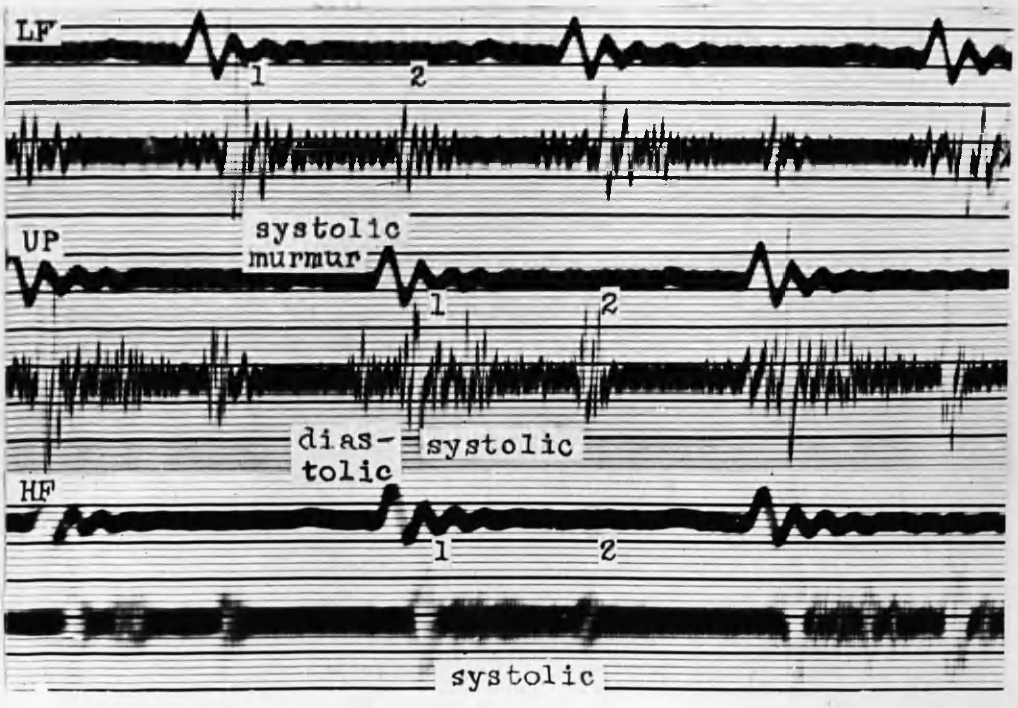


FIG. 58.

Mrs. A.C., aet 20 yrs.

A case of severe megaloblastic anaemia. The first tracing illustrated on the opposite page, was taken on 17.11.48, with the blood count; Hb. - 32% of 14 grams. RBC. - 1.42 million/cu.mm. WBC. - 2.500/cu.mm.

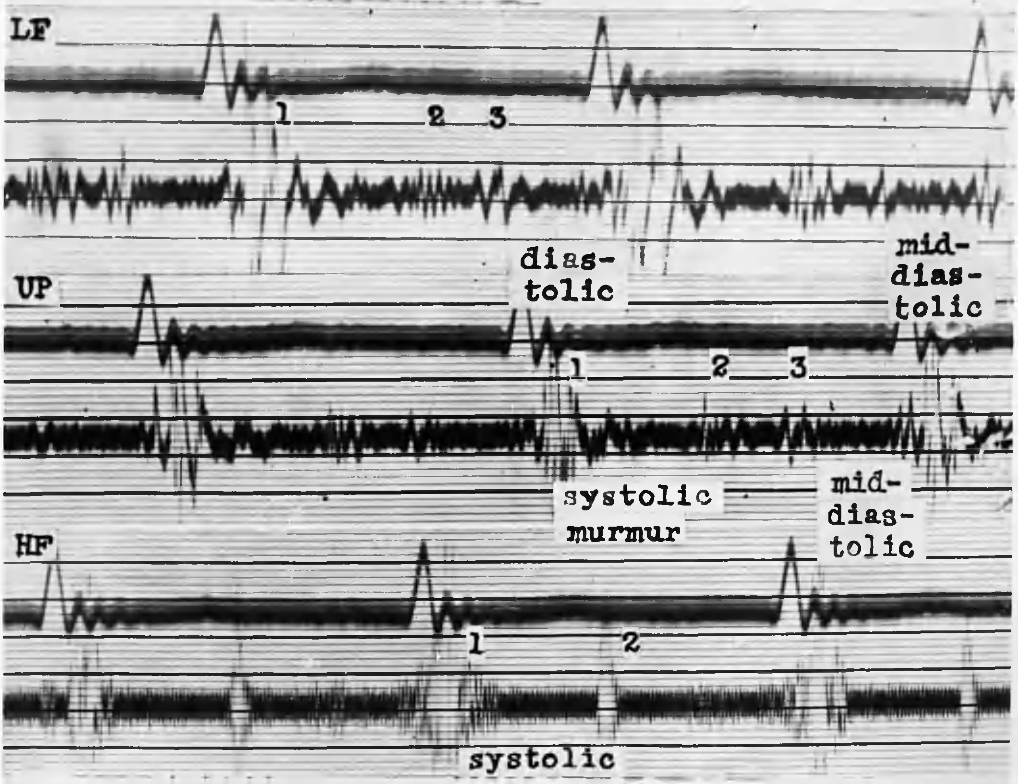
At the apex there was a low frequency, low amplitude mid-diastolic murmur following an unduly prominent 3rd sound, with high frequency presystolic accentuation well seen in the high frequency band and which was continuous with a short, early, medium and high frequency systolic murmur. At the base an early systolic murmur of medium and high frequency, low amplitude, and long duration was seen, with doubtful vibrations of high frequency immediately after the 2nd sound suggesting an early diastolic murmur. The appearances could not be distinguished from mitral incompetence and stenosis with aortic stenosis and perhaps incompetence.

Fig 58.

Murmurs in Anaemia.

Systolic and Diastolic Murmurs.

Apical Tracings.



Basal Tracings.

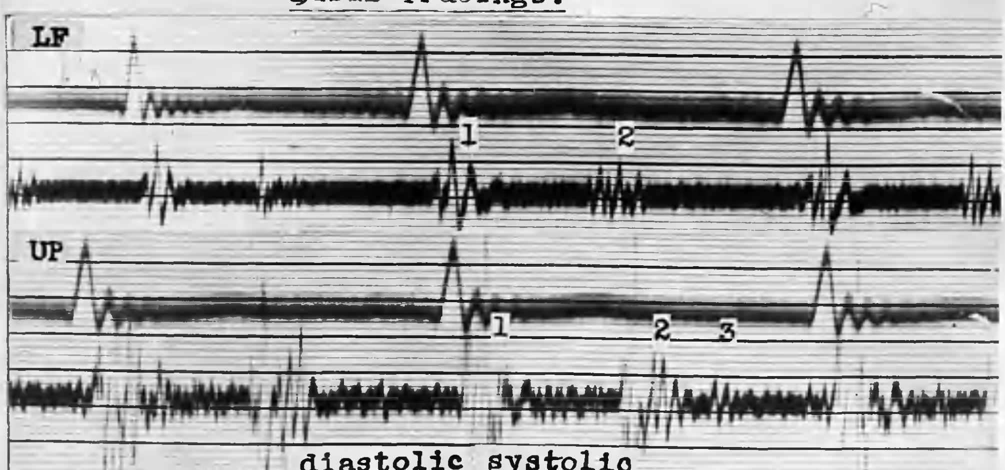
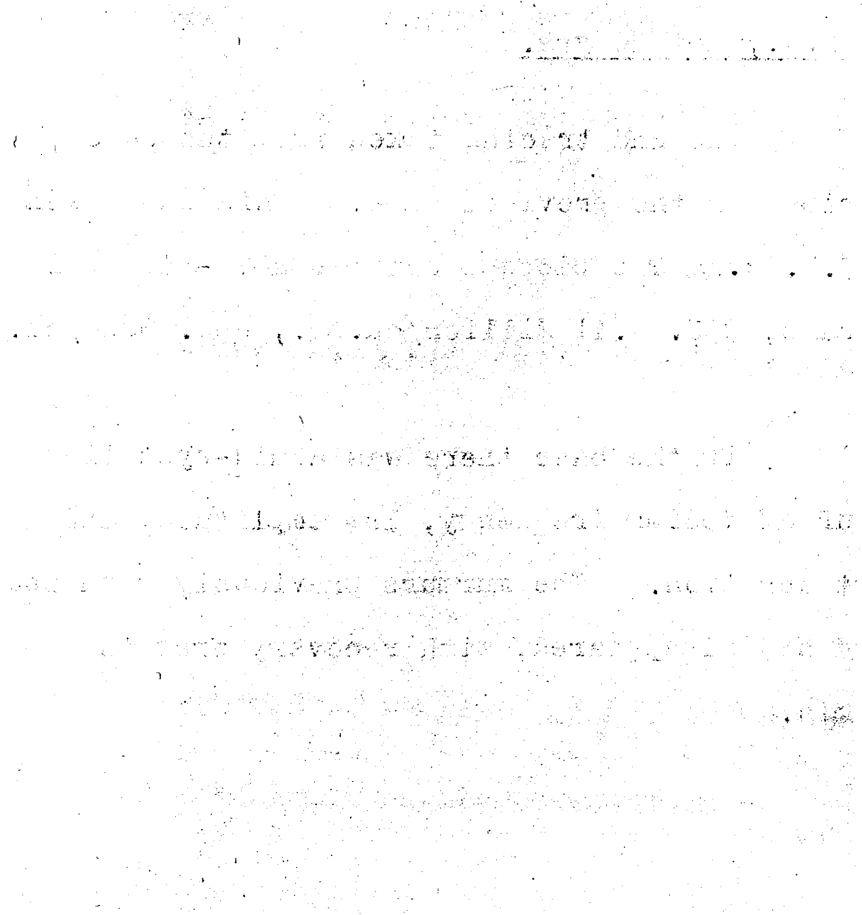


FIG. 59



Mrs. A.C., aet 20 yrs.

The 2nd tracing taken from the case described on the previous page. This was taken on 30.1.49. The blood count was Hb. - 102% of 14 grams, RBC. 4.41 Million/cu.mm., WBC. 8000/cu. mm.

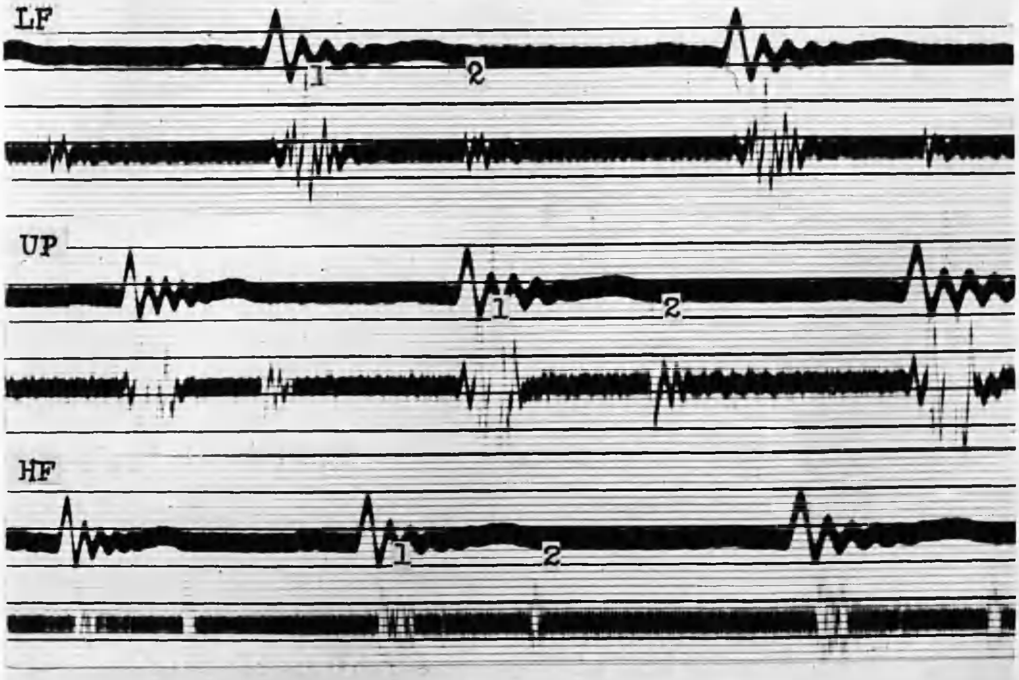
At the base there was a mid-systolic murmur of medium frequency, low amplitude, and short duration. The murmurs previously seen and heard had disappeared with recovery from the anaemia.

Fig. 59.

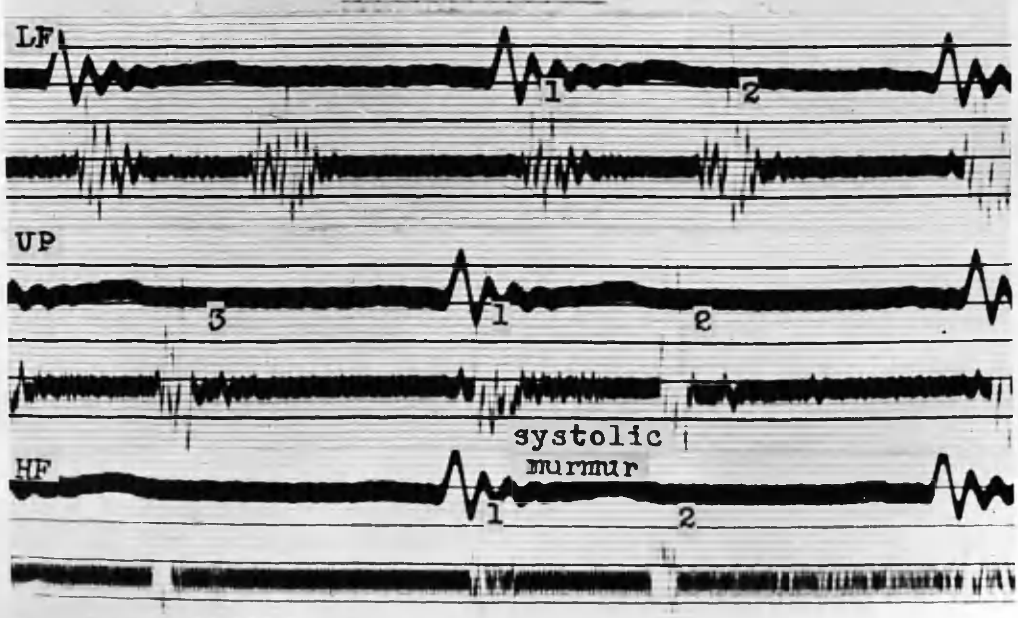
Murmurs in Anaemia.

Disappearance following treatment.

Apical Tracings.



Basal Tracings.



MURMURS IN THYROTOXICOSIS

FIG. 60.

Mrs. M.F., aet 25 yrs.

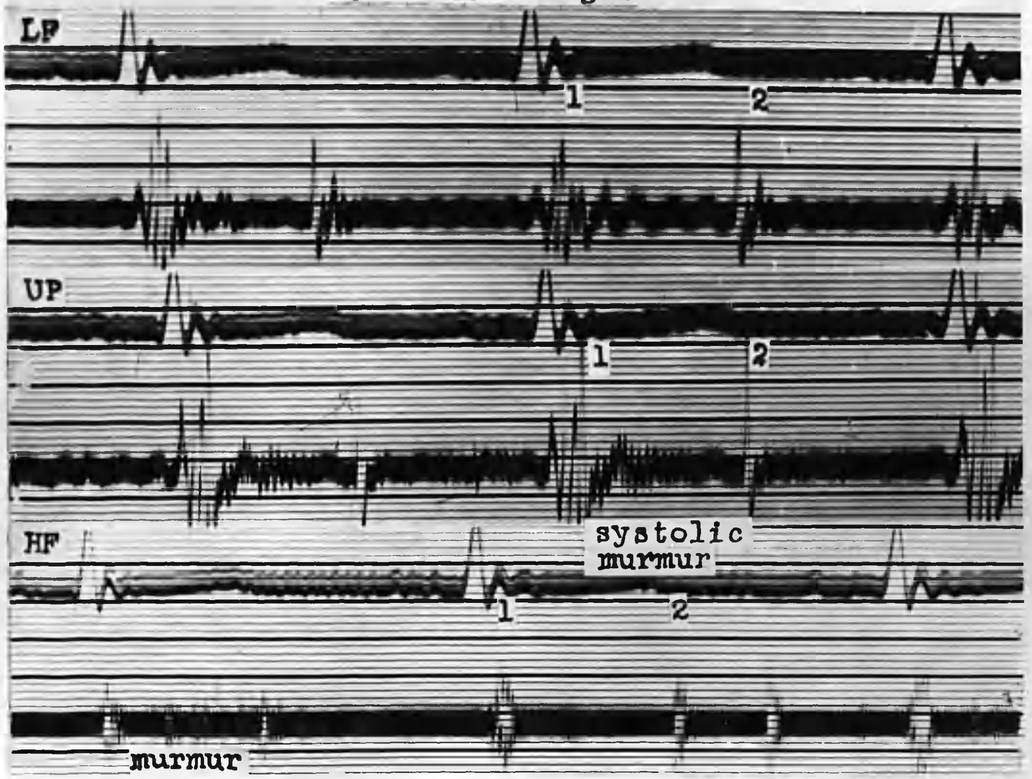
A case of moderate severity. A mid-systolic murmur was recorded at the apex. It was of low amplitude, narrow frequency range, and short duration; appearances similar to that of the "Innocent" systolic murmur. Elements of the murmur were also visible at the base where the 2nd sound was split.

Fig 60.

Murmurs in Thyrotoxicosis.

An Apical Mid-Systolic Murmur.

Apical Tracings.



Basal Tracings.

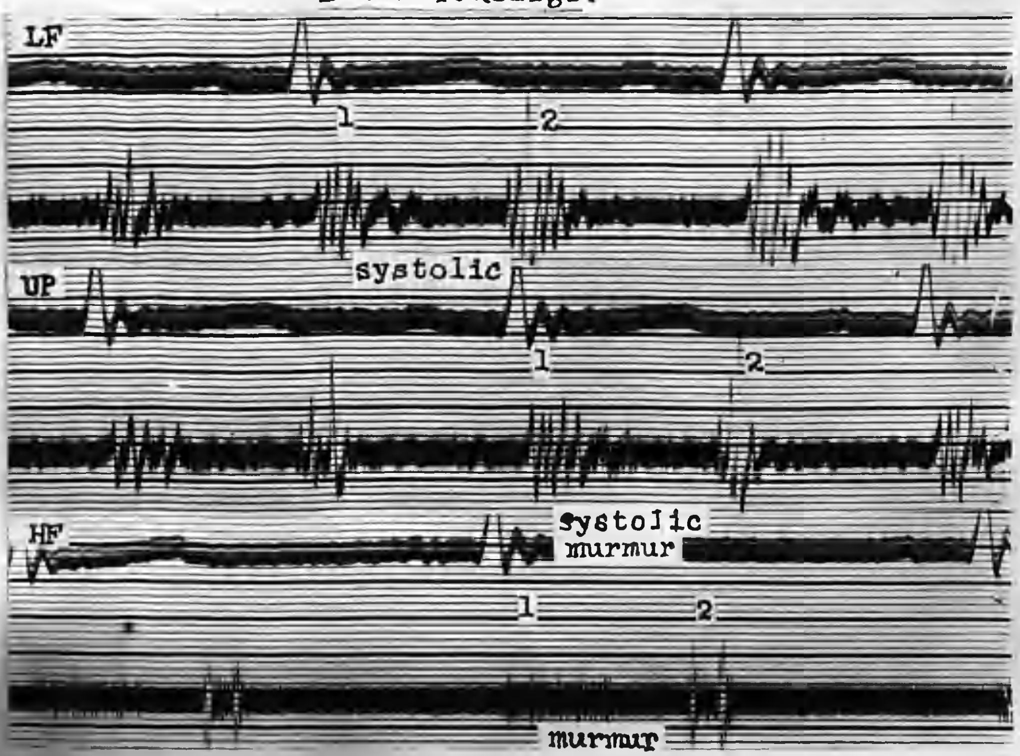


FIG. 61.

A.B., aet 56 yrs.

A case of moderate severity in a male. The murmur was similar to that shown by the previous case. It was mid-systolic, short, of moderate amplitude and narrow frequency range.

A.W., aet 46 yrs.

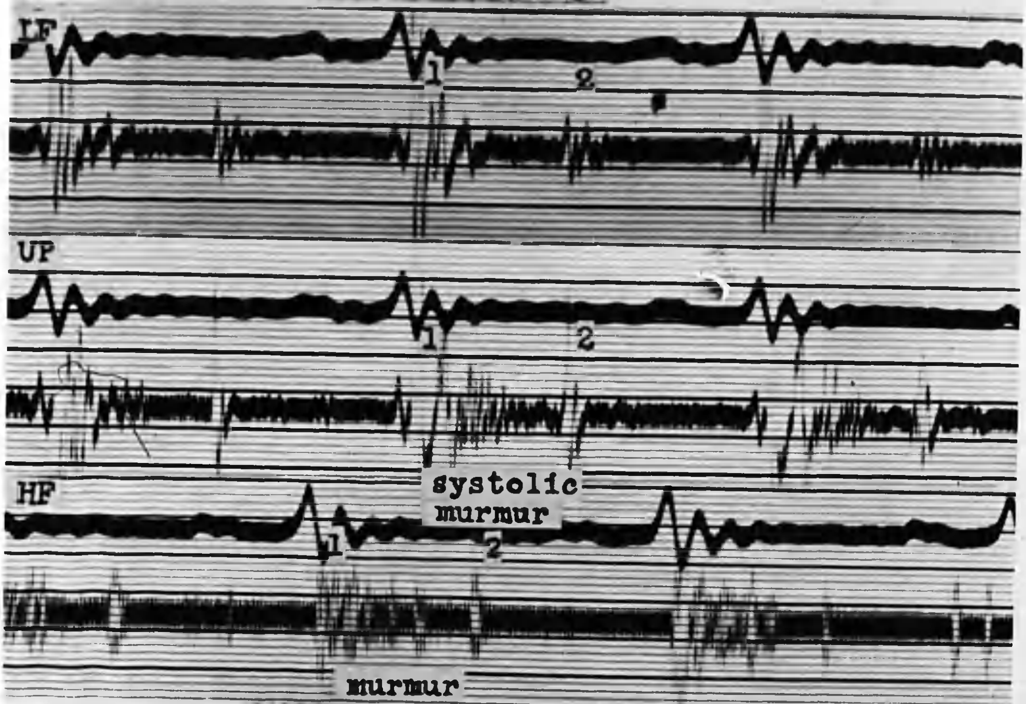
A further case of moderate severity in a male. The mid-systolic murmur was demonstrated.

Fig 61.

Murmurs in Thyrotoxicosis.

Apical Mid-Systolic Mummurs.

Apical Tracings.



Apical Tracings.

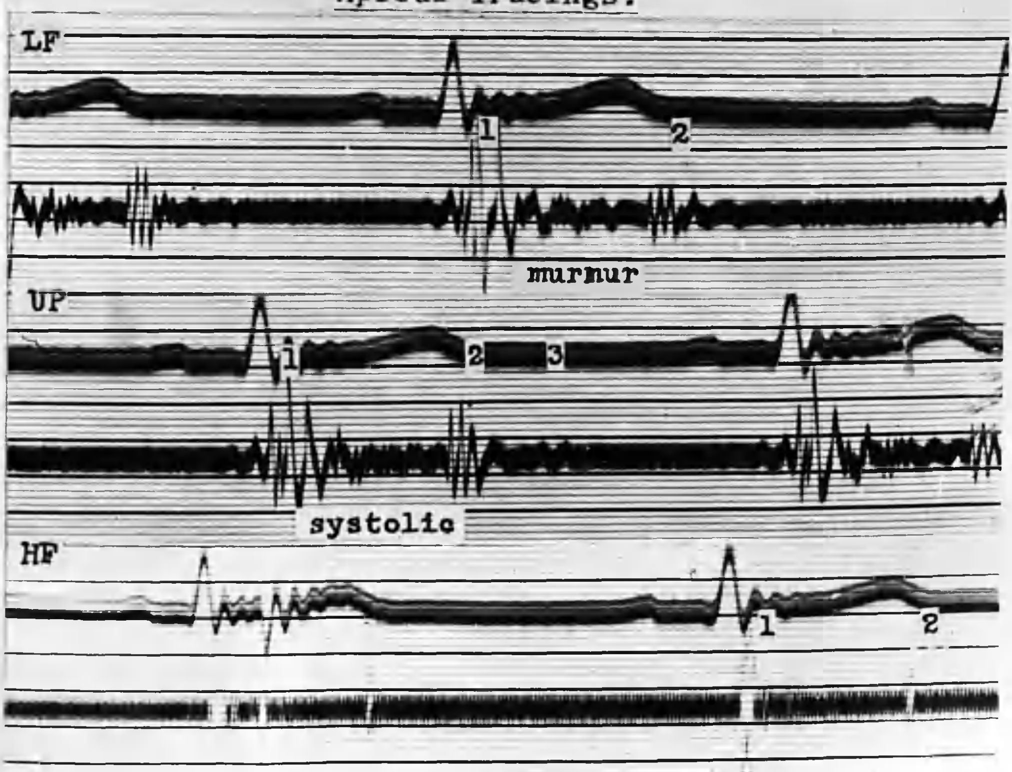


FIG. 62.

Mrs. E.S., aet 51 yrs.

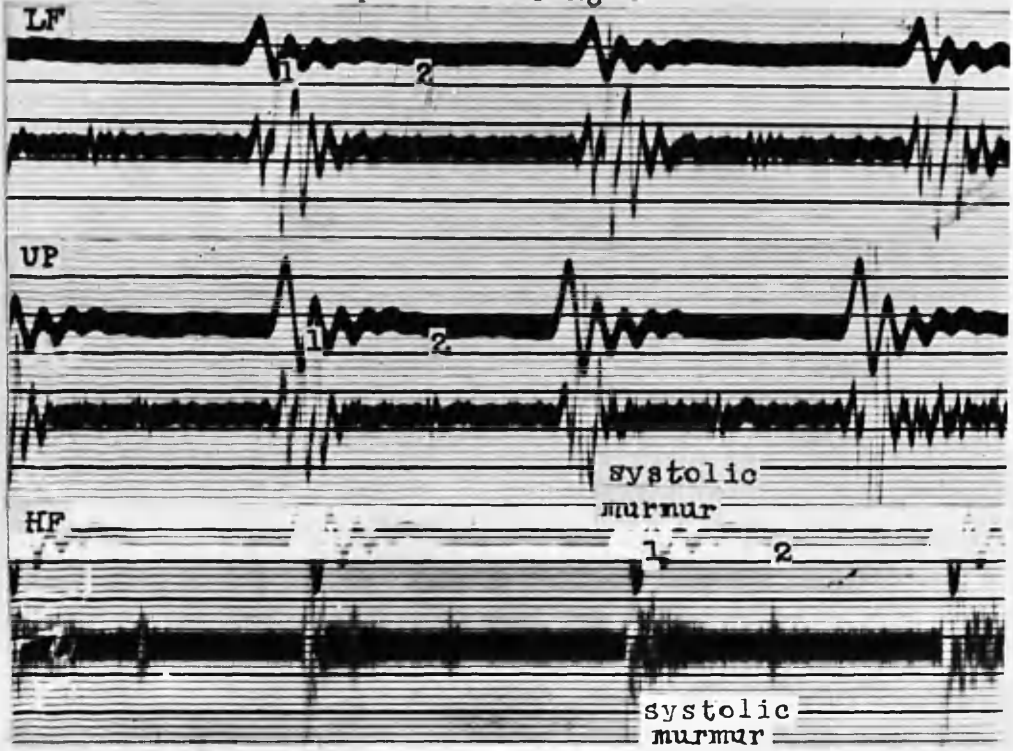
A case of moderate severity. The prominent feature was the early systolic murmur of moderate amplitude and long duration which was seen in all three recordings at the base. Radiology demonstrated dilatation and elongation of the aorta, with slight increase in cardiac size to the left. This aortic dilatation probably accounted for the murmur. A short high frequency early systolic murmur was seen at the apex, which may have been due to a degree of functional mitral incompetence.

Fig 62.

Murmurs in Thyrotoxicosis.

Early Systolic Murmurs at Apex and Base.

Apical Tracings.



Basal Tracings.

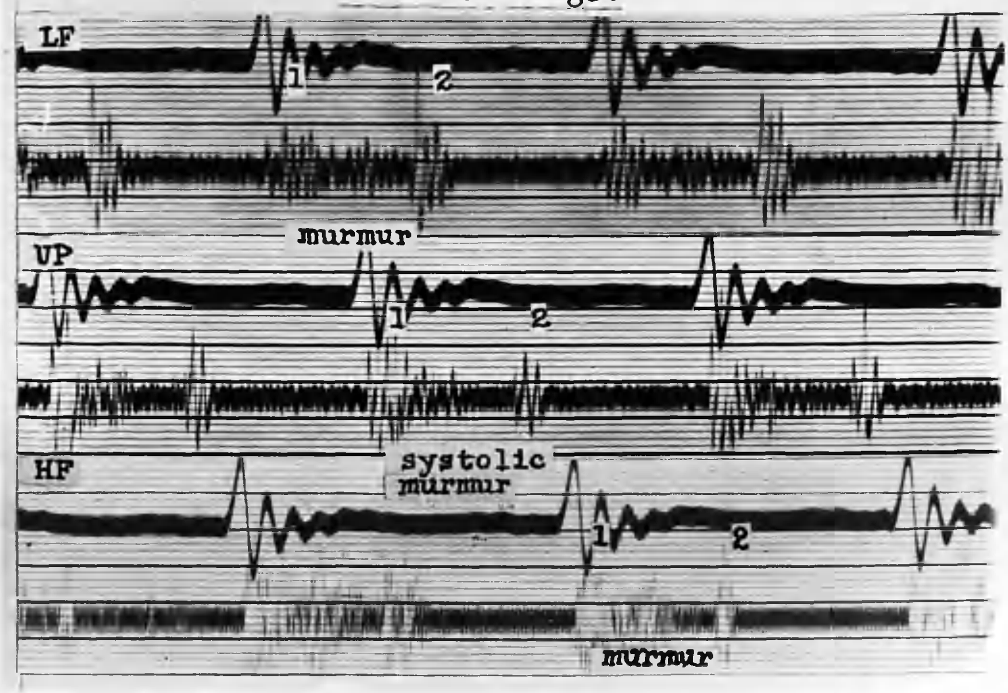


FIG. 63.

Mr. E.S., aet 51 yrs.

Tracings from over the thyroid of the previous case. The bruit was seen to be continuous through systole and diastole, diminuendo in diastole.

Murmurs in Thyrotoxicosis.

A Thyroid Bruit.

Tracings from over the Thyroid.

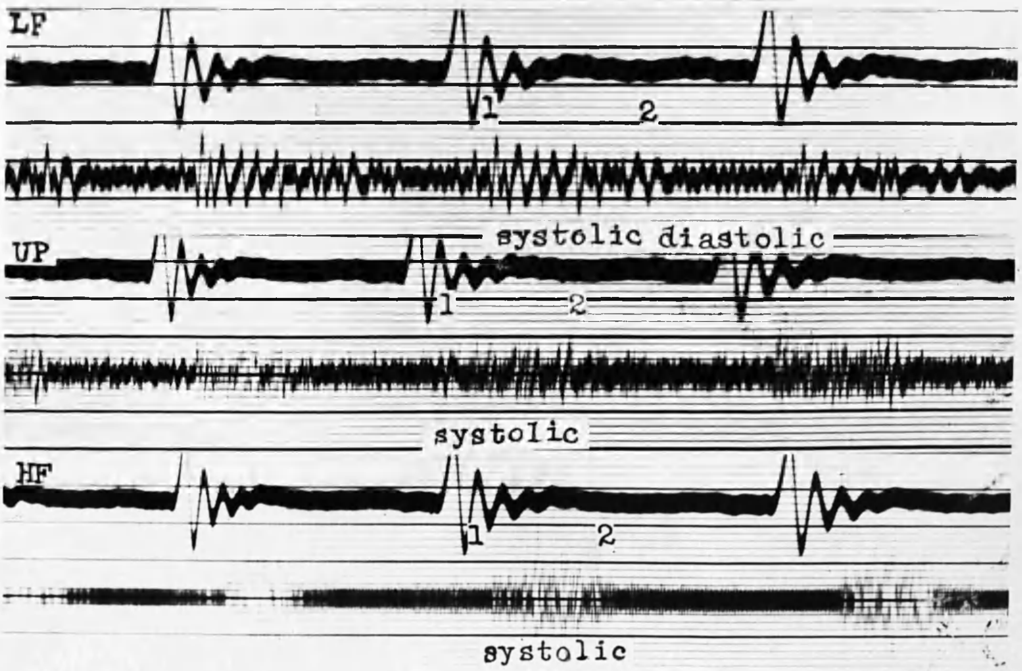


FIG. 64.

Mrs. G.S., aet 29 yrs.

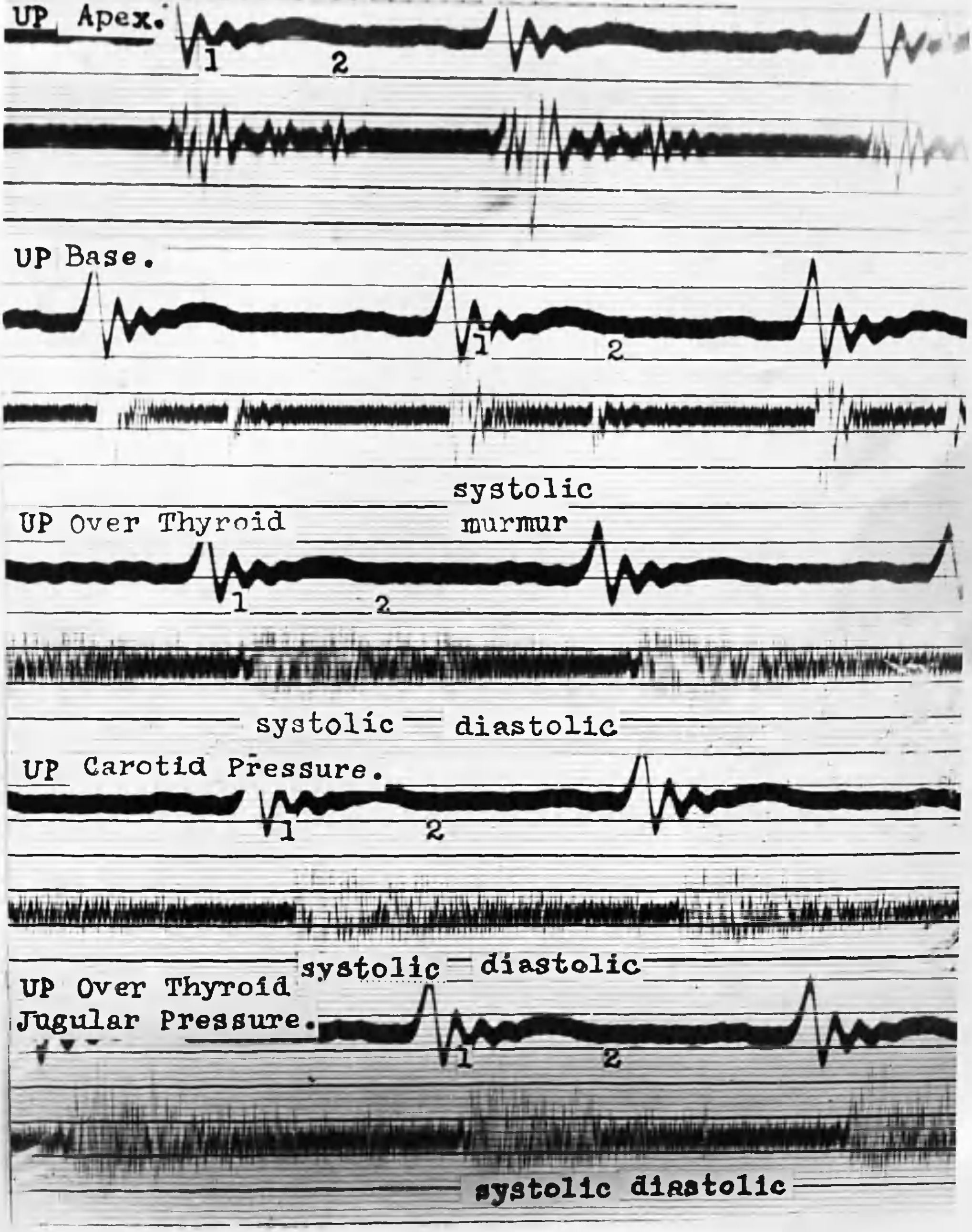
A case of moderate severity. Numerous records were taken and an extract is illustrated, using the unfiltered phonocardiograms.

A basal mid-systolic murmur of functional nature was visible. The thyroid bruit was seen to continue throughout systole and diastole diminuendo in diastole and was unaltered by pressure on the Jugular veins, or on the Carotid arteries.

Murmurs in Thyrotoxicosis.

A Mid-Systolic Basal Murmur.

The Bruit over the Thyroid Gland.



MURMURS IN HYPERTENSION

FIG. 65.

Mrs. M.McC., aet 49 yrs.

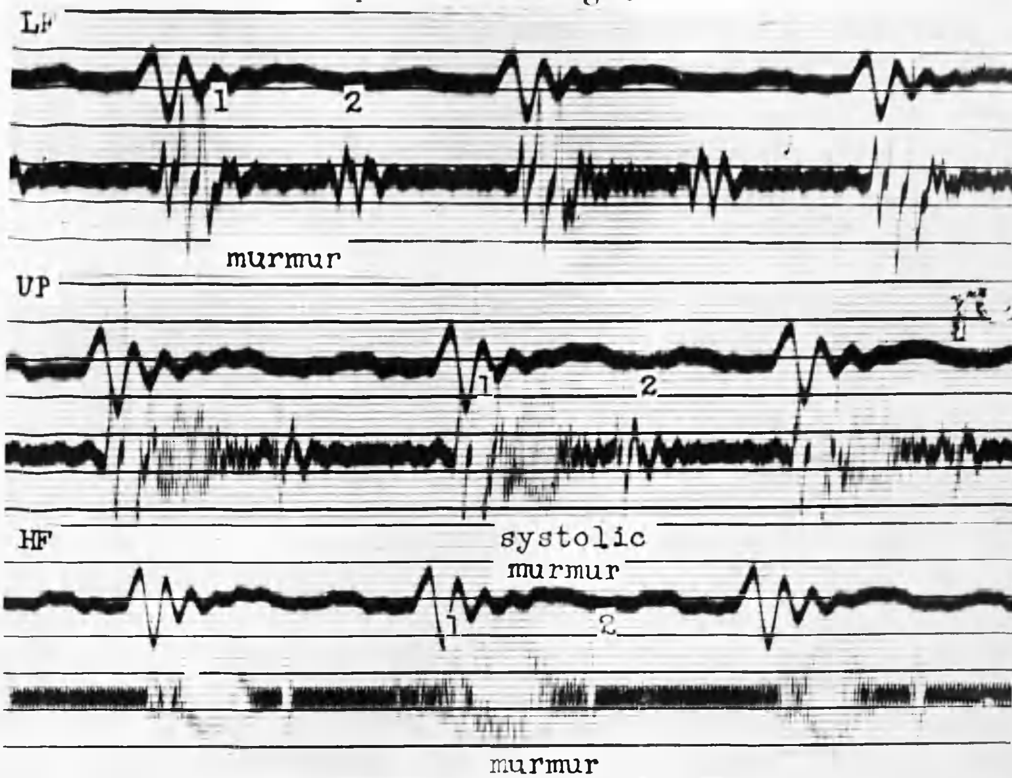
The features were the definite mid-systolic murmur of short duration and medium and high frequency at the apex, presumably due to ventricular hypertrophy; in contrast with the early, all frequency, long, high amplitude systolic murmur at the base, thought to be due to aortic sclerosis.

Fig 65.

Murmurs in Hypertension.

An Apical Mid-Systolic, and Basal Early-Systolic Murmurs.

Apical Tracings.



Basal Tracings.

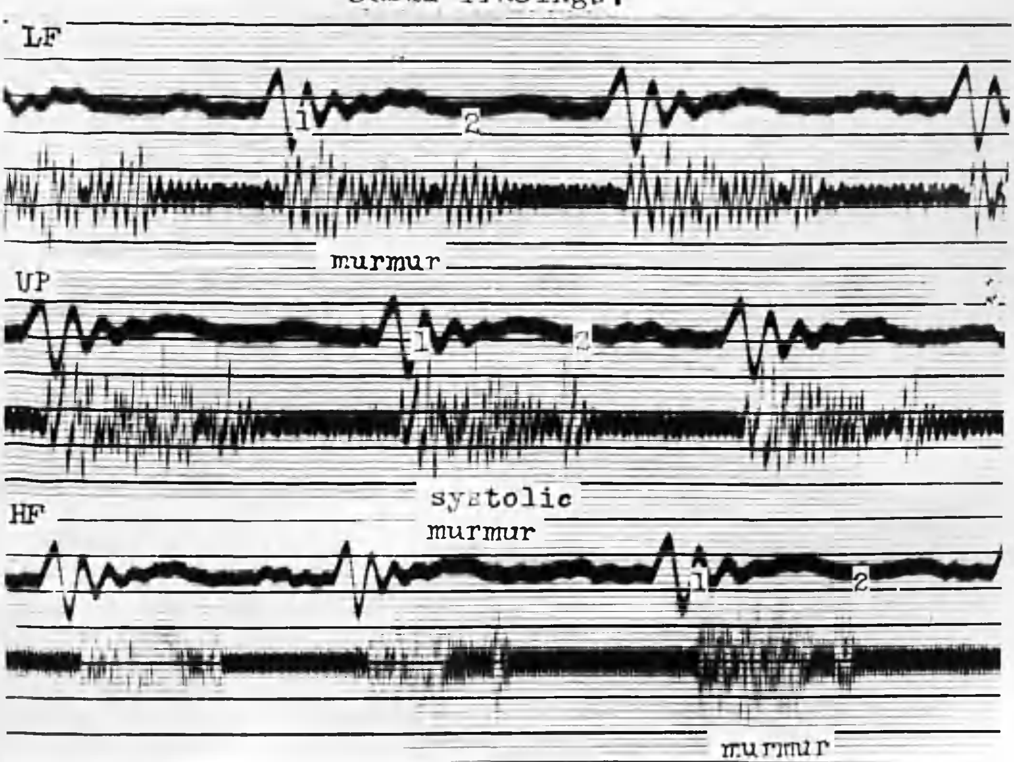
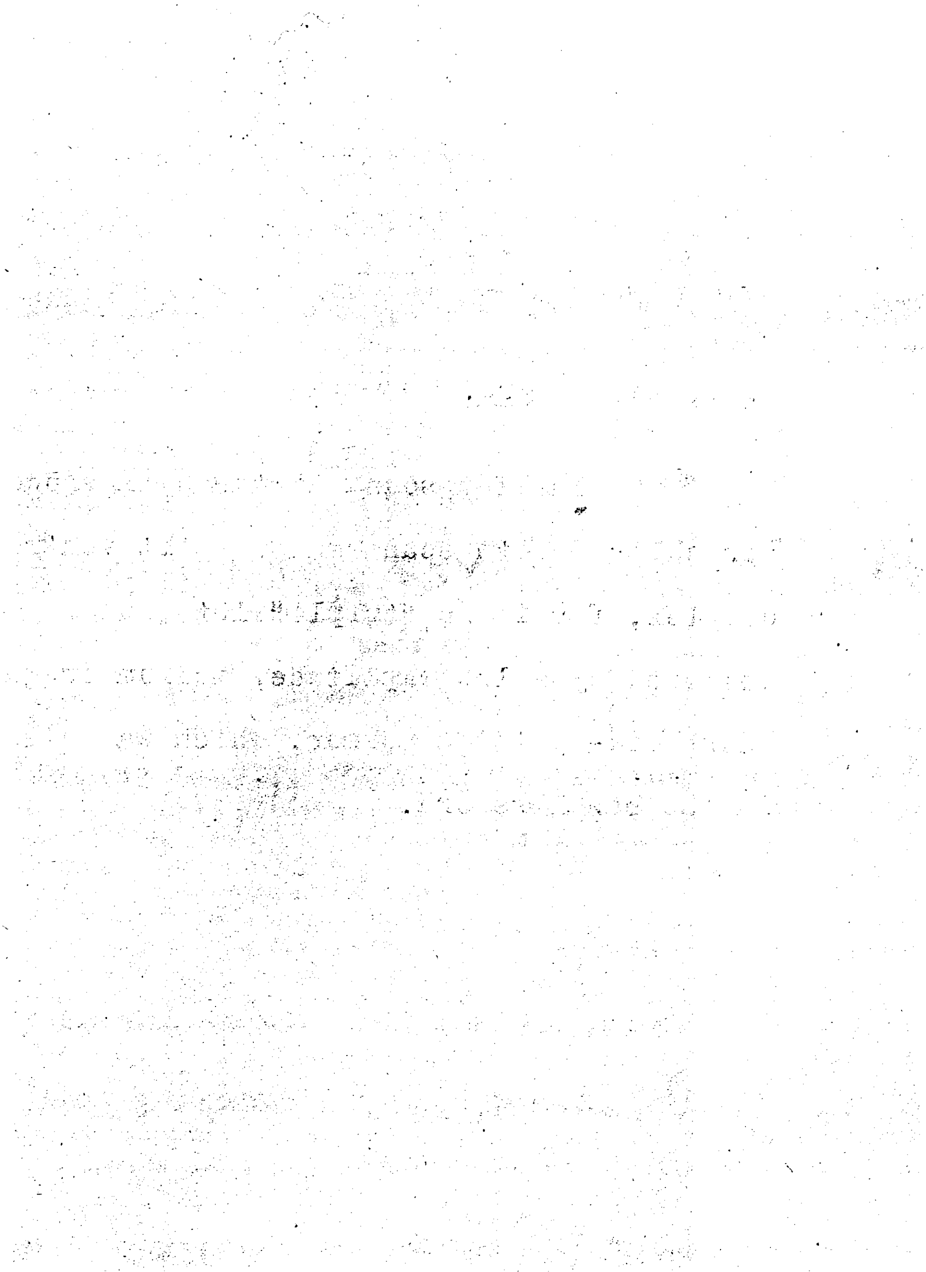


FIG. 66.



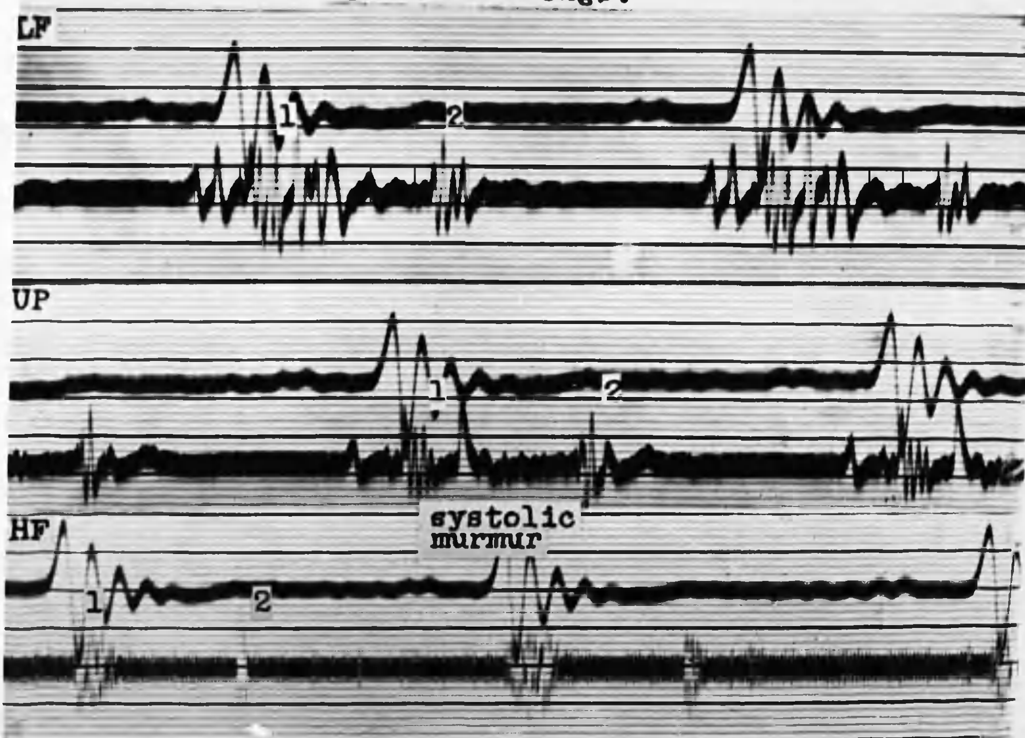
D.B., aet 60 yrs.

The 1st sound at the apex showed a marked auricular or 4th sound and a split ventricular complex, forming a "triple" 1st sound. This was followed by a low amplitude, medium frequency, short mid-systolic murmur, which was also visible in the basal record.

Murmurs in Hypertension.

A Basal Mid-Systolic Murmur.

Apical Tracings.



Basal Tracings.

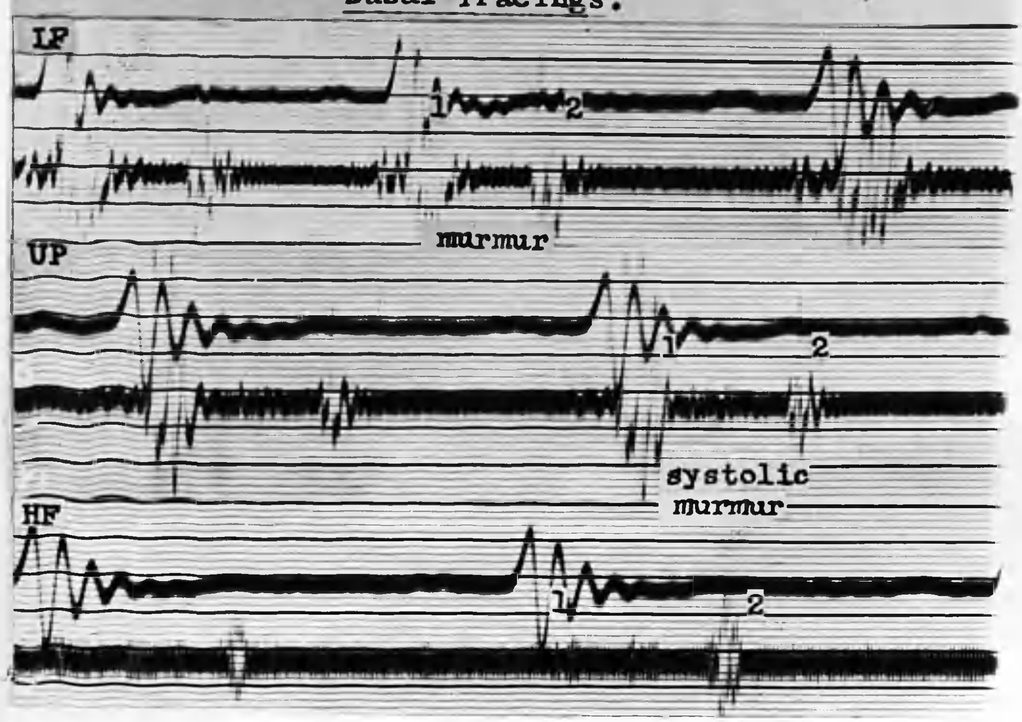


FIG. 67.

J.M., aet 69 yrs.

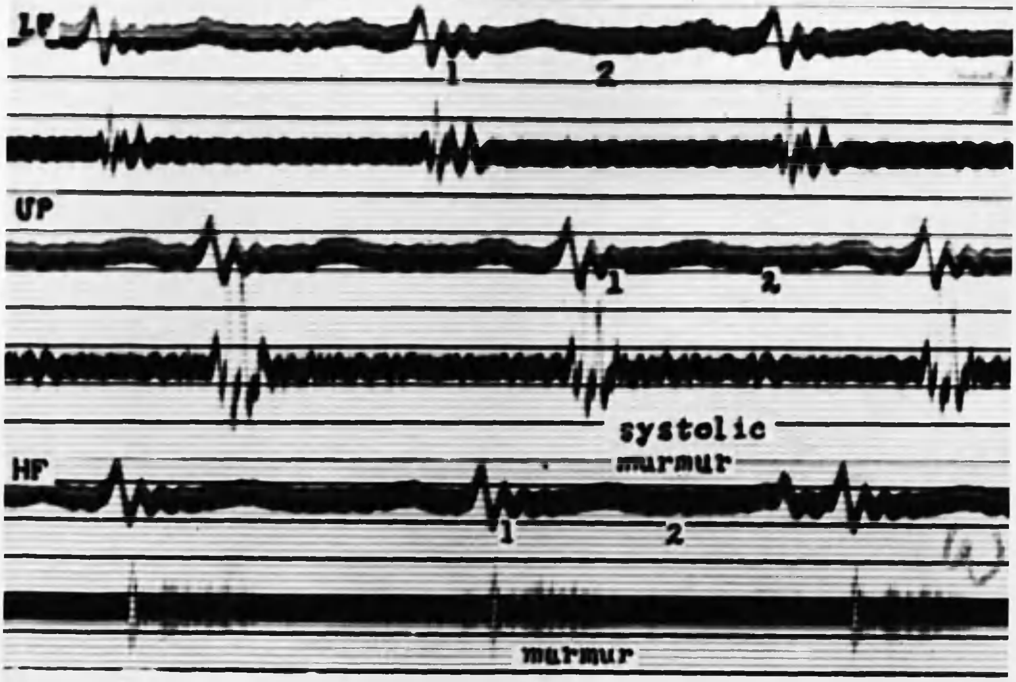
This record demonstrated an early basal systolic murmur of relatively high frequency, of low amplitude and long duration, which was probably due to a degree of sclerosis of the aortic valve, or dilatation of the aorta.

Fig 67.

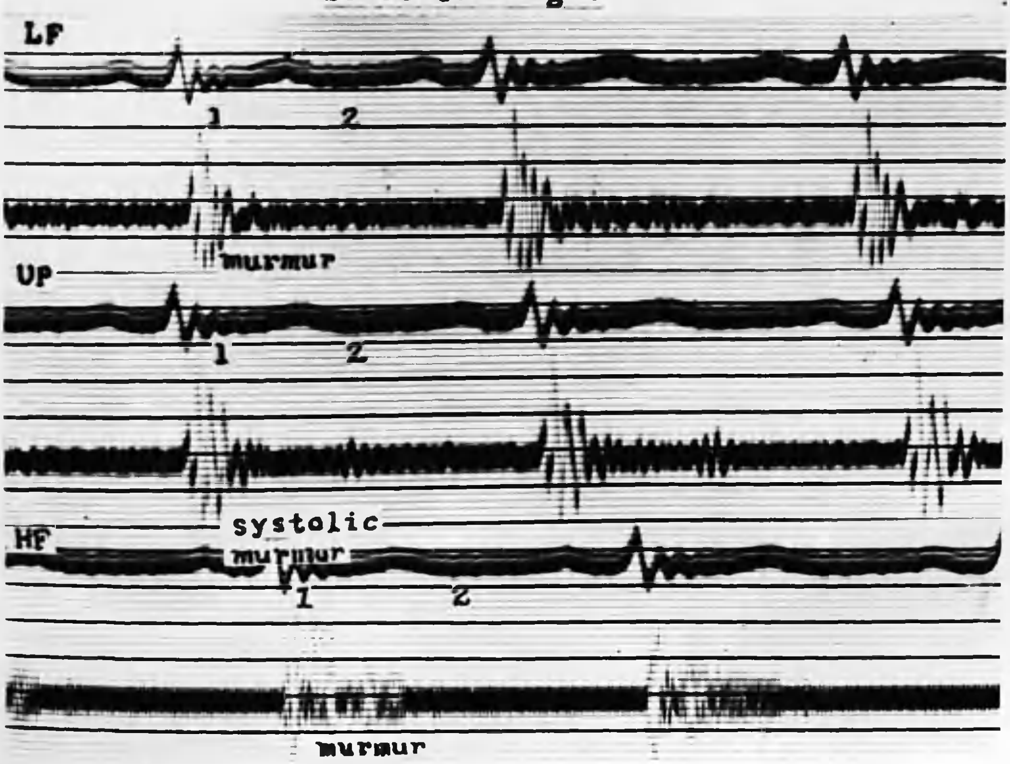
Murmurs in Hypertension.

An Early Basal Systolic Murmur

Apical Tracings.

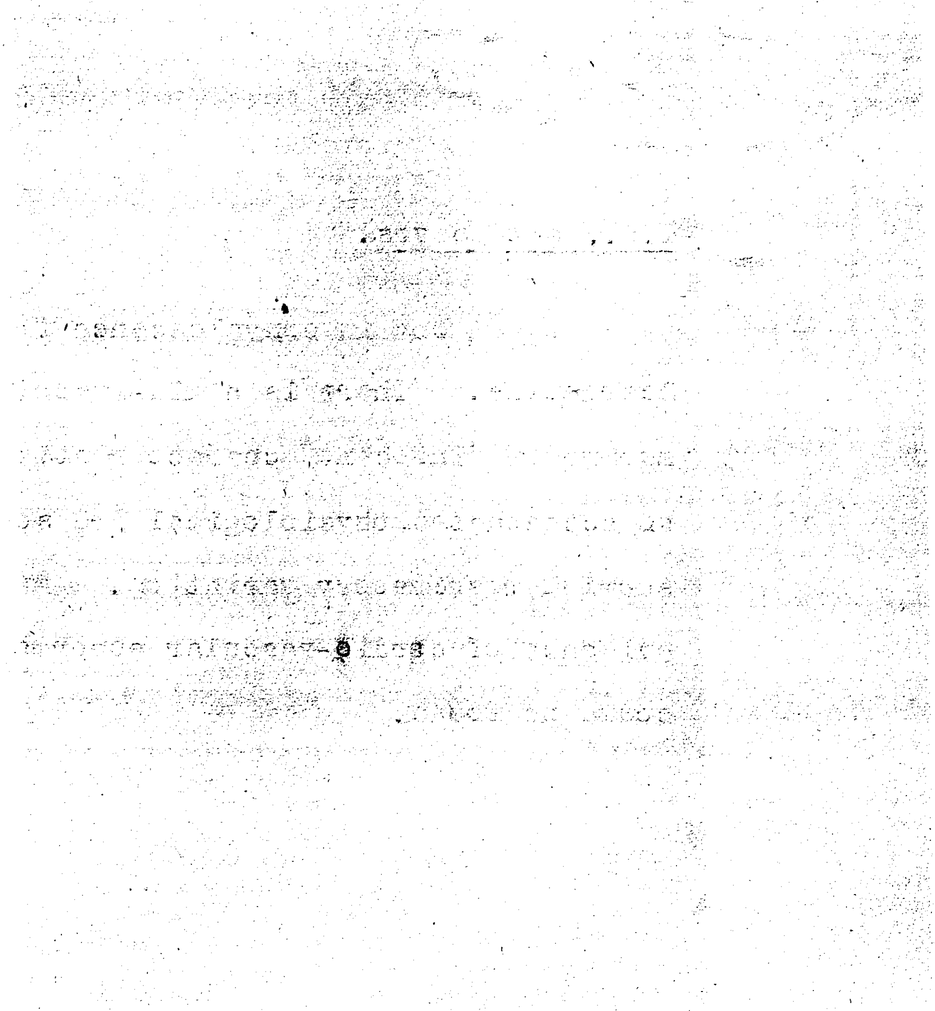


Basal Tracings.



ABNORMALITIES OF SOUNDS

FIG. 68.



T.H., aet 15 yrs.

A boy in convalescence from Scarlatina. There is a mid-systolic murmur of "innocent" characteristics and an accentuated physiological 3rd sound showing respiratory variation. No other evidence of cardio-vascular abnormality could be found.

Fig.68.

Gallop Rhythm (Diastolic).

Proto-diastolic Gallop

Rapid Ventricular Filling Gallop.

Apical Tracings.

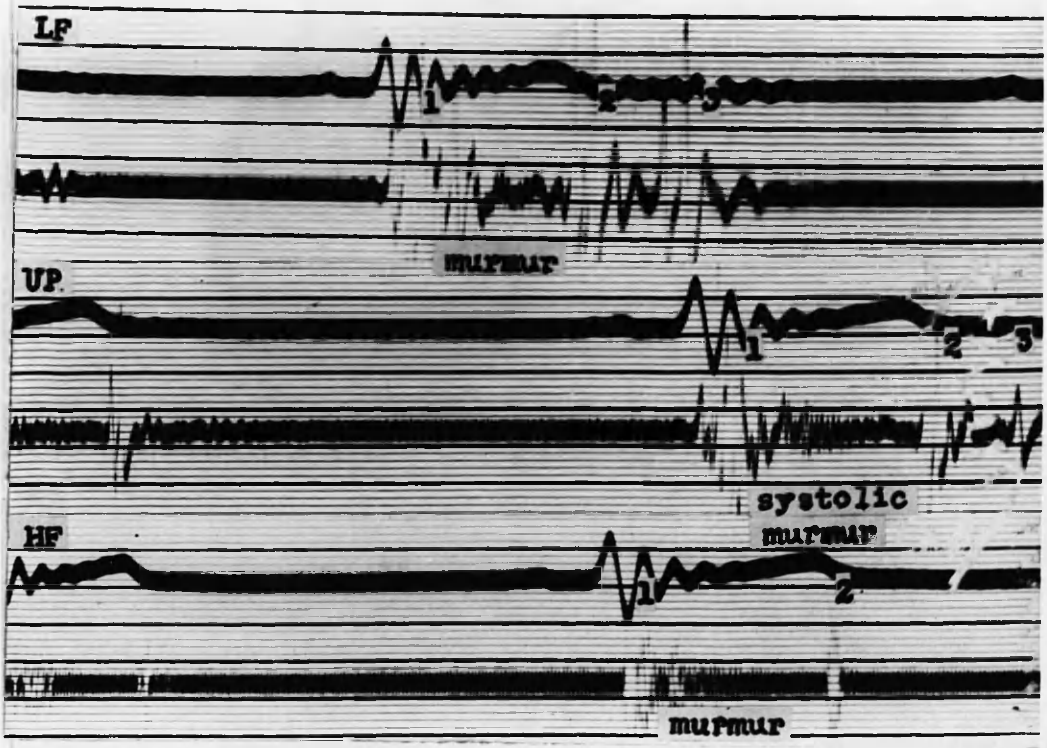


FIG. 69.

D.B. aet 60 yrs.

The auricular, or 4th sound, was clearly demonstrated. The presenting feature was hypertension of long standing, with considerable cardiac enlargement.

B.F., aet 50 yrs.

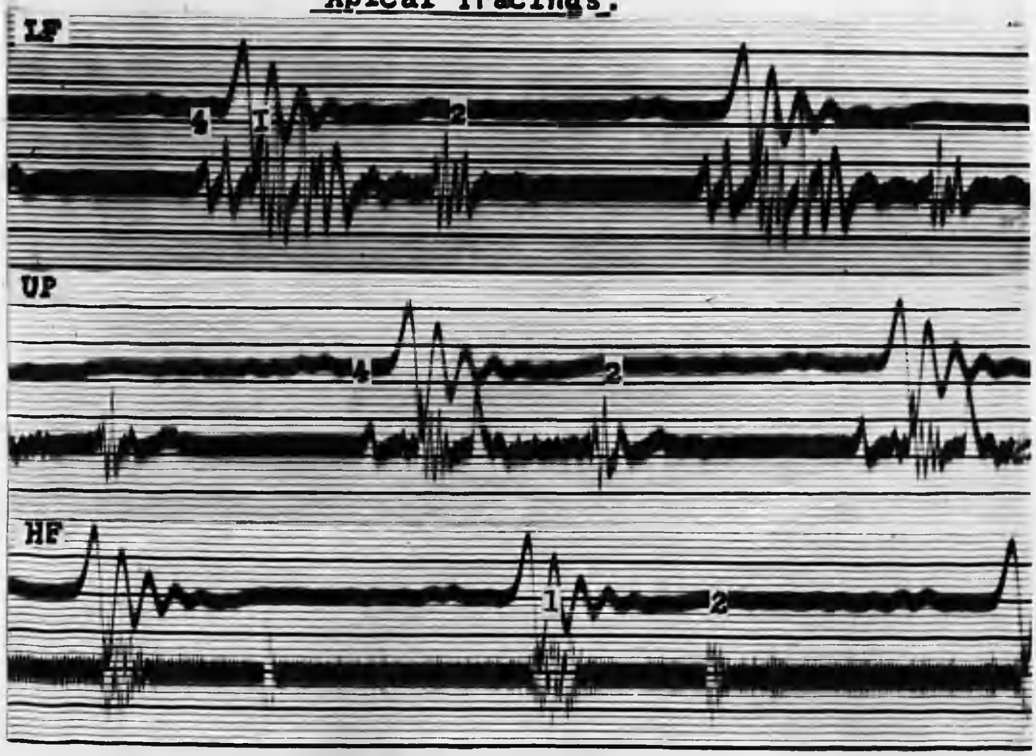
The unduly prominent auricular sound is seen. This was a case of congenital interventricular septal defect.

Fig.69.

Gallop Rhythm (Diastolic).

Presystolic Gallop Rhythm.

Apical Tracings.



Apical Tracings.

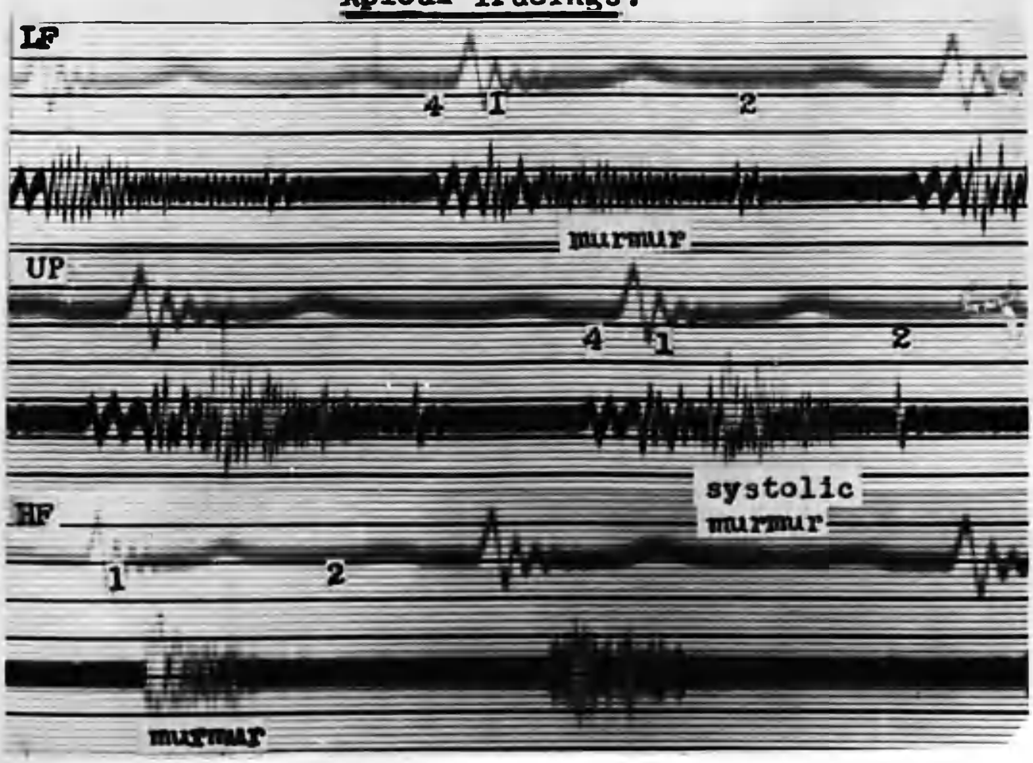


FIG. 70.

S.M., aet 30 yrs.

A case of an acute exacerbation of a chronic bronchitis and emphysema. There was tachycardia, rate 130/min. Chronic cor pulmonale developed. Autopsy showed no valvular lesions to be present. There was superimposition, or summation, of the 3rd and 4th sounds to form a sound which was clearly audible, though the rapidity of the heart beat prevented precise timing and definition. The phonocardiogram showed it's exact timing and origin.

Fig.70.

Gallop Rhythm (Diastolic).

Summation Gallop Rhythm.

Apical Tracings.

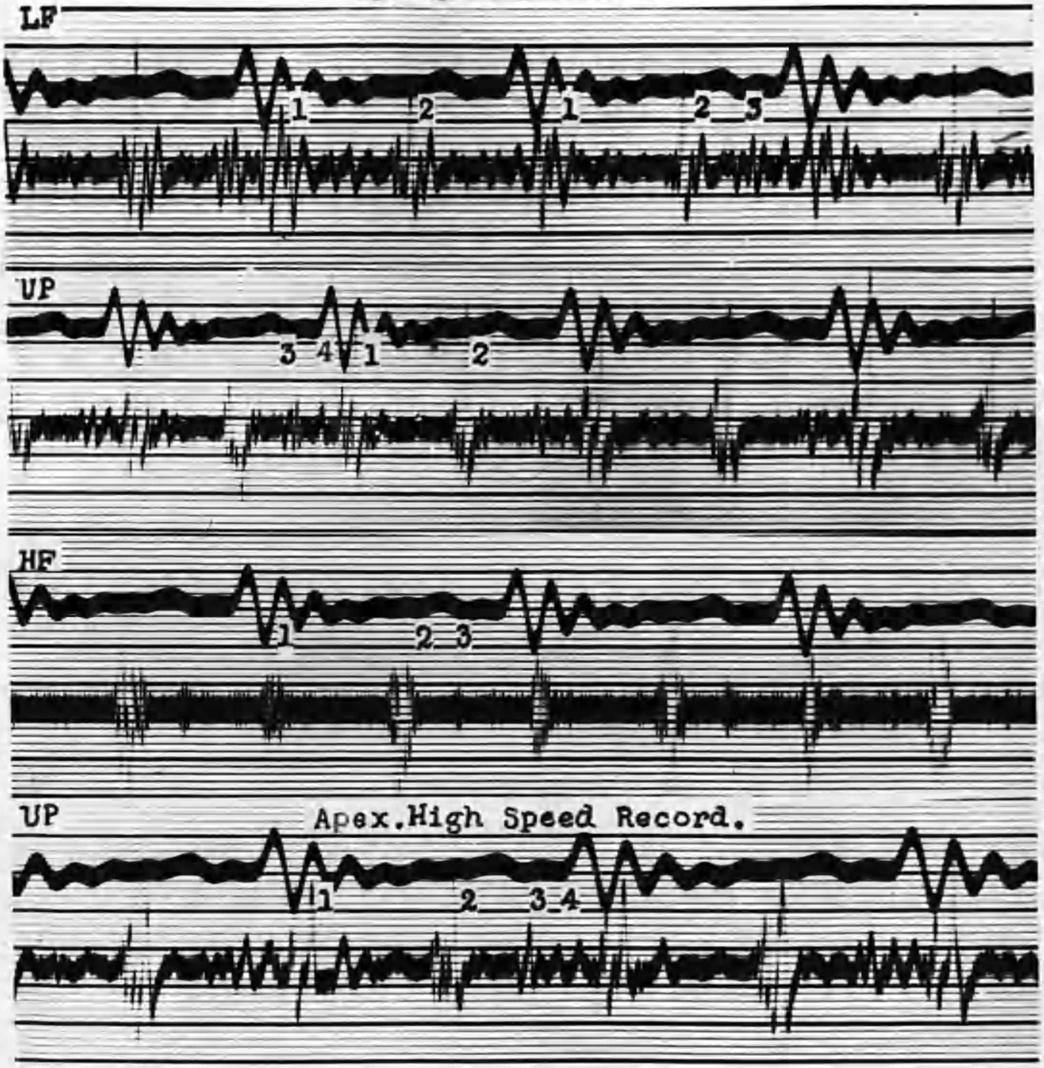


FIG. 71.

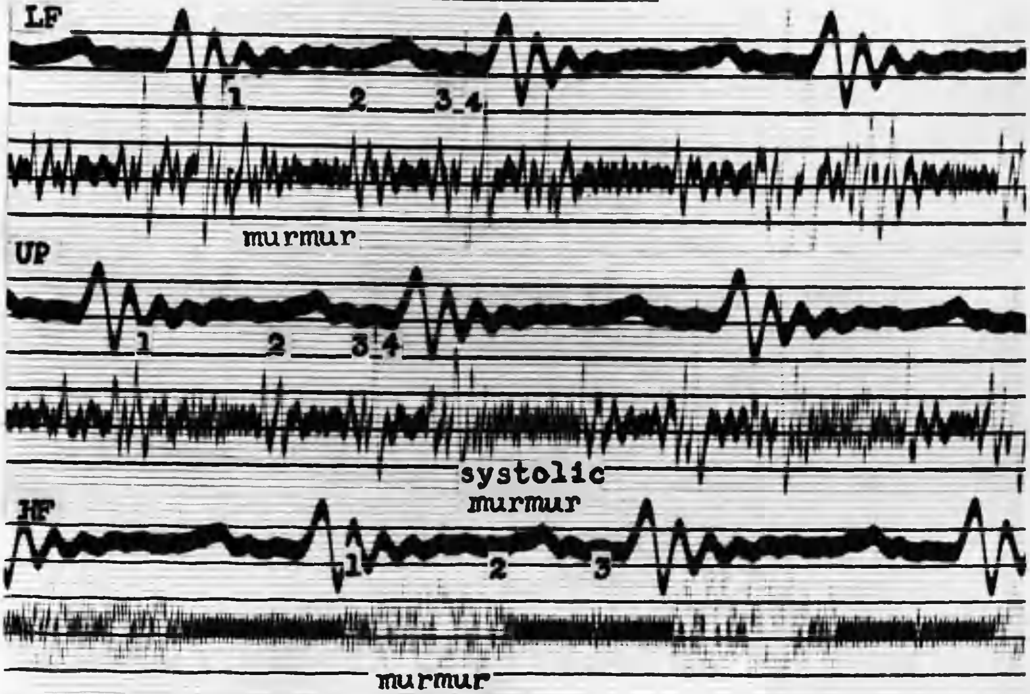
M.McL., aet 19 yrs.

A congenital heart lesion was present. Eisenmenger's Syndrome was the final diagnosis. Because of the marked tachycardia, rate 130/min., there was a summation gallop present, similar in nature to the previous case.

Gallop Rhythm (Diastolic).

Summation Gallop Rhythm.

Apical Tracings.



Basal Tracings.

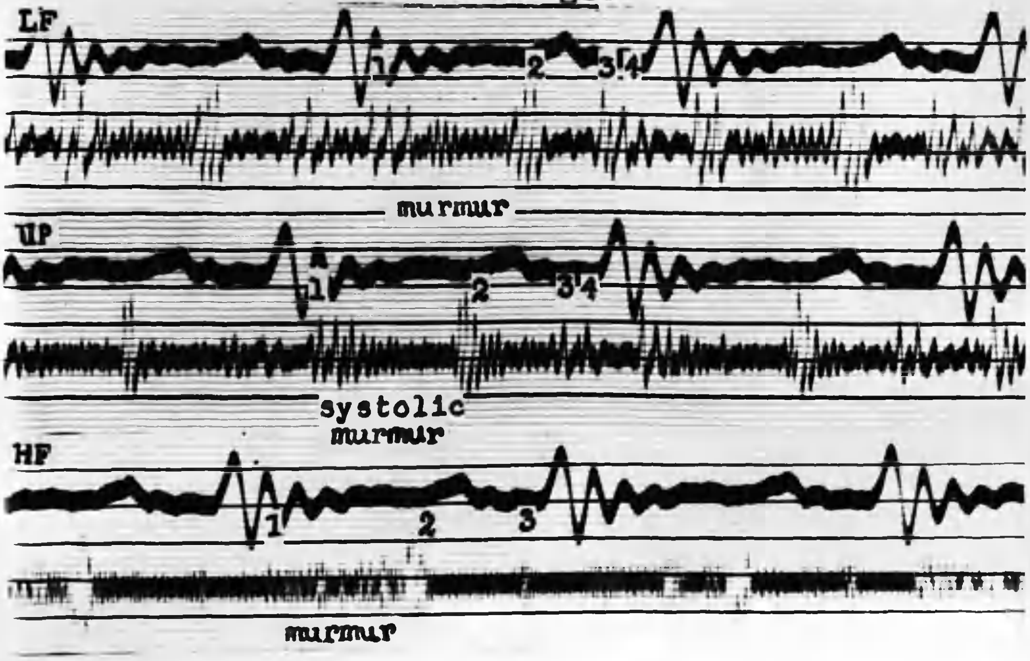


FIG. 72.

I.R., aet 12 yrs.

A boy with marked chronic bronchitis and early chronic cor pulmonale. There was an unusual form of split 1st sound with what was thought to be an accentuated 5th sound (auricular-diastolic sound) due to a hypertrophied and dilated right auricle.

J.R., aet 22 yrs.

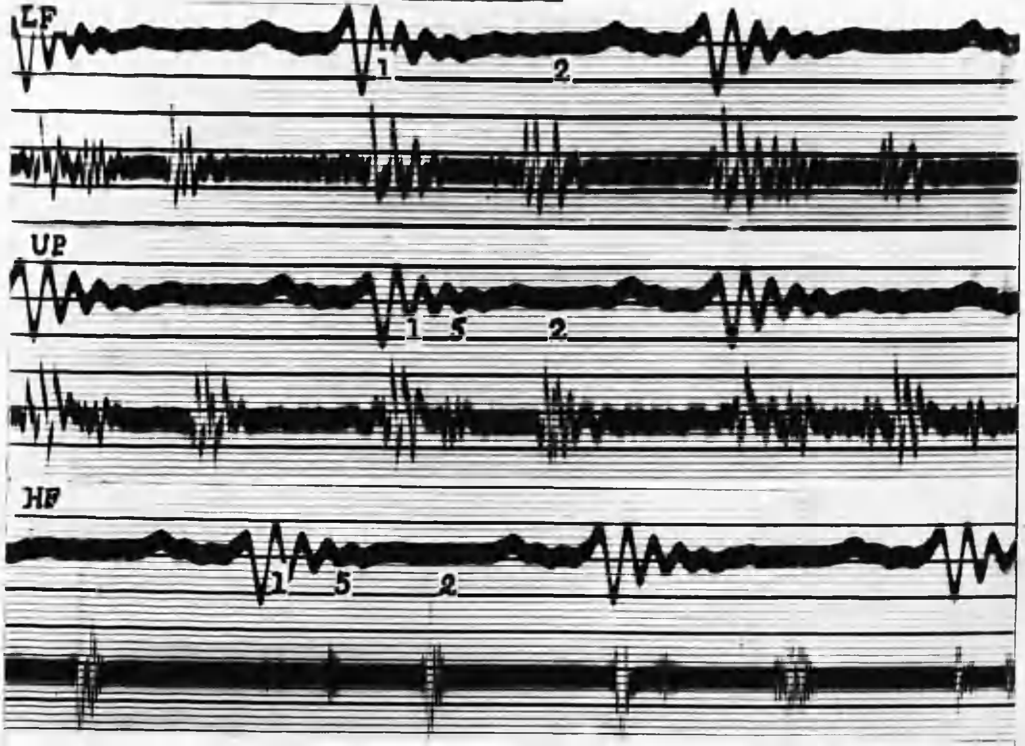
This slow speed record was taken from a case of interventricular septal defect with complete heart block. The auricular sounds could not be defined with certainty in a high speed record due to their low amplitude.

Fig.79.

Gallop Rhythm (Systolic).

The 5th Sound Type.

Apical Tracings.



Isolated Auricular Sounds.

Basal Tracings.

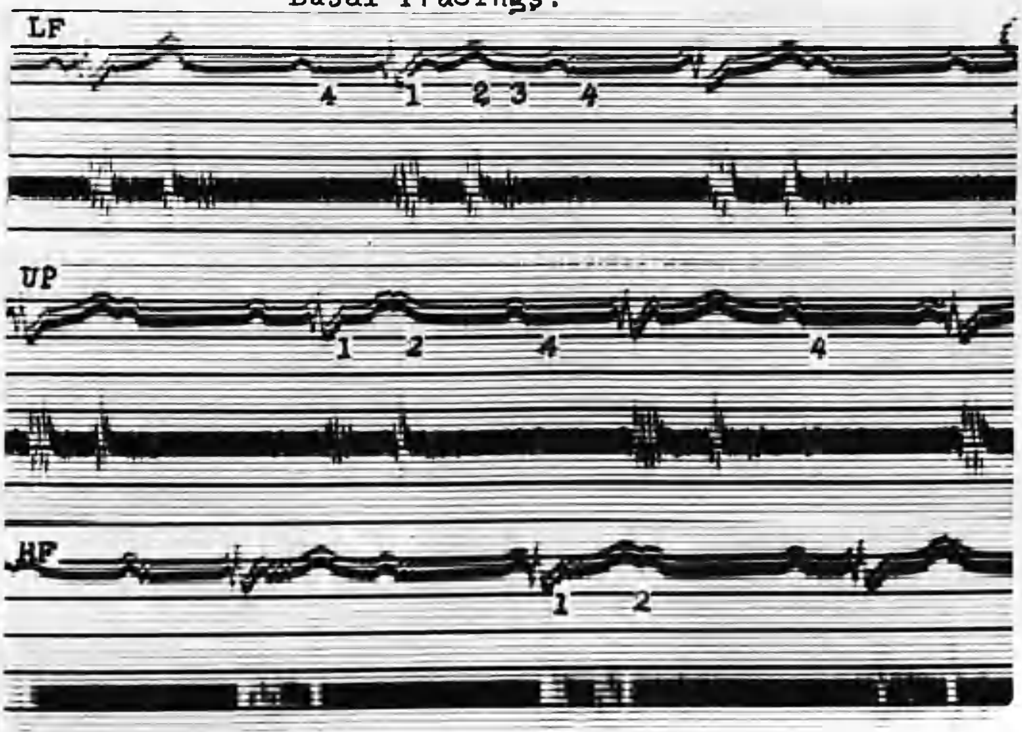


FIG. 73.

W.D., aet 55 yrs.

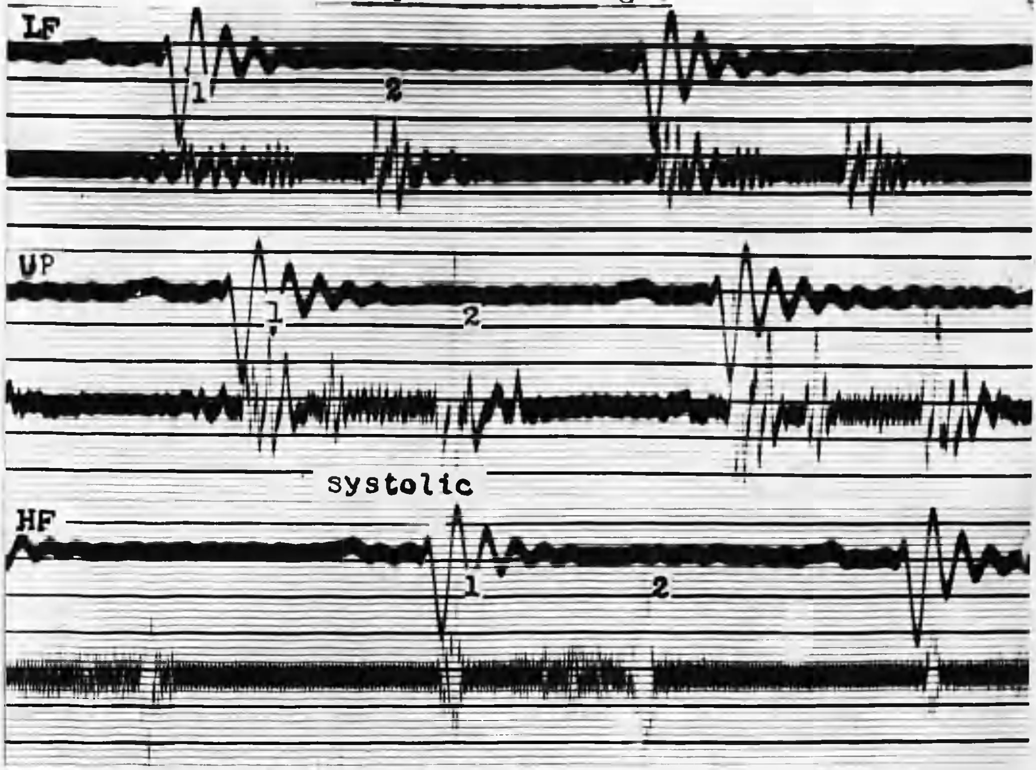
A man with marked hypertension B.P. 280/100, without clinical or radiological evidence of cardiac enlargement. There was a sound in early systole which may have been due to the separation of the isometric components of the 1st heart sound, or was an extra sound in early systole. A mid-systolic murmur of "functional" characteristics followed this sound.

Fig.73

Systolic Gallop Rhythm.

Isometric Splitting of the First Sound.

Apical Tracings.



Basal Tracings.

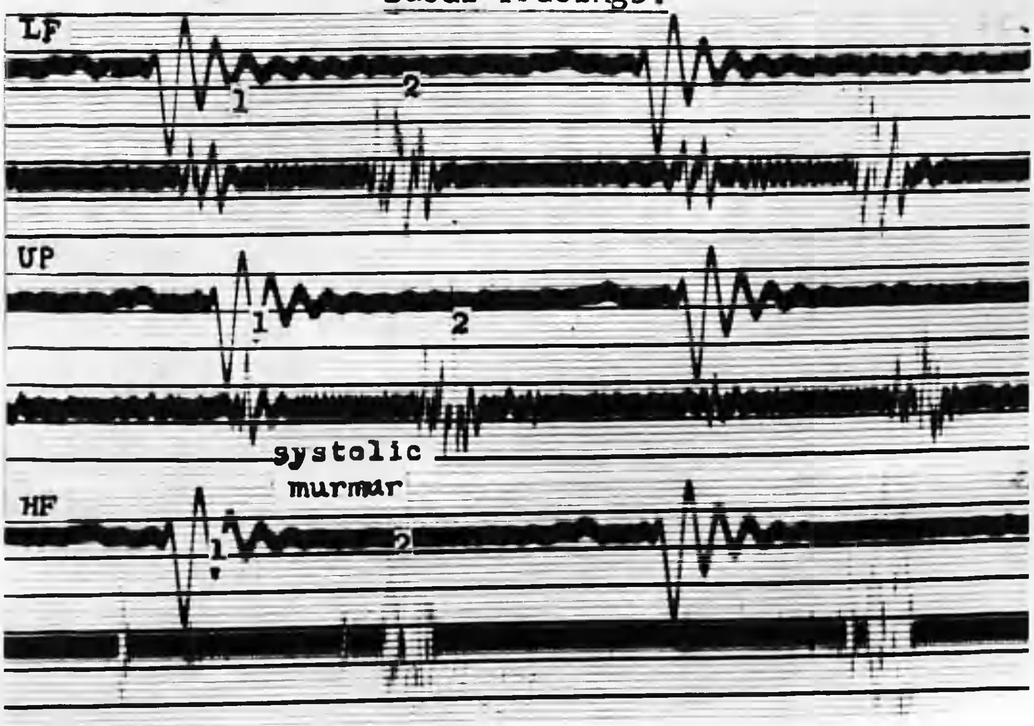


FIG. 74.

J.G., aet 50 yrs.

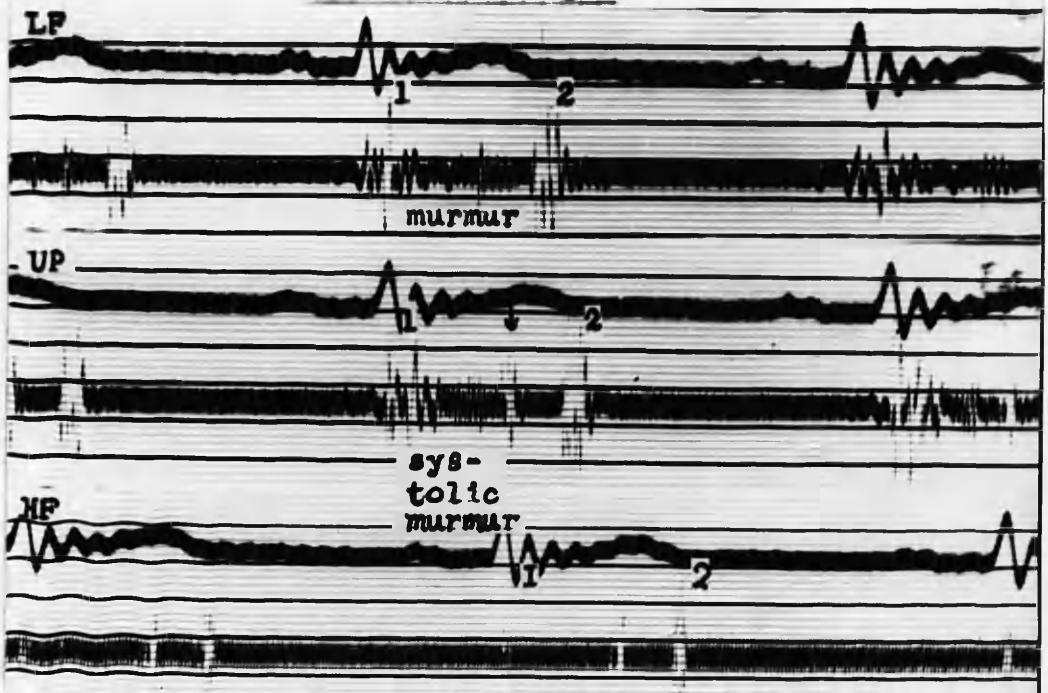
This extra sound was discovered on routine examination of a man who complained of dyspepsia of peptic ulcer type. No other evidence of cardiovascular abnormality could be found. It was audible as a "clicking" sound. The systolic murmur was mid-systolic in timing, of low amplitude, narrow frequency range, and short duration. These changes were thought to be "innocent" in nature.

Fig. 74

Gallop Rhythm (Systolic).

An Extra Sound in Late Systole.

Apical Tracings.



Basal Tracings.

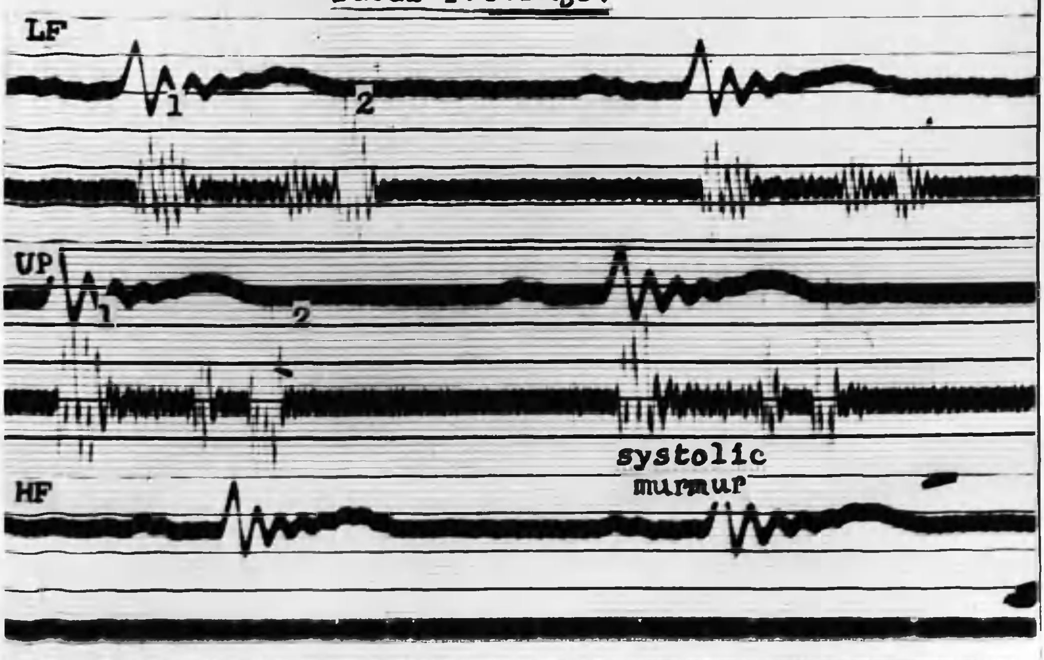


FIG. 75.

F.W., aet 42 yrs.

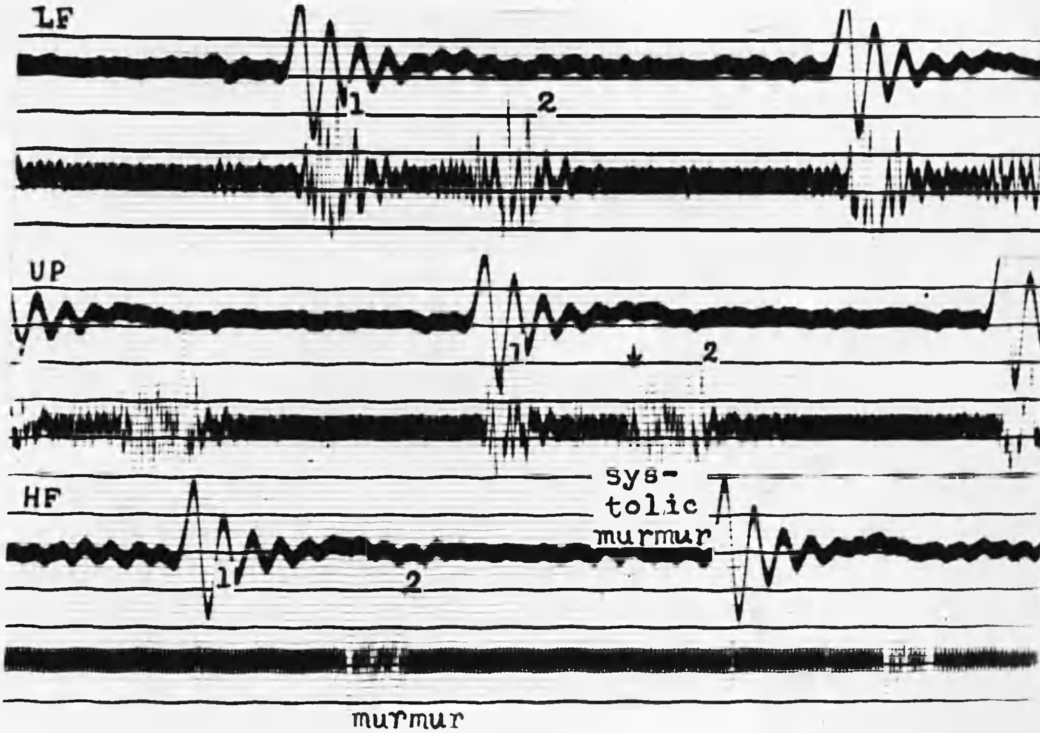
A man who presented himself with a history of haemoptysis for which no definite cause could be found. A triple rhythm and indefinite murmur raised the possibility of mitral stenosis. The phonocardiograph gave the proper timing and perspective to the changes in heart sounds. Further investigation was essentially negative, the cardiac shadow was normal on screening. There was a systolic murmur following an extra sound in late systole, both of which were probably cardio-respiratory in nature.

Fig. 75.

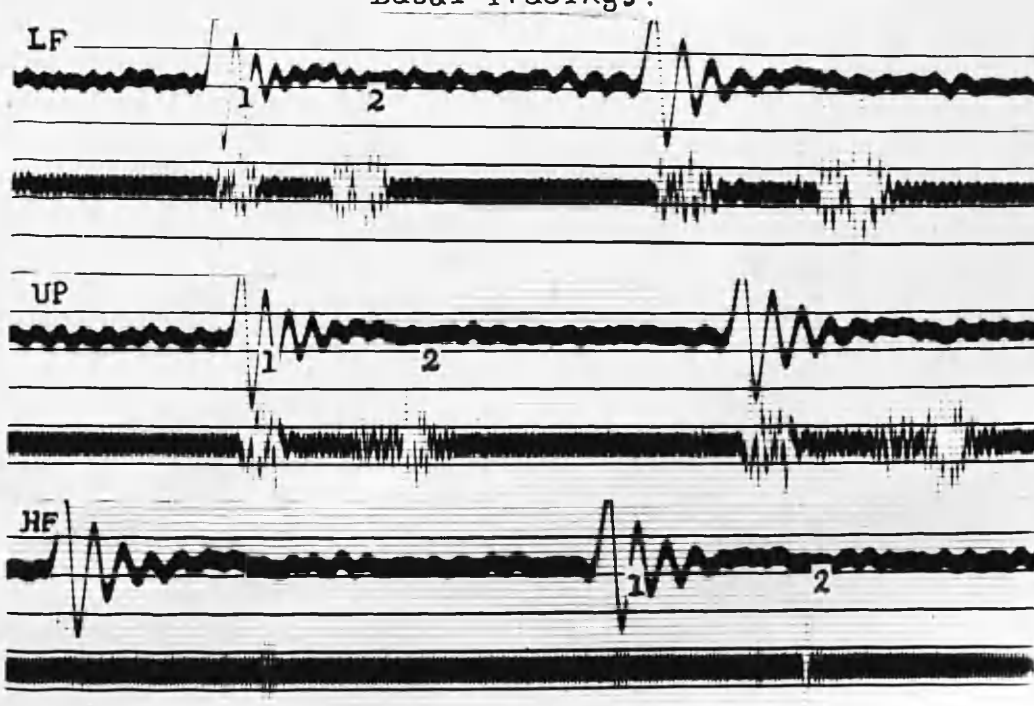
Gallop Rhythm (Systolic).

An Extra Sound in Late Systole.

Apical Tracings.



Basal Tracings.



MURMURS IN CONGENITAL HEART DISEASE

FIG. 76.

C.W., aet 24 yrs.

Clinical examination and investigation confirmed the diagnosis of interauricular septal defect.

The apical tracing showed a mid-systolic murmur, of low amplitude and short duration. The basal tracing showed a more prominent short mid-systolic murmur. A very low amplitude, high frequency early diastolic murmur followed the 2nd sound.

Interauricular Septal Defect.

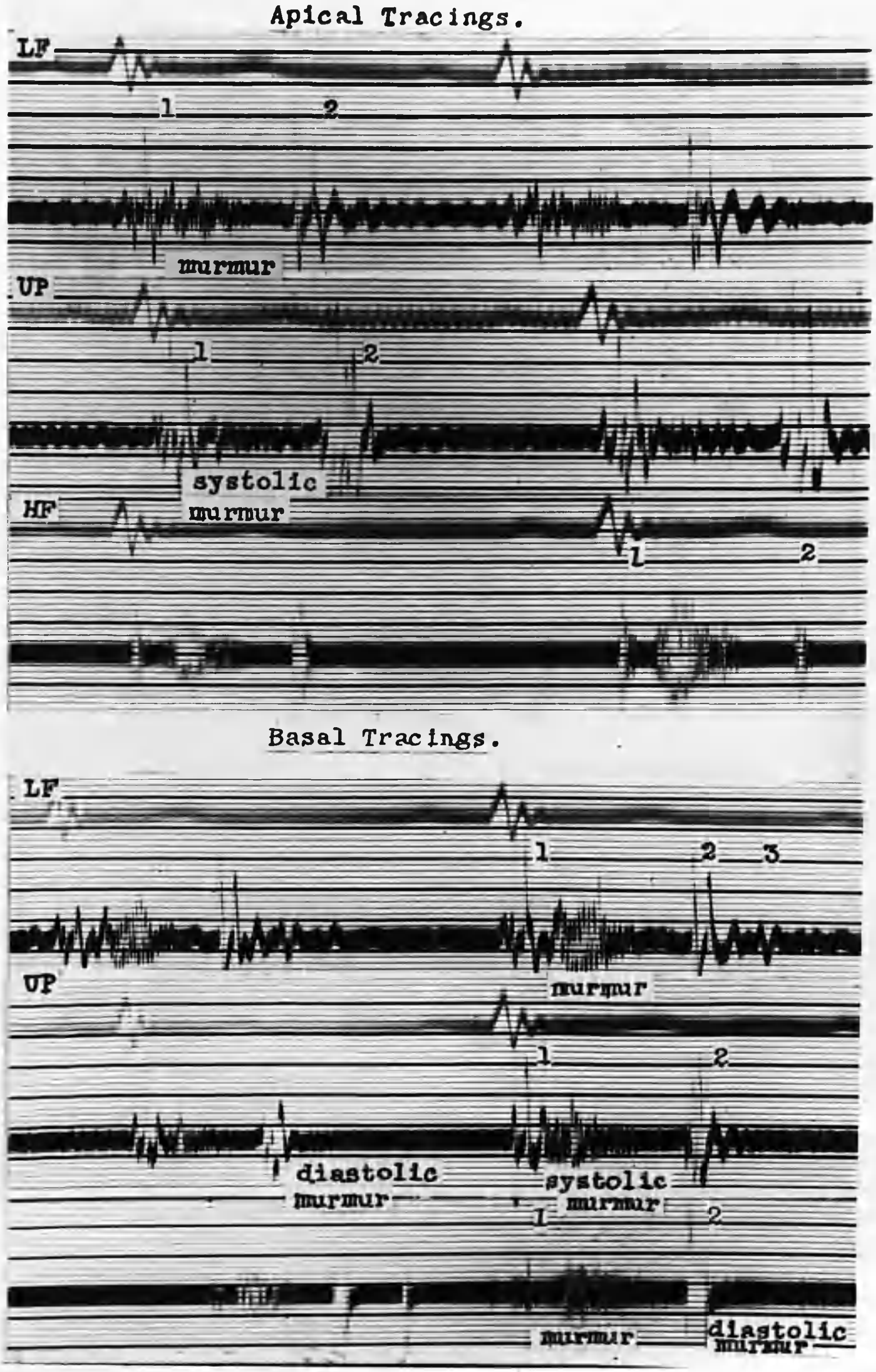


FIG. 77.

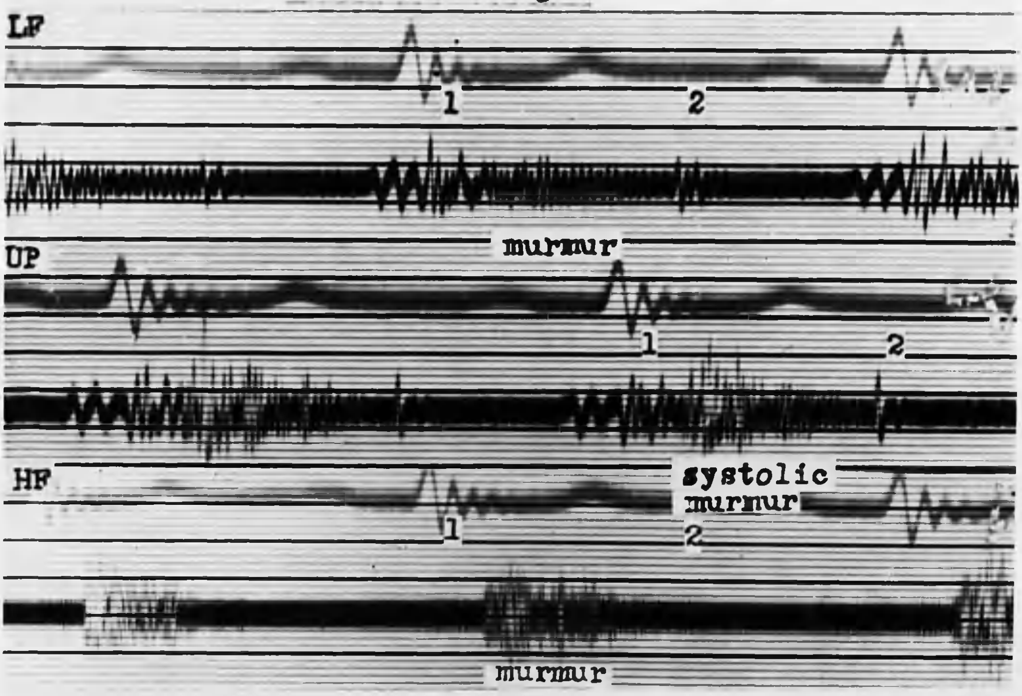
B.F., aet 50 yrs.

This case presented as a haematemesis. Examination and investigation revealed the presence of an interventricular septal defect. The typical murmur of this lesion was well demonstrated.

There was an early systolic murmur, beginning with the 3rd complex of the 1st heart sound, of wide frequency range, long duration, and with a crescendo - decrescendo character.

Interventricular Septal Defect.

Apical Tracings.



Basal Tracings.

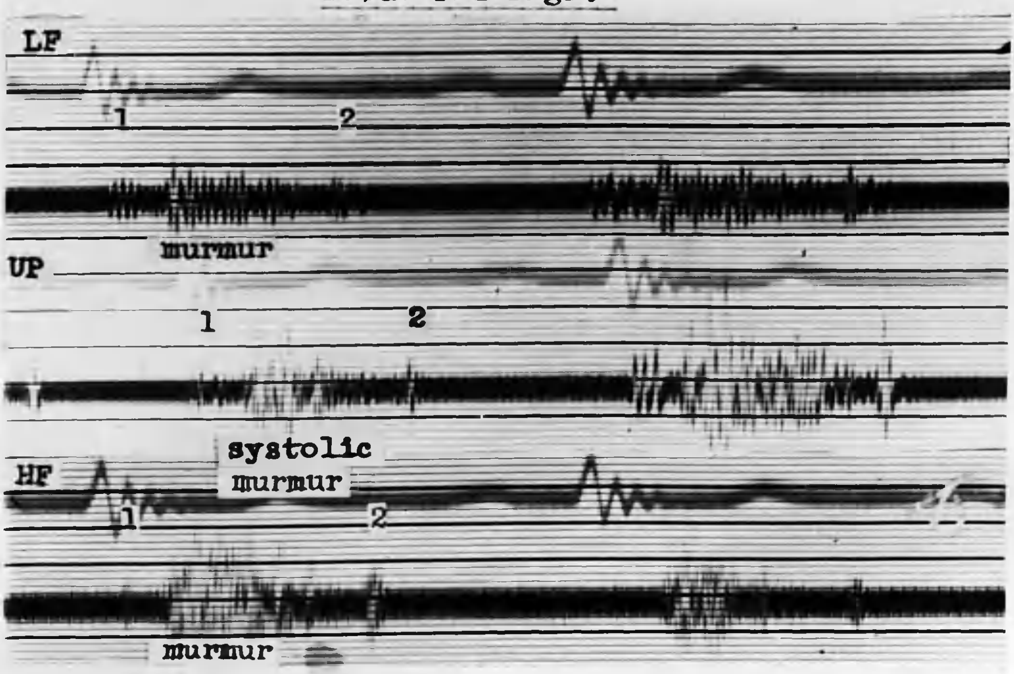


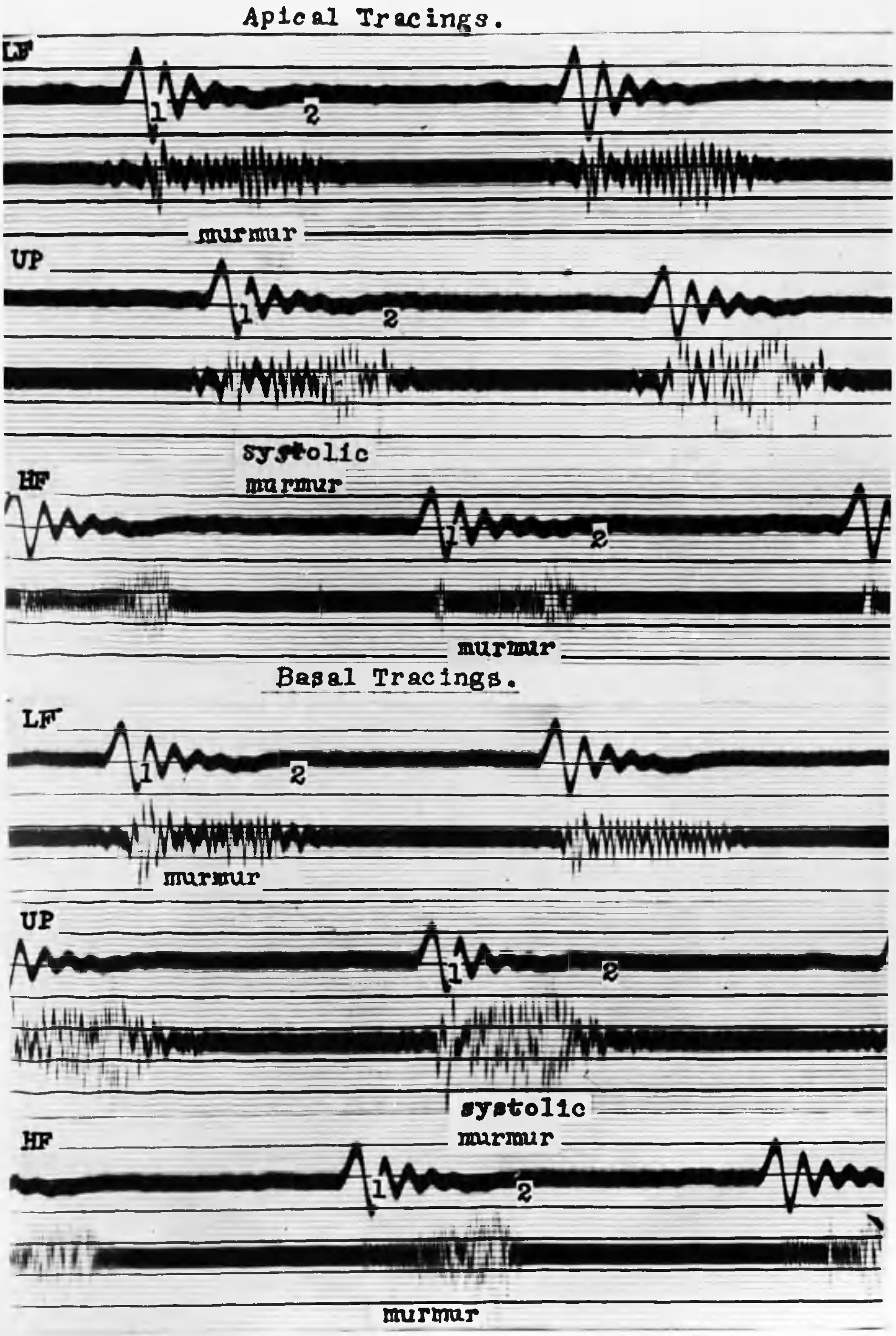
FIG. 78.

P.L. aet 20 yrs.

A further example of the typical murmur of Interventricular Septal Defect, similar in characteristics to the previous case and illustrating tracings taken from over the area of maximum intensity of the murmur at the 4th left intercostal space.

Fig. 78.

Interventricular Septal Defect.



Interventricular Septal Defect.

Tracings from the 4th. Left Intercostal Space.

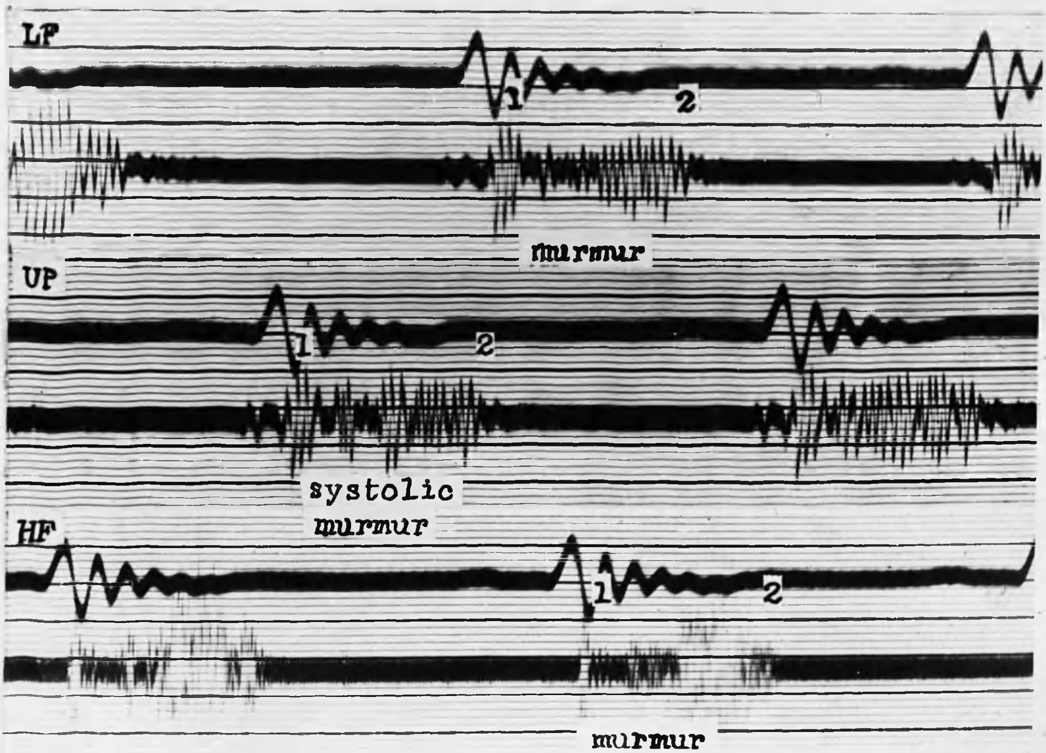


FIG. 79.

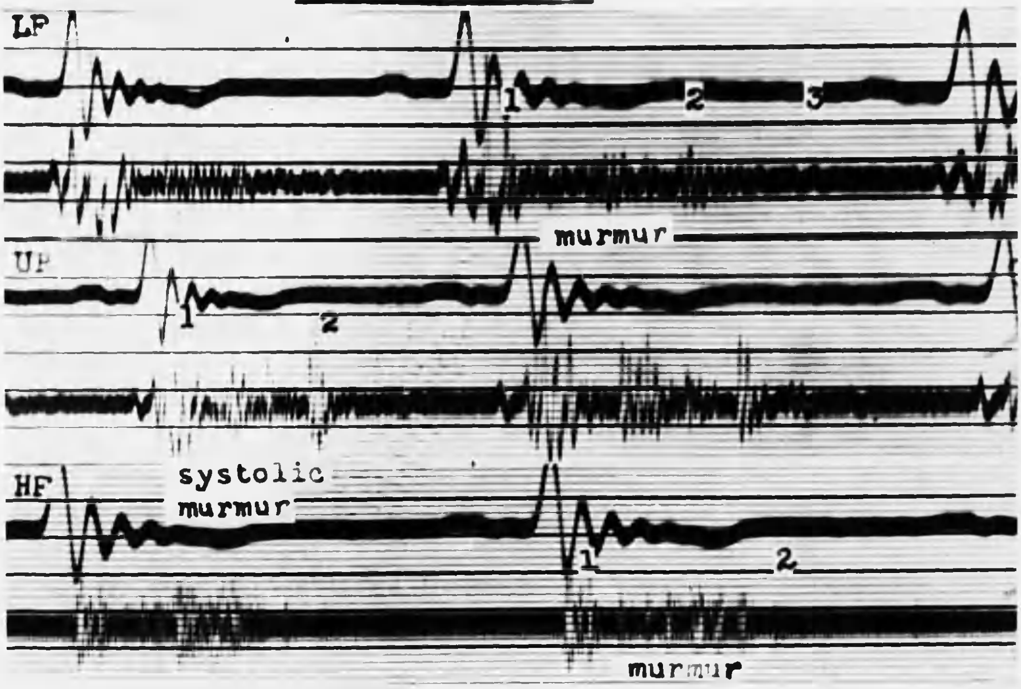
J. McG., aet 27 yrs.

This record was derived from an aortic stenosis who gave no history of a rheumatic infection. The lesion may have been congenital in origin. There was an early systolic murmur at the base, of wide frequency range, high amplitude and long duration. The apical murmur may be due to a degree of mitral incompetence.

Fig.79.

Aortic Stenosis (?congenital).

Apical Tracings.



Basal Tracings.

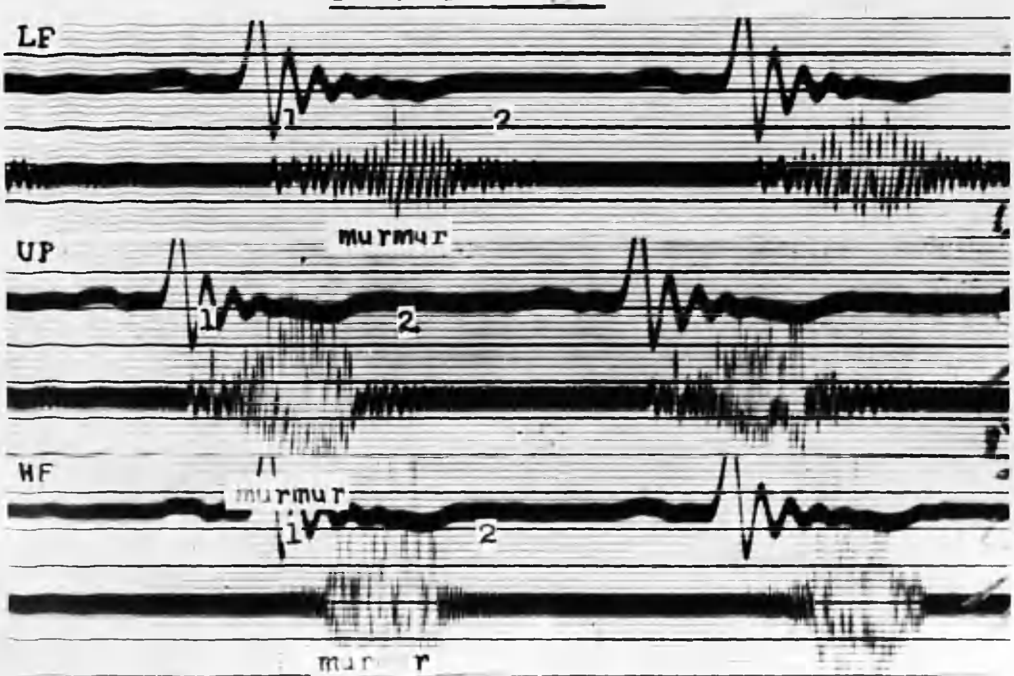


FIG. 80.

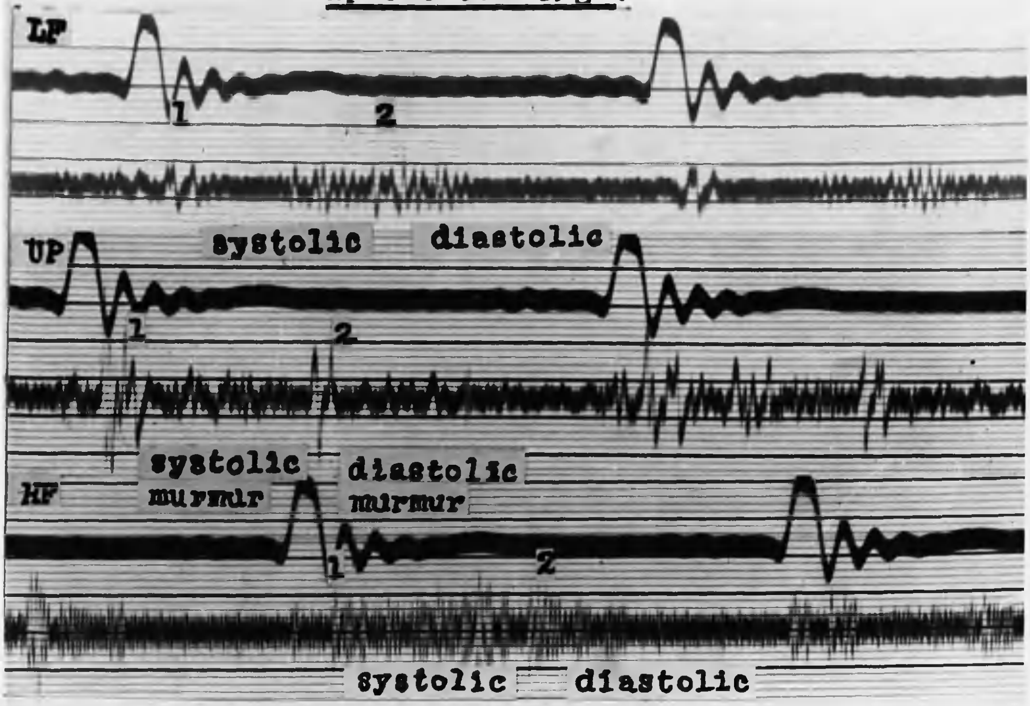
C.S., aet 18 yrs.

The apical systolic murmur was mid-systolic in timing and may have been due to ventricular hypertrophy. The aortic diastolic murmur was well recorded in the apical tracings and had characteristic features. At the base a practically continuous bruit, which was of comparatively wide frequency range and low amplitude, was recorded.

Coarctation of the Aorta.

and Aortic Incompetence.

Apical Tracings.



Basal Tracings.

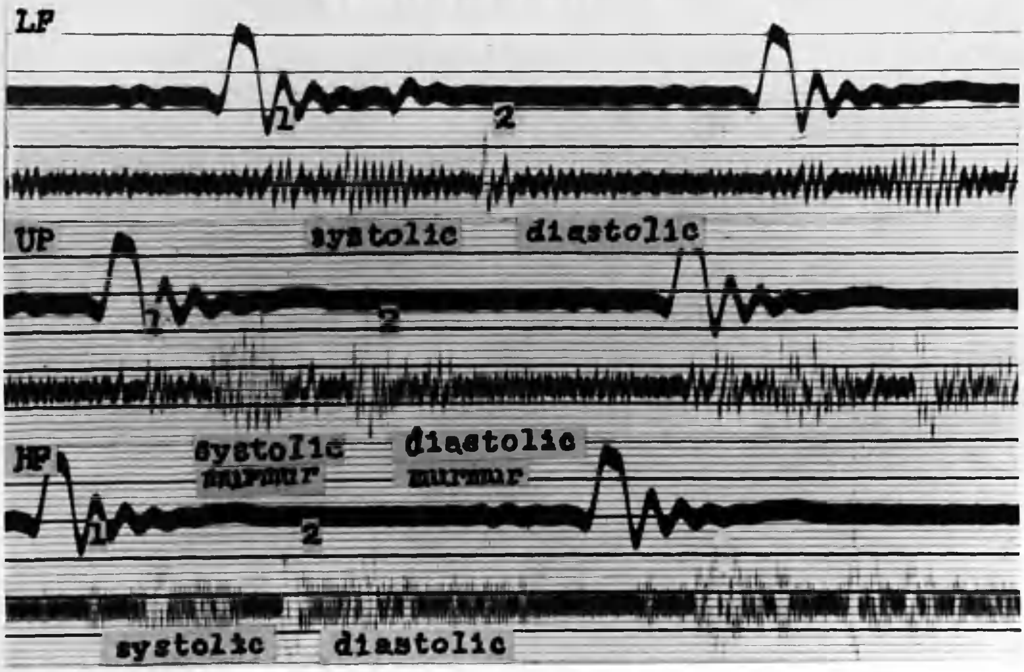


FIG. 81.

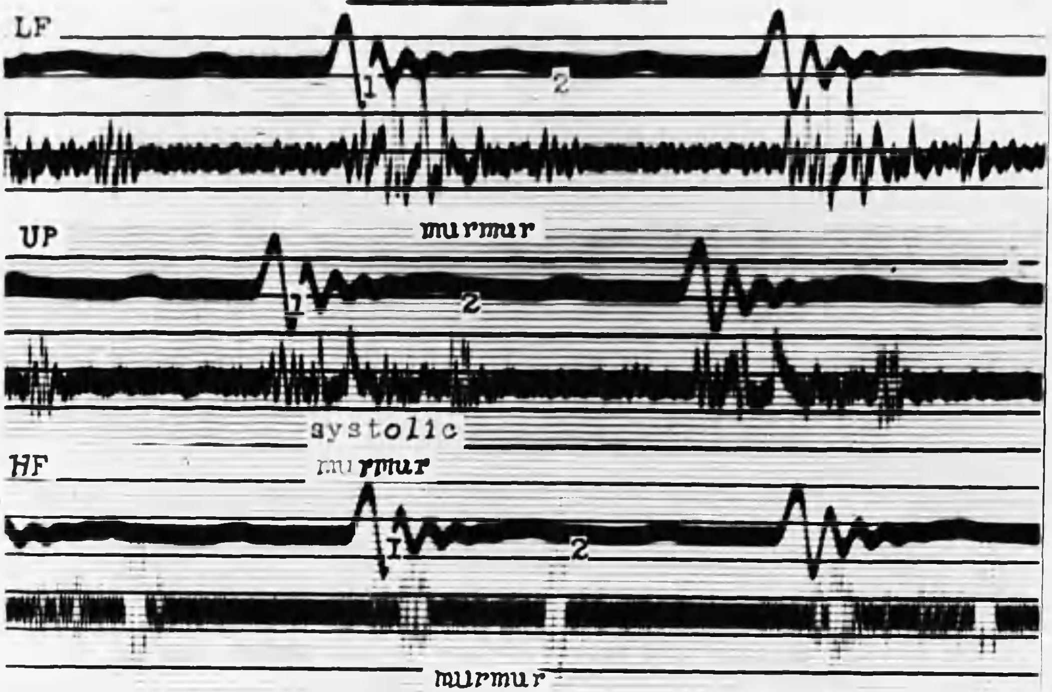
J.I., aet 14 yrs.

The murmurs were somewhat similar to the previous case. A feature seen in both records, but more marked in this one was the prolonged split first sound. This was seen in other cases of co-arctation of the aorta. The apical murmur was mid-systolic.

At the base systolic and diastolic murmurs were recorded. The systolic murmur was earlier than the apical murmur, the frequency range wider, and the duration longer. It may be due to a degree of sclerosis of the aortic valve. The diastolic murmur has the early onset and higher frequency characteristic of the murmur of aortic incompetence.

Coarctation of the Aorta.

Apical Tracings.



Basal Tracings.

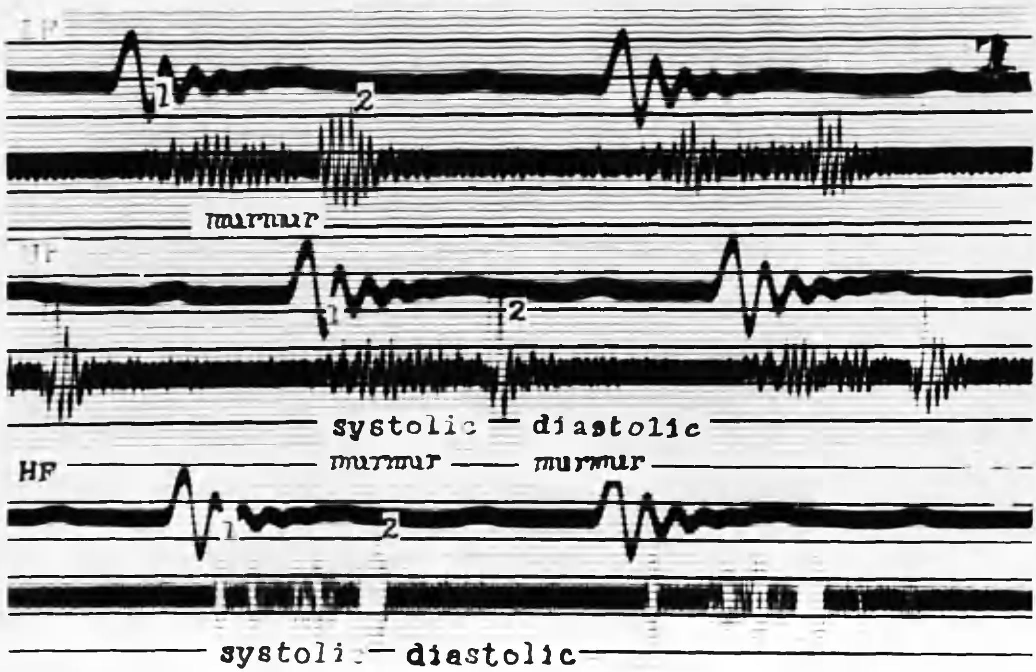


FIG. 82.

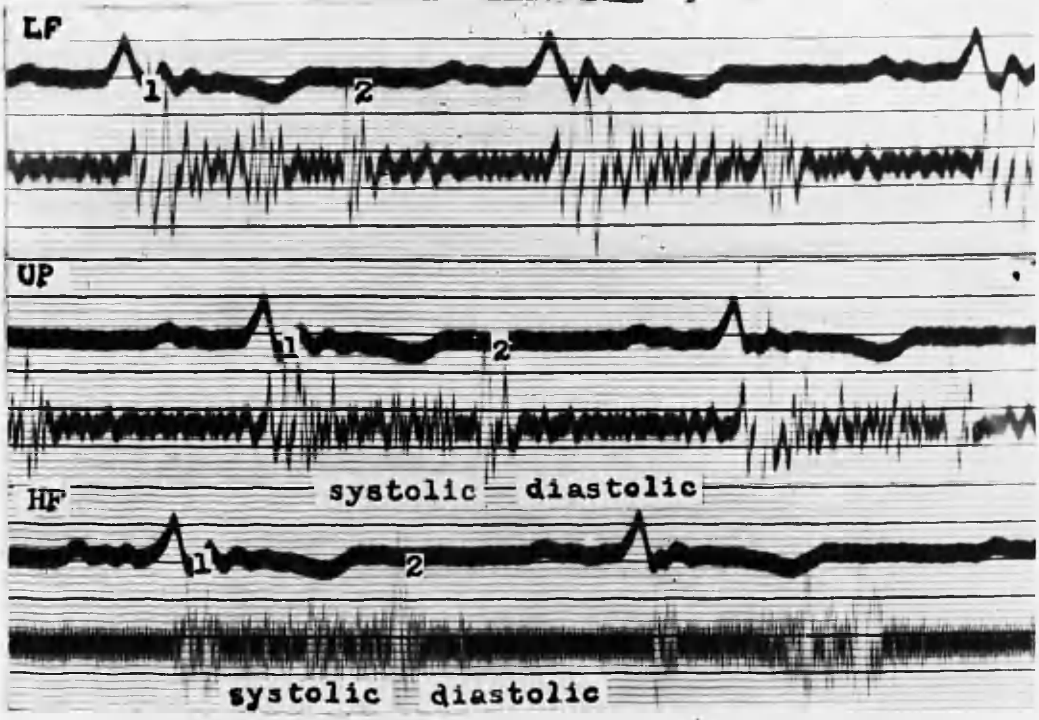
J.S., aet 20 yrs.

Tracings from the apical region, base, and the 2nd left intercostal space are demonstrated. The propagation of the murmur was widespread over the praecordium with systolic and diastolic elements visible at both apex and base. The continuous "machinery" nature of the murmur with the prominence of the systolic phase was well demonstrated.

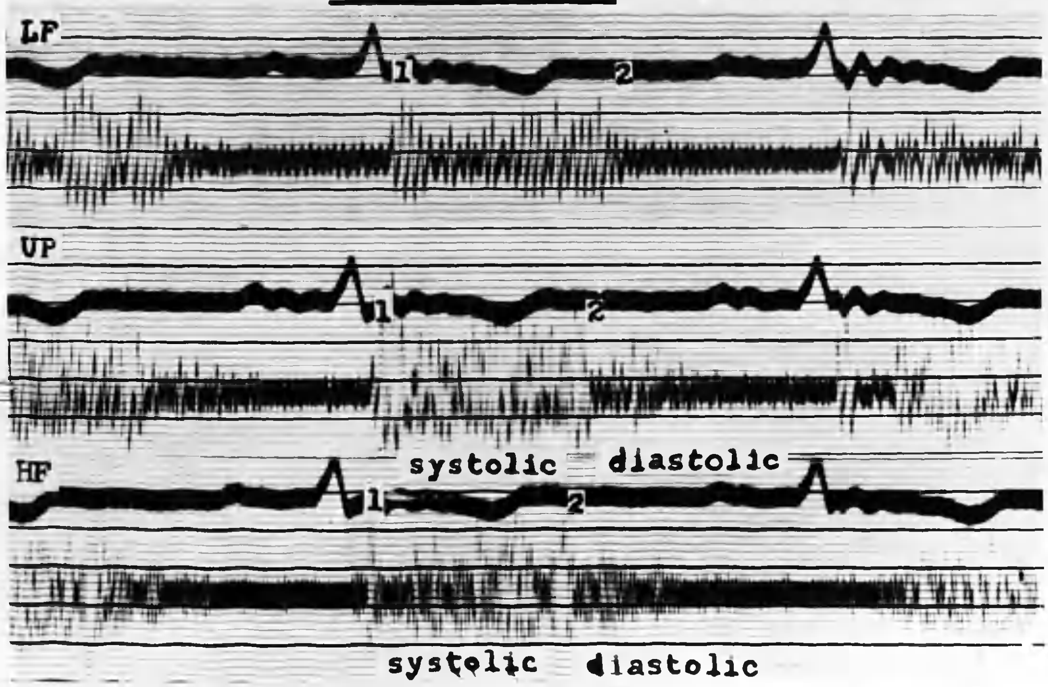
Fig.82.

Patent Ductus Arteriosus.

Apical Tracings.



Basal Tracings.



Patent Ductus Arteriosus.

Tracings from the 2nd. Left Intercostal Space.

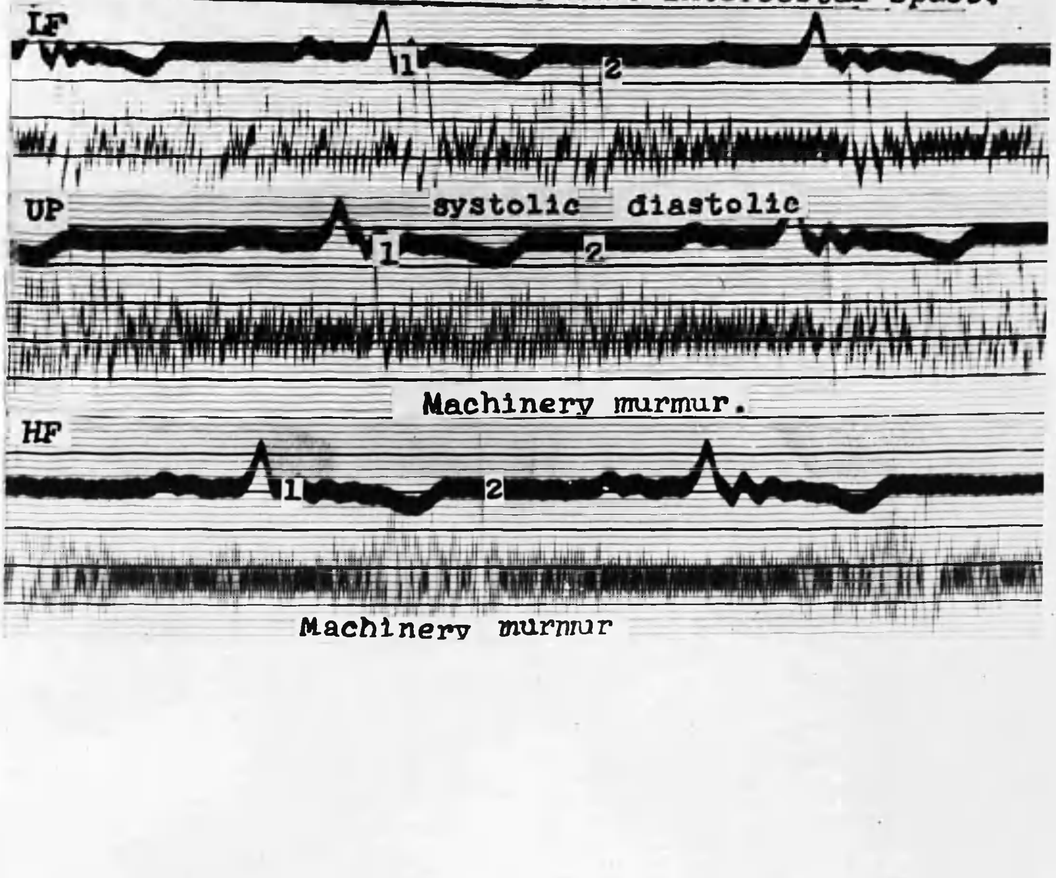


FIG. 83.

J.McN. aet 16 yrs.

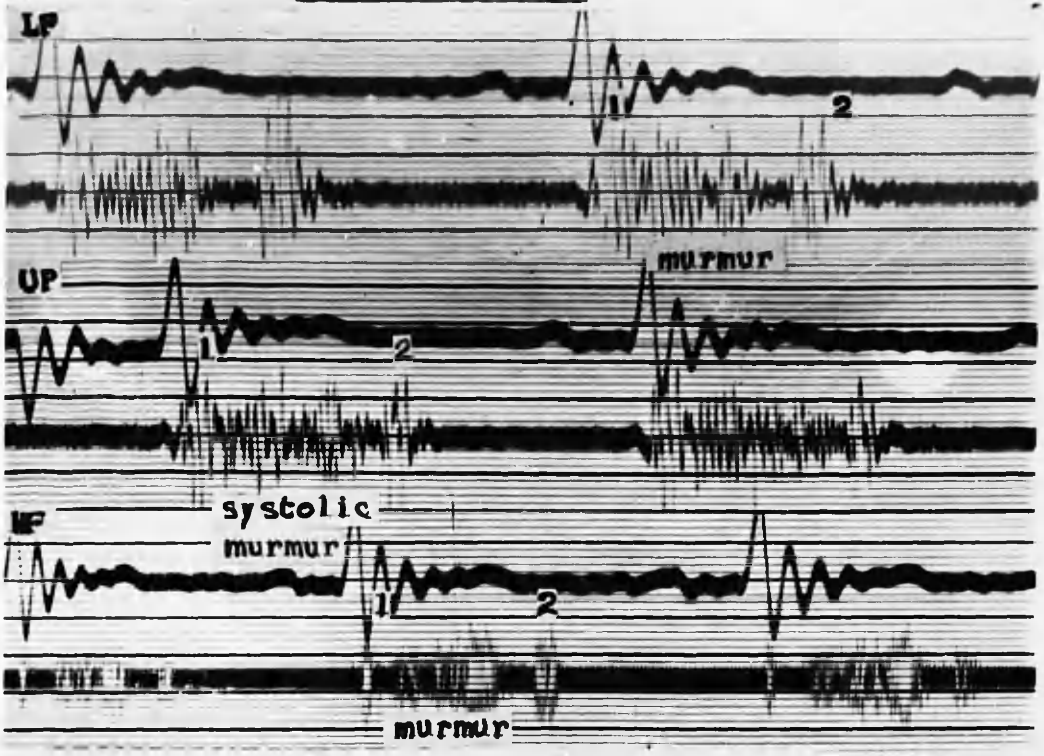
A typical case of Fallot's Tetralogy. The apical murmur was that already described as being typical of interventricular septal defect.

The basal tracing showed the murmur due to pulmonary stenosis. The onset was later than the apical murmur, the frequency range was wide but relatively higher, the duration was long and the amplitude high.

Fig. 83.

Fallot's Tetralogy.

Apical Tracings.



Basal Tracings.

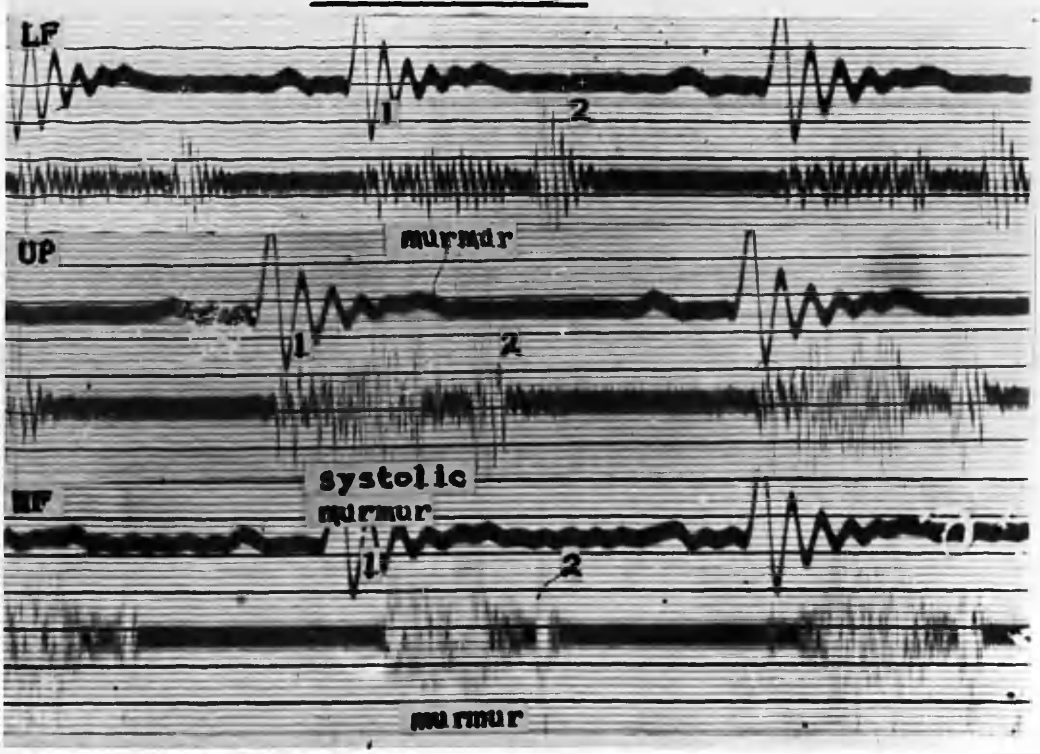


FIG. 84.

A.M. aet. $5\frac{3}{4}$ yrs.

This girl had been known to have a cardiac lesion from the age of 5 months. The clinical picture was that of Fallot's Tetralogy.

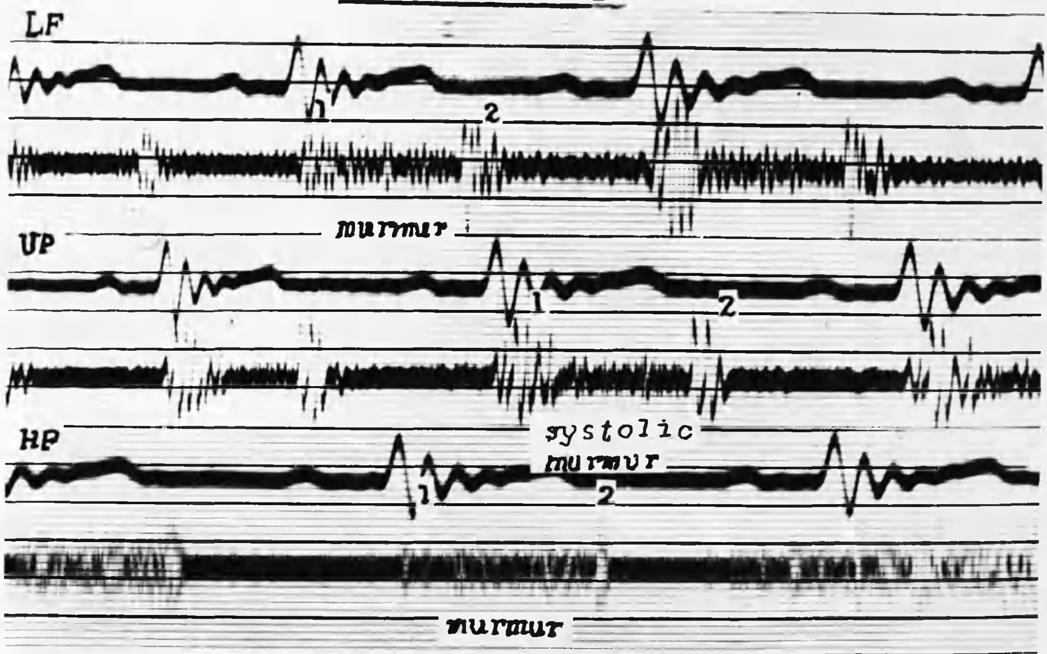
Typical murmurs were seen. The apical murmur was less prominent than in the previous case.

The crescendo character in late systole was a feature frequently seen in the murmur of pulmonary stenosis, and was well demonstrated in this case.

Fig.94.

Fallot's Tetralogy.

Apical Tracings.



Basal Tracings.

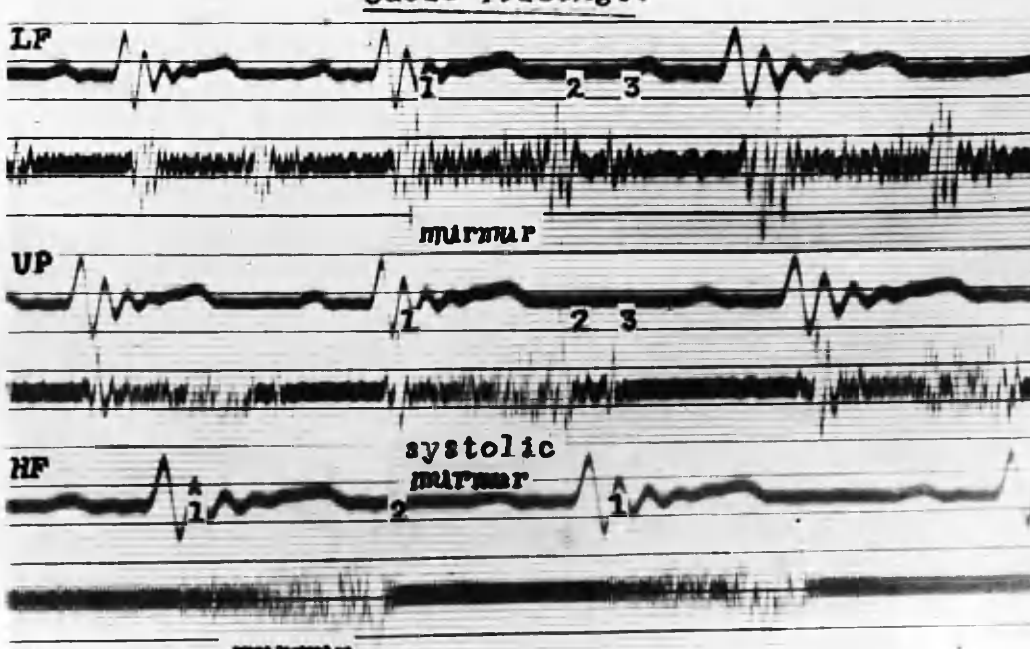


FIG. 85.

M.McL. aet 19 yrs.

A case of Eisenmenger's Complex. This tracing has been shown already under the heading of Summation Gallop Rhythm.

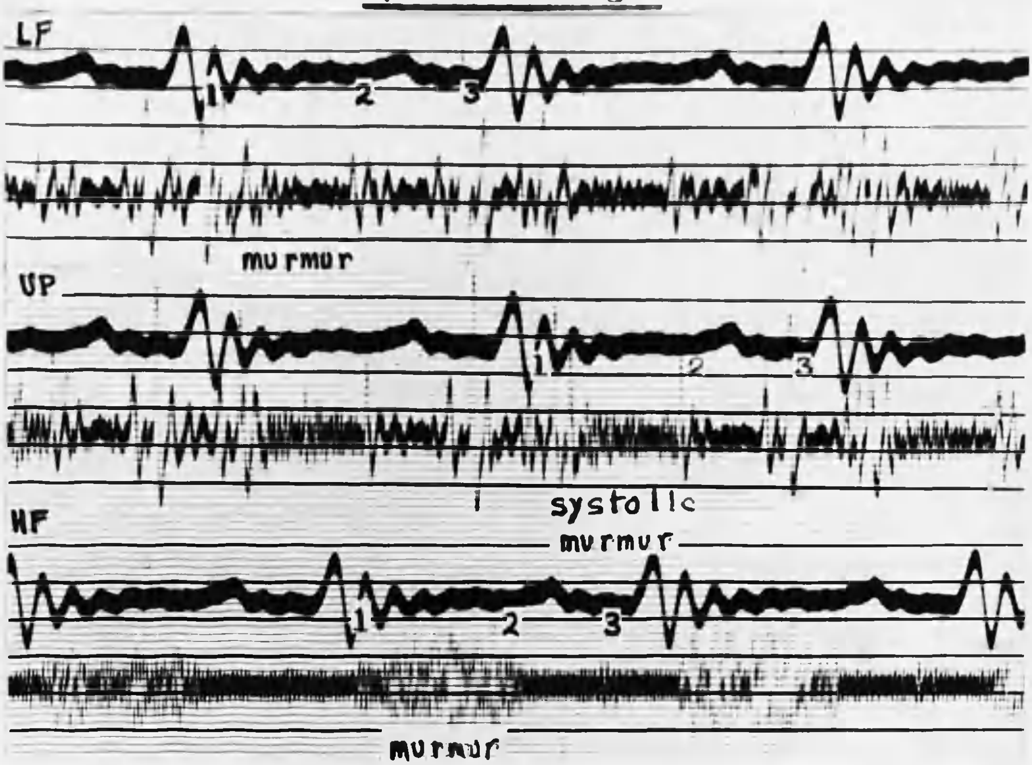
The apical murmur was that of interventricular septal defect.

The murmur of pulmonary dilatation has similar characteristics to that of pulmonary stenosis, though in this case, not of so great an amplitude.

Fig.85.

Eisenmenger's Complex.

Apical Tracings.



Basal Tracings.

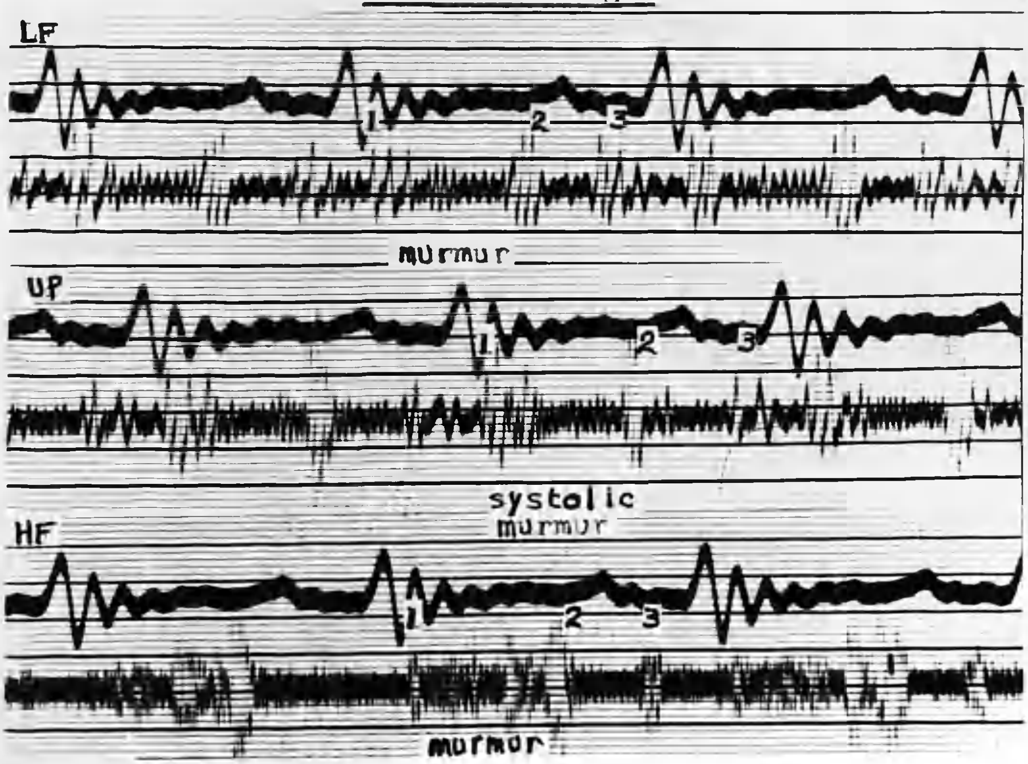


FIG. 86.

J.H., aet 46 yrs.

The clinical diagnosis was made in November 1948 following an investigation including cardiac catheterisation. Autopsy in November 1949 confirmed the clinical diagnosis. The characteristics of the murmur on auscultation which had been previously described in the literature as typical, were that of a machinery murmur in the region of the 4th left costal cartilage, more prominent in diastole.

The phonocardiogram confirmed the clinical description.

At the apex there was a systolic murmur of relative mitral incompetence, and conducted elements of an early diastolic murmur.

At the base, a systolic murmur of aortic stenotic nature was explained by a degree of calcification of two of the aortic cusps. The diastolic murmur was conducted from the 4th left costal cartilage, and the two combined gave a "machinery" murmur appearance.

The loud harsh nature of the machinery murmur was well portrayed by the records from the 4th left costal cartilage, the onset of the systolic element in mid-systole and the prominence of the diastolic phase was elicited by the high frequency band.

Fig. 86.

Rupture of the Right Sinus of Valsalva into the Right Ventricle.

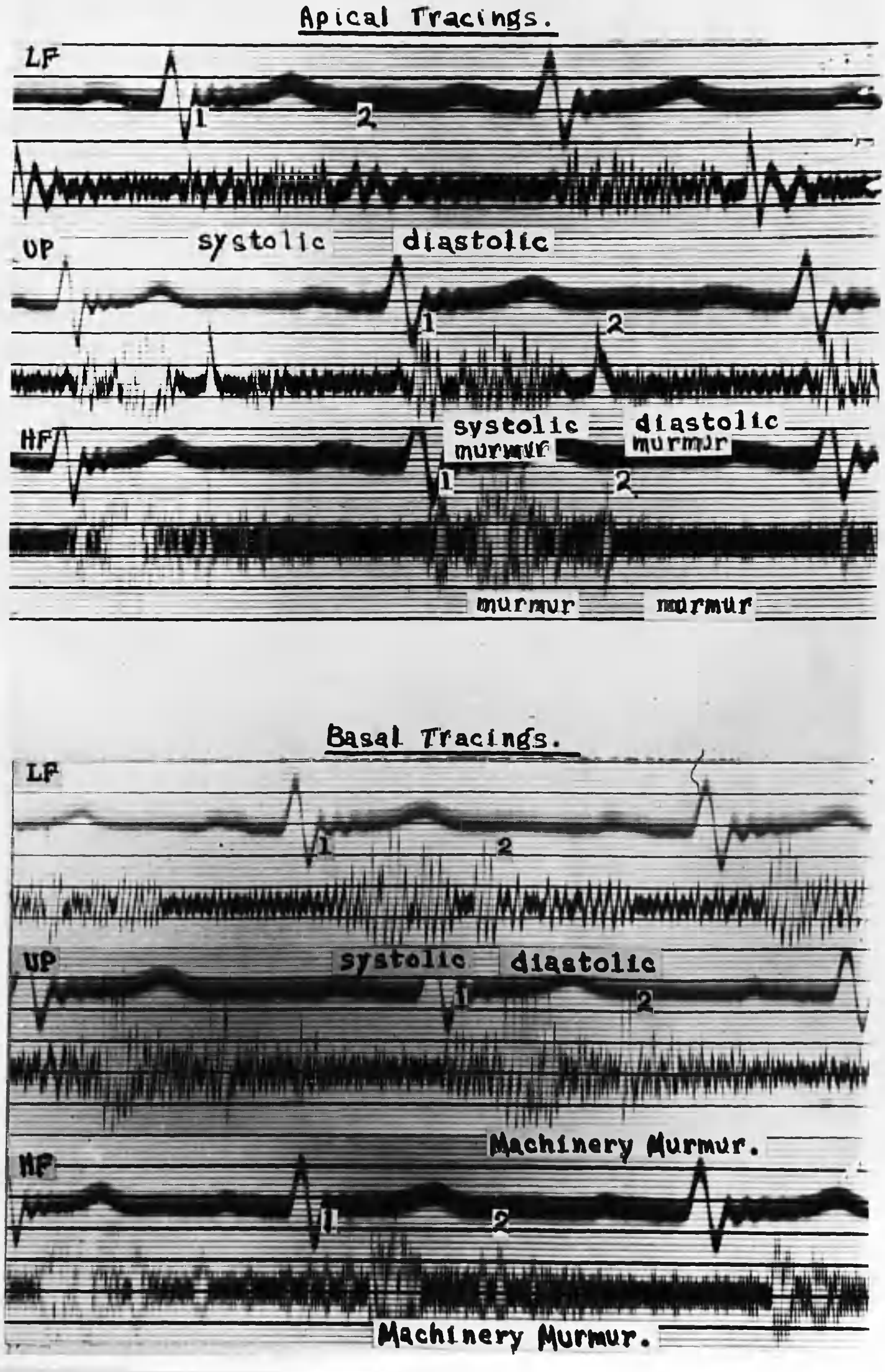


Fig.86

Rupture of the Right Sinus of Valsalva into the Right Ventricle.

Tracings from the 4th Left Costal Cartilage.