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RESEARCH MEMORANDUM

TIME-HISTORY DATA OF MANEUVERS PERFORMED BY A REPUBLIC F-84G AIRPLANE DURING SQUADRON OPERATIONAL TRAINING

By Harold A. Hamer and Alton P. Mayo

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NATIONAL ADVISORY COMMITTEE
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TIME-HISTORY DATA OF MANEUVERS PERFORMED BY A REPUBLIC F-84G AIRPLANE DURING SQUADRON OPERATIONAL TRAINING

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SUMMARY

Preliminary results of one phase of a control-motion study program involving several jet fighter-type airplanes are presented in time-history form and are summarized as maximum measured quantities plotted against indicated airspeed. The results pertain to approximately 1,000 maneuvers performed by a Republic F-84G jet-fighter airplane during squadron operational training. The data include most tactical maneuvers of which the F-84G airplane is capable. Maneuvers were performed at pressure altitudes of 0 to 30,000 feet with indicated airspeeds ranging from the stalling speed to approximately 515 knots.

INTRODUCTION

The determination of the design loads on airplane surfaces requires, among other things, a knowledge of the control motions. In the present methods, the maximum design loads are obtained by specifying what are believed to be the critical control-surface motions and determining the associated airplane response; however, the actual control motions and load-factor variations obtained in regular operational flying may differ appreciably from the specified variations. Although the specified control motions do not exceed the limit of the pilot or airplane, the resulting design criteria may be too conservative so that the structural weight is excessive.

In order to gain information on the actual control motions used by service pilots, the National Advisory Committee for Aeronautics in cooperation with the U. S. Air Force and the Bureau of Aeronautics, Department of the Navy, is conducting a control-motion study program using several jet fighter-type airplanes. This program is directed toward obtaining statistical data on rates, amounts, and combinations

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of control motions actually used in carrying out operational training missions. From tests of this kind, it may be possible to determine more realistic design load criteria as well as obtain information useful in the design of airplane control-boost systems. References 1 to 4 are other papers which originated from this program.

The present paper includes data in time-history form of maneuvers performed by a Republic F-84G airplane during regularly scheduled operational training missions. In order to expedite the presentation of these data, only a minor analysis of the results is included to present maximum values. The time-history figures have been reduced to page size to facilitate the reproduction and distribution of the large amount of material. These figures are considered adequate for limited analysis of the data. If extensive analysis of some of the included data is desired, copies of the time histories, approximately two and one-half times larger, may be obtained upon request to the NACA.

AIRPLANE

A standard U. S. Air Force F-84G-1-RE airplane was used in these tests. A photograph of the test airplane is presented as figure 1. The F-84G is a single-place, low-wing fighter-bomber airplane powered by a turbojet engine. The airplane is equipped with a hydraulic aileron boost with a variable boost ratio. A speed brake is installed in the bottom of the fuselage.

Neither the external appearance nor the weight and balance of the airplane was altered by the NACA instrumentation except for the installation of a boom mounted in the nose. A three-view drawing of the F-84G test airplane is presented in figure 2 and its dimensions and physical characteristics are given in table I. The moments of inertia given in table I are values estimated in accordance with the latest information available.

INSTRUMENTS

Standard NACA photographically recording instruments were used to measure (1) the quantities defining the flight conditions - that is, airspeed, altitude, and speed-brake position; (2) the imposed control-surface motions; and (3) the response of the airplane in terms of load factors, angular velocities, angular accelerations, angle of sideslip, and angle of attack. The recorders were synchronized at 1-second intervals by means of a common timing circuit. All recording instruments were mounted in the nose section, with the exception of the single- and

three-component accelerometers which were located in the fuselage wing-gun ammunition compartment above the wing and the left wing-gun bay, respectively.

In order to relieve the pilot of any recording-instrument switching procedure and hence assist in obtaining normal operations, a pressure switch was employed to turn on automatically the recording instruments at an indicated airspeed of approximately 95 knots. In conjunction with this, a microswitch was attached to the nose-wheel door, which was actuated when the door was up, to insure continuous operation of the recorders during maneuvers below 95 knots.

A standard two-cell pressure recorder connected to the airplane service system was used to measure the altitude and airspeed. The service system employs a total-pressure tube located in the nose inlet and flush static-pressure orifices on either side of the lower fuselage approximately 5 feet rearward of the nose inlet. (See figs. 1 and 2.)

A switch was incorporated on the speed-brake cockpit control handle to indicate whether the speed brake was in the open or closed position. The control surface deflections were measured by a control-position recorder having remote recording electrical transmitters installed near the control surfaces. The elevator and rudder transmitters were installed inside the tail fairing at the inner hinge, and the aileron transmitter was located in the right wing-gun bay at the link arm connecting the aileron push-pull rods.

Angular velocities and angular accelerations were recorded about three mutually perpendicular axes in which the longitudinal reference axis is the one commonly used for leveling the airplane. (See fig. 2.) Load factors along these three axes were recorded by NACA air-damped recording accelerometers. The single-component accelerometer used to measure the airplane normal load factor was located 16 inches directly above the average flight center-of-gravity location (25 percent of the wing mean aerodynamic chord). The three-component accelerometer, two components of which were used to measure the longitudinal and transverse load factors, was located 11 inches behind, 4 inches below, and 37 inches to the left of the average flight center of gravity.

The angle of sideslip and angle of attack were measured by flow-direction recorders whose transmitters were mounted on a boom extending from the upper right nose-gun port. (See figs. 1 and 2.)

Table II is a summary list of the quantities measured, the instruments used, the accuracy of the measurements, and the natural frequencies of the various measuring elements. The accuracy of each measured quantity is divided into two parts: instrument accuracy, based on the error introduced by instrument characteristics, and the reproduction accuracy, based

[redacted]

on the inherent error resulting from preparing and reproducing the time histories. The addition of these two parts will give the total possible error with respect to the true zero. Incremental values would be associated only with the instrument accuracy.

The natural frequencies of all recording instrument elements were selected so as to minimize the magnitudes of extraneous airplane vibrations and still give correct response to the maneuver. These elements were damped to about 0.65 of critical damping.

TESTS

The recorded measurements were obtained in 20 squadron operational training flights carried out during January 1952. The operational flights included acrobatics as well as simulated dive-bombing, gunnery, and dogfighting missions. Other than to request that the airplane be used in as many types of missions as were normally carried out by the squadron, no attempt was made to specify the type or severity of maneuvers. Since the pilots were aware of the instrumentation, it was stressed that this was not to restrict their normal handling of the airplane since they would not be identified with the test results. The maneuvers were performed at pressure altitudes of 0 to 30,000 feet with indicated airspeeds ranging from the stalling speed to approximately 515 knots.

Sufficient film was available during each flight to obtain approximately 80 minutes of continuous records. This amount of time was generally enough to record the complete flight. A total of 14 pilots, performing approximately 1,000 maneuvers, participated in these tests. A total of 19.7 hours of flight time were recorded, of which approximately 8 hours are presented in this paper as maneuvers in time-history form. A ratio of flight time to maneuver time of 2.5 to 1 is not necessarily representative of normal operation because the pilots were requested to perform as many maneuvers as practical during each flight in order to minimize the time required to collect the data. All except two flights were made with the use of external fuel tip tanks. Table III is a summary of the scope of the tests and lists for each flight, the pilot, scheduled mission, configuration, airplane weight and center-of-gravity position, and pertinent remarks.

During the course of the tests it became evident that the F-84G airspeed system had a rather large airspeed-altitude error; therefore, an airspeed calibration was made. A plot of this static-pressure position error is presented in figure 3.

METHOD AND RESULTS

The basic results obtained are presented in figures 4 to 357 as time histories of the measured quantities. The time-history data are

summarized in figures 358 to 366 as maximum measured quantities plotted against indicated airspeed.

In order to expedite the conversion of the flight data to time-history figures, a photographic method of reproducing the records was developed. This method consisted of direct reproduction of the film records and the photographing of the assembled records for each particular maneuver through a master-grid overlay. The use of this method has resulted in maintaining a high over-all accuracy and in preserving many of the film-record details.

The master-grid overlay was constructed to conform to the various instrument sensitivities, calibrations, and film-drum speeds. Because of this, some of the quantities have nonlinear vertical scales; also the dimensions of the linear vertical scales vary slightly for each quantity measured. Since a constant time scale was used in reproducing the time histories, error was introduced due to variation of drum speed throughout a flight. This error falls within the ±1 percent limit as given in table II for over-all time accuracy, except for figures 68, 69, and 240. The amount of time-scale error in these figures is indicated by a correction factor in the figure legends.

In most cases a time-history figure includes a series of maneuvers in which one merged into another. Care was taken to begin and end each time-history figure at a relatively normal steady-flight condition. The time-history figures are arranged according to the maneuver classification shown in table IV. Where a figure included more than one maneuver, its classification was established by that portion which was of greatest interest. Included in the legends of the figures are a description of the type of maneuver or maneuvers and the estimated in-flight airplane weight and center-of-gravity location. The flight from which each time-history figure was taken is also included. The description of the maneuvers is, of necessity, done in a general sense since it was sometimes difficult to determine from the flight records exactly the type of maneuver performed. Most of the maneuvers were interpreted from descriptions given in references 5 and 6. The in-flight airplane weight and center-of-gravity location were determined by interpolation with respect to total amount of fuel used and the length of time for the flight including warm-up and taxying.

In the time histories, the altitude is the NACA standard pressure altitude and the airspeed is given in terms of indicated airspeed which is defined as the reading of a differential-pressure airspeed indicator, calibrated in accordance with the accepted standard adiabatic formula to indicate true airspeed for standard sea-level conditions only. No correction has been made to the recorded quantities for static-pressure position error. Figure 3 contains the necessary information for applying

these corrections. In figure 3 the static-pressure position error Δp is defined as

$$\Delta p = p' - p$$

where p' is the uncorrected static pressure and p is the true static pressure, so that

$$q_c = q'_c + \Delta p$$

where q'_c is the uncorrected impact pressure and q_c is the true impact pressure. The impact pressures corresponding to the values of indicated airspeeds in the time-history figures may be obtained from tables such as found in reference 7. In a few of the figures abrupt changes in the airspeed record will be noted without a corresponding change in the longitudinal acceleration. This change is due to total-pressure error which is characteristic of total-pressure tubes when at high angles of attack. Examples of this may be seen in figures 246 and 338.

The control positions shown in the time-history figures were measured with respect to the streamline position of the surfaces. Only the right aileron position was measured. Periods during which the speed brake was open are indicated in the figures by dashed lines and the words "brake open." Load factors associated with forces acting up, forward, and to the right are positive. No corrections have been made in the time histories to the recorded load factors for the effect of angular velocities and angular accelerations due to the displacement of the accelerometers from the airplane center of gravity. Nose up, nose right, and right wing down are positive for the pitching, yawing, and rolling angular velocities and angular accelerations which are given in radians per second and radians per second per second, respectively. In some of the time histories the angular-acceleration records are missing either in whole or in part. In these cases, airplane structural vibrations caused the angular accelerometers to vibrate at high frequencies and amplitudes, so that the records were of poor quality for reproduction. The angular accelerations are represented by the vibratory or dashed lines. The dashed lines indicate that the traces have been faired, with the long dashes denoting better accuracy in fairing than the short dashes.

The angle of sideslip shown in the time histories is the angle between the longitudinal axis and the projection of the relative wind in the horizontal plane of the airplane. The angle of attack is the

angle between the longitudinal axis and the projection of the relative wind in the vertical plane of the airplane and is positive for a nose-up attitude. In several figures it was necessary to fair the angle-of-sideslip and angle-of-attack records with a dashed line because excessive vibrations, ordinarily incurred during take-offs, stalls, and landings, made them of poor reproductive quality. The angle-of-sideslip and angle-of-attack values in the figures are uncorrected for angular-velocity, sidewash, and upwash effects. It is estimated that the effects of sidewash and upwash increase the measured angle of sideslip and angle of attack by approximately 5 percent and 10 percent, respectively.

The variation of normal load factor with indicated airspeed is presented in figure 358. The V-n envelopes shown in this figure are the operational limits for the test airplane, with the exception of the curves showing the stall boundaries at the various altitudes. These curves were determined from maximum-lift data obtained in these tests at the average flight gross weight of 15,000 pounds. No correction was made for position error. At maximum lift the position error varies between 5 and 10 percent of q'_c. The load-factor test points shown in figure 358 were taken directly from the time histories and were selected so as to demonstrate to what extent the operational limit envelopes for altitude, airspeed, and normal load factor were obtained. The load factors are plotted without corrections for angular velocity or angular acceleration since such corrections were found to be small.

The maximum transverse load factors and the corresponding indicated airspeeds are presented in figure 359. Because of the large number of transverse load factors available from the time histories, only the values above the arbitrary limit of 0.05 are shown. The load factors given in this figure have been corrected for the effects of angular velocity and angular acceleration.

The maximum control rates and their variation with indicated airspeed are shown in figures 360, 362, and 364. These maximum values for elevator, aileron, and rudder rates were obtained from the maximum slope of the appropriate control-position record. In these figures only those control rates which resulted in significant airplane response or large control deflections are included.

The variations of maximum pitching, rolling, and yawing angular accelerations with indicated airspeed are given in figures 361, 363, and 365. Where the angular-acceleration records were missing in the time histories, the maximum angular accelerations were obtained from the maximum slope of the appropriate angular-velocity record. Only the maximum angular-acceleration values above the arbitrary limit of 0.2 radian per second per second for pitch, 0.5 radian per second per second for roll, and 0.1 radian per second per second for yaw are

considered to be significant and are presented in these figures. Directional oscillations are distinguished in figure 365 at the higher speeds by a different symbol.

The variation of maximum angles of sideslip with indicated airspeed is shown in figure 366. These angles, which were taken from the time histories, have not been corrected for sidewash effects. In figure 366, the angles of sideslip are classified under four categories. The term rolling pull-out was used for maneuvers in which the maximum angle of sideslip occurred simultaneously with a noticeable amount of rolling velocity and at or above a normal load factor of 2.0. (See figs. 170, 183, 184, and 188.) The term roll was used for rolling maneuvers in which the normal load factor was less than 2.0. (See figs. 208, 210, and 307.) Sideslips included maneuvers in which no rolling velocity existed, and stalls were considered only at the lower airspeeds.

As mentioned previously, it was seldom that each time history contained only a single maneuver. Therefore, in general, several values for the maximums, given in figures 358 to 366, were available from each time history. Because of the large quantity of data, only those maximum values which established the boundaries and trends are presented. In these summary figures the maximum values obtained during or as a result of stalled maneuvers are indicated by a different symbol only at low speeds, since the envelope at the higher speeds was not materially affected by stalls. The maximum values obtained in the vicinity of take-off and landing were taken only when the airplane was completely airborne and are also denoted by a different symbol on the control-rate summary figures. In figures 358 to 366 no corrections have been made to the indicated airspeeds for position error. It will be noted in these figures that there are some data given at indicated airspeeds close to zero knots. These data were taken directly from the time histories and are considerably in error because of the large position error at low speeds and high angles of attack.

DISCUSSION

Although this investigation was limited to relatively few hours of actual flying, the data obtained represent a cross section of the maneuvers performed during operational training and include most of the tactical maneuvers within the capabilities of the F-84G airplane.

The operational limits of the V-n diagram shown in figure 358 were approached for many combinations of normal load factor, airspeed, and altitude and the positive load-factor region was utilized to a much greater extent than the negative load-factor region. Examination of the figure shows that the positive limit load factor of 7.33 was reached at

an indicated airspeed of 375 knots during a turn and a high-speed pull-out shown in figures 48 and 174, respectively. The largest negative load factor of -1.1 was obtained at 235 knots in a push-down. (See fig. 202.) Positive load factors of about 6.5 were also obtained in pull-ups and turns. The high positive load factors in the right-hand portion of the diagram were associated mainly with pull-out or turn recoveries from dive-bombing and strafing runs. (See figs. 299 and 328.) At indicated airspeeds near 330 knots, positive load factors up to 4.8 were experienced in barrel rolls. (See figs. 172 and 183.)

Examination of figure 359 shows that the maximum corrected transverse-load-factor values were usually between ±0.2. All values greater than ±0.22 were obtained in snap rolls. The largest corrected value of 0.35 at an indicated airspeed of 250 knots occurred during the snap roll shown in figure 188 at time 23 seconds. During this snap roll the transverse load factor reached a value of 1.0; however, this recorded value is reduced to 0 when corrected for effects of the rolling and yawing velocities. Other transverse load factors of about 0.2 were produced in barrel rolls, sideslips, and fishtails, examples of which may be seen in figures 250, 259, and 261. Although a value of 0.18 was measured during a stall (fig. 25 at time 94.5 seconds), the transverse load factors rarely exceeded ±0.1 in such maneuvers.

The maximum elevator rates, shown in figure 360, decreased with increasing airspeed. Except for the high rates which occurred at low indicated airspeeds during stalls, take-offs, and landings, the maximum elevator rates maintained nearly a constant value at airspeeds up to 300 knots. As a whole the maximum positive elevator rates were somewhat larger than the negative values. The high positive and negative elevator rates at indicated airspeeds greater than 150 knots were not associated particularly with any one type of maneuver. In several cases, high positive and negative rates were obtained by rapid elevator movement of small amplitude during a maneuver. Even though the rates were large, the amount of deflection was not enough to cause appreciable changes in airplane motion. Examples of this are illustrated in figure 86 at time 7 seconds and figure 90 at time 18.5 seconds where the elevator rates are 0.38 and -0.41 radian per second, respectively. The largest negative value of -0.68 radian per second at 320 knots occurred in an abrupt pull-up. (See fig. 190 at time 96.8 seconds.) A value of -0.58 radian per second at 240 knots occurred near the stall during a turn. (See fig. 189 at time 71.7 seconds.) At the higher airspeeds the largest positive elevator rates of about 0.45 radian per second were produced during barrel rolls (fig. 213 at time 78.6 seconds) and abrupt push-downs (fig. 190 at time 111.4 seconds and fig. 202 at time 5.6 seconds). Values up to 0.4 radian per second were obtained during snap rolls. Examples of large positive and negative rates during stalls or spins can be seen in figures 345 and 347. Many of the stalls occurred

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during Immelmans and loops with the result that excessive control was used in an attempt to hold the maneuver. (See figs. 205 and 246.)

The results given in figure 361 reveal that the maximum positive and negative pitching accelerations measured during these tests increased with increasing airspeed up to about 325 knots and decreased sharply beyond this point. In general, the high accelerations were equally distributed between the positive and negative values and were obtained in various types of maneuvers. The highest positive pitching acceleration obtained, 1.75 radians per second per second at 320 knots, occurred in the abrupt pull-up shown in figure 190 at time 97 seconds and corresponded to the highest positive elevator rate obtained at that speed. (See fig. 360.) In the present tests, pull-ups into maneuvers such as Immelmans, chandelles, and loops and pull-outs from dive-bombing and ground-gunnery runs were always gradual with relatively low pitching accelerations, usually 0.1 to 0.2 radian per second per second. The largest negative pitching acceleration obtained was -2.0 radians per second per second and occurred at an airspeed of 320 knots during a recovery from a turn (fig. 44 at time 67 seconds) and at an airspeed of 340 knots during a recovery from an abrupt pull-up (fig. 201 at time 5.5 seconds). Negative pitching accelerations of -1.0 radian per second per second were obtained in the abrupt push-downs shown in figures 42, 190, and 202 and these values corresponded to the largest negative elevator rates at those speeds. Maneuvers, other than abrupt pull-ups and push-downs, which produced positive and negative pitching accelerations greater than ±1.0 radian per second per second were barrel rolls and turns, as well as stall-type maneuvers such as snap rolls and stall turns. Comparatively small positive and negative pitching accelerations were obtained during low-speed stalls or spins, with the largest value of 0.85 radian per second per second being recorded during the spin shown in figure 346.

In general, the maximum aileron rates shown in figure 362 remained at a nearly constant value up to 300 knots and gradually decreased with increasing airspeed beyond this point. The largest aileron rate measured during this investigation was 1.21 radians per second at 110 knots and occurred during a stall at the top of an Immelman as shown in figure 205 at time 44.2 seconds. As in the case of the elevator, large aileron rates were used during such maneuvers to hold the maneuver at the approach of stall. During take-offs and landing, the aileron rates were usually less than ±0.4 radian per second. Examples of the highest rates used during take-off and landing can be seen in figure 10 at times 7 and 12.5 seconds and in figure 350 at times 45.5 to 48 seconds. At the higher airspeeds, the largest positive and negative aileron rates used occurred during banks and rolling into or out of turns. Such maneuvers where values of about ±1.0 radian per second were obtained may be seen in figures 119, 178, 213, and 349 and examples of the largest rates at 490 knots are illustrated in figure 267 where values of 0.45

and -0.33 radian per second were obtained. Other aileron rates up to about ±0.8 radian per second were recorded in barrel and snap rolls.

The maximum rolling accelerations, shown in figure 363, increased with increasing indicated airspeed up to about 300 knots and then decreased beyond this point. The highest rolling accelerations, which were between 4.0 and 4.7 radians per second per second and near 240 knots, were the result of the turn in the landing pattern as can be seen in figures 349, 350, and 355 and were associated with the highest aileron rates at that speed. In other cases, rolling into or out of turns produced values of rolling acceleration up to ±4.0 radians per second per second at indicated speeds up to 350 knots and values up to about ±2.0 radians per second per second from 350 to 500 knots. It was usual for this type of maneuver and these high rolling accelerations to be found during ground-gunnery runs such as the banks in figures 310 and 313 and the peel-off in figure 317. Values of rolling acceleration obtained during barrel and snap rolls were usually less than ±3.0 radians per second per second; however, a value of 4.0 radians per second per second was obtained at 315 knots at the completion of the barrel rolls shown in figure 174.

For all types of maneuvers, the maximum rudder rates which are shown in figure 364 were low relative to those measured for the elevator and aileron. In general, the maximum rudder rates decreased with increasing airspeed, with the higher values occurring during take-offs, landings, stalls, and spins. Values up to about ±0.5 radian per second were obtained in fishtail maneuvers such as seen in figures 261 and 263. Rudder rates up to about ±0.4 radian per second were measured in all types of rolling maneuvers such as turns, split-S's, vertical recoveries, barrel rolls, and Cuban eights. During sideslips the rudder rates used did not exceed ±0.25 radian per second except during the landing approach shown in figure 357 where values of -0.38 and -0.32 radian per second were measured at times 14.9 and 17 seconds, respectively. During dive-bombing runs the rudder rates used for peel-offs, banks, and turns never exceeded ±0.18 radian per second; however, in maneuvering near the ground such as in ground-gunnery or strafing runs, values up to ±0.46 radian per second were measured.

As would be expected, because of the larger moment of inertia about the airplane vertical axis, the maximum angular accelerations for yaw which are shown in figure 365 are lower than those measured for pitch or roll. The maximum yawing accelerations increased with increasing indicated airspeed up to about 300 knots and then tended to decrease with further increase in airspeed. However, the airplane was subjected to some large yawing accelerations at the higher speeds or Mach numbers where the effect of the inadvertent directional oscillations was especially pronounced. (See fig. 199 at time 15 seconds and fig. 328 at time 26 seconds.) The highest yawing accelerations obtained during

these tests were -0.9 and -1.05 radians per second per second at 305 and 260 knots and occurred in snap rolls. (See figs. 189 and 190.) Yawing accelerations above ±0.5 radian per second per second were also obtained in barrel rolls (figs. 172, 174, 180, and 181) and fishtails (figs. 261, 262, 264, and 265). As would be expected, the yawing accelerations obtained in fishtails were usually associated with the largest rudder rates at those speeds. Values of yawing acceleration during turns were generally low, the largest occurring in the stall turns shown in figure 25 and the chandelle shown in figure 278. Values during stalls or spins were generally below ±0.3 radian per second per second although such values as 0.58 and 0.55 radian per second per second were obtained in the stall shown in figure 25 at time 26 seconds and in the spin shown in figure 345.

The maximum angles of sideslip as shown in figure 366 were largest at low indicated airspeed and decreased in magnitude with increasing airspeed. In several cases, large angles near 32.0° were recorded during stalls or spins. (See figs. 211 and 346.) It will be noted that the vertical scale was broken in figure 366 to include these large angles. In the case of the two largest angles of sideslip of 31.0° and 32.0° which were recorded during the spin shown in figure 346 the limits of the recorder were exceeded. It is shown that almost any type of maneuver may produce large angles of sideslip throughout the speed range, and in this connection equally as large vertical-tail loads may be possible.

Considering the data of all maneuvers obtained during this investigation, as summarized in figures 358 to 366, no particular type of maneuver can be singled out in which the maximum values for all the quantities occurred simultaneously. The types of maneuvers which most nearly approach this condition appeared to be the barrel roll or rolling pull-out. In such maneuvers it was usual to obtain combinations of high load factors and angular accelerations with corresponding changes in the angles of attack and sideslip.

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REFERENCES

1. Hamer, Harold A., and Henderson, Campbell: Time Histories of Maneuvers Performed With an F-86A Airplane During Squadron Operations. NACA RM I51K30, 1952.

2. Huss, Carl R., Andrews, William H., and Hamer, Harold A.: Time-History Data of Maneuvers Performed by a McDonnell F2H-2 Airplane During Squadron Operational Training. NACA RM I52B29, 1952.

3. Henderson, Campbell, Thornton, James, and Mayo, Alton: Time-History Data of Maneuvers Performed by an F-86A Airplane During Squadron Operational Training. NACA RM I52C19, 1952.

4. Huss, Carl R., Fisher, Raymond A., and Gainer, Patrick A.: Time-History Data of Maneuvers Performed by a Lockheed F-94B Airplane During Squadron Operational Training. NACA RM I53B27, 1953.

5. National Advisory Committee for Aeronautics: Nomenclature for Aeronautics. NACA Rep. 474, 1933.

6. Cram, Jack R., and Brimm, Daniel J., Jr.: Part Three - Restricted Commerical Flight Course. Civil Pilot Training Manual, C. A. Bull. No. 23, CAA, U. S. Dept. Commerce, Sept. 1940.

7. Aiken, William S., Jr.: Standard Nomenclature for Airspeeds With Tables and Charts for Use in Calculation of Airspeed. NACA Rep. 837, 1946. (Supersedes NACA TN 1120.)

TABLE I

DIMENSIONS AND PHYSICAL CHARACTERISTICS

OF THE F-84G TEST AIRPLANE

Wing (true dimensions and areas):	
Total wing area with tip tanks off (including flaps, ailerons, and 38.3 sq ft covered by fuselage), sq ft	261.0
Span, in.	
Without tip tanks	438.8
With tip tanks (fin to fin)	498.2
Aspect ratio (based on plan dimensions)	5.10
Taper ratio (Tip chord/Root chord)	0.57
Root chord, in.	110.3
Location of root chord (below horizontal center line of fuselage), in.	11.0
Mean aerodynamic chord (at wing station 98.3 measured normal to horizontal center line of fuselage), in.	88.8
Distance from nose to leading edge of wing M.A.C. (parallel to fuselage center line), in.	169.6
Sweepback (leading edge), deg	6.2
Sweepforward (trailing edge), deg	6.2
Root and tip airfoil section (theor.)	R4,45-1512-.9(12-percent thickness)
Incidence (intersection of wing and fuselage), deg	0
Incidence (at tip), deg	-2.0
Dihedral (from jig reference plane to horizontal), deg	5.0
Total aileron area (two), sq ft	32.2
Aileron span, in.	100.0
Aileron root chord (hinge center line to trailing edge), in.	20.6
Aileron tip chord (hinge center line to trailing edge), in.	15.4
Aileron static control limits (from neutral position), deg	
Up	17.2
Down	15.2
Aileron root-mean-square chord, in.	18.1
Horizontal tail (true dimensions and areas):	
Total area (including elevator, tabs, and 2.2 sq ft covered by vertical tail), sq ft	48.4
Span, in.	179.3
Aspect ratio (based on plan dimensions)	4.65
Taper ratio	0.56
Root chord, in.	50.0
Mean aerodynamic chord, in.	40.1
Root and tip airfoil section (theor.)	R4,40-010

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TABLE I.- Continued

DIMENSIONS AND PHYSICAL CHARACTERISTICS

OF THE F-84G TEST AIRPLANE

Incidence, deg	0
Dihedral (from horizontal to chord plane), deg	5.0
Sweepback (leading edge), deg	10.0
Sweepforward (trailing edge), deg	4.5
Location of root chord (above horizontal center line of fuselage), in.	24.0
Distance from 25 percent wing M.A.C. to 25 percent horizontal-tail M.A.C., in.	217.0
Total elevator area (two including tabs), sq ft	16.9
Elevator root chord (hinge center line to trailing edge), in.	15.0
Elevator tip chord (hinge center line to trailing edge), in.	8.8
Elevator span (one), in.	79.7
Elevator static control limits (from neutral position), deg	
Up	25.0
Down	10.0
Elevator root-mean-square chord, in.	12.0
Vertical tail:	
Total area (including rudder, 2.1 sq ft of dorsal fin, and 3.5 sq ft of ventral fin), sq ft	36.5
Aspect ratio	2.23
Root chord, (at fuselage center line), in.	77.8
Tip chord, in.	30.0
Mean aerodynamic chord, in.	63.0
Span (from fuselage center line), in.	99.5
Airfoil section	R4,40-010
Distance from 25 percent wing M.A.C. to 25 percent vertical-tail M.A.C., in.	218.3
Total rudder area, sq ft	10.0
Rudder span, in.	70.2
Rudder root chord, in.	17.8
Rudder tip chord, in.	9.5
Rudder static control limits, deg	±23.5
Rudder root-mean-square chord, in.	14.8
Fuselage:	
Total length (excluding nose boom), in.	461.4
Maximum width, in.	49.9
Frontal area (excluding canopy), sq ft	17.0

TABLE I.- Concluded

DIMENSIONS AND PHYSICAL CHARACTERISTICS

OF THE F-84G TEST AIRPLANE

Dive brake (frontal area exposed), sq ft	3.4
Dive-brake open position, deg down	54.8
Tip tanks:	
Length, in.	162.0
Maximum diameter, in.	28.8
Weight (one empty), lb	178
Capacity (one), U. S. gal	230
Fin root chord (measured parallel to tank center line), in.	34.9
Fin tip chord (measured parallel to tank center line), in.	4.0
Fin span, in.	25.0
Airplane serial number	AF 51-835
Power plant (one)	Allison J-35-A-29
Measured airplane weights (including three 50-caliber machine guns without ammunition, 200-pound pilot, recording instruments, and 302 pounds of ballast in the nose), lb:	
Full internal fuel and full tip tanks[a]	18,200
Full internal fuel and empty tip tanks	15,440
Full internal fuel and no tip tanks	15,090
No internal fuel and empty tip tanks	12,790
No internal fuel and no tip tanks	12,430
Measured center-of-gravity locations (gear up), percent M.A.C.:	
Full internal fuel and full tip tanks[a]	25.2
Full internal fuel and empty tip tanks	23.8
Full internal fuel and no tip tanks	23.4
No internal fuel and empty tip tanks	27.9
No internal fuel and no tip tanks	27.5

Approximate moments of inertia about airplane axes (gear up), slug-ft^2:

	I_X	I_Y	I_Z
Full internal fuel and full tip tanks[a]	51,280	21,920	72,150
Full internal fuel and empty tip tanks	18,560	21,300	38,870
Full internal fuel and no tip tanks	14,740	21,160	34,920
No internal fuel and empty tip tanks	13,690	20,380	33,210
No internal fuel and no tip tanks	9,810	20,250	29,210

[a]Tip tank fuel is used before internal fuel.

TABLE II

SUMMARY OF INSTRUMENTATION AND ACCURACIES F-84G

Quantity measured	Instrument used	Units	Instrument accuracy excluding reproduction error (units as given)	Reproduction accuracy (units as given)	Instrument natural frequency, cps
Pressure altitude	Airspeed-altitude recorder	feet	----------	----	>100 (diaphragm)
Indicated airspeed	Airspeed-altitude recorder	knots	----------	----	>100 (diaphragm)
Rudder angle	Control-position recorder	degrees	±0.4 (-10° to 10°) ±.7 (large angles)	±0.5	14
Aileron angle	Control-position recorder	degrees	±.4 (-12 to 12°) ±.7 (large angles)	±.3	14
Elevator angle	Control-position recorder	degrees	±.4 (-4° to 15°) ±.7 (large angles)	±.3	14
Normal load factor	Single-component accelerometer	-------	±.03	±.05	19
Longitudinal load factor	Three-component accelerometer	-------	±.01	±.02	14.7
Transverse load factor	Three-component accelerometer	-------	±.01	±.02	14.7
Pitching velocity	Angular-velocity recorder	$\frac{\text{radians}}{\text{sec}}$	±.02	±.01	14

TABLE II.- Concluded

SUMMARY OF INSTRUMENTATION AND ACCURACIES F-84G

Quantity measured	Instrument used	Units	Instrument accuracy excluding reproduction error (units as given)	Reproduction accuracy (units as given)	Instrument natural frequency, cps
Pitching acceleration	Angular accelerometer	$\frac{\text{radians}}{\text{sec}^2}$	±.08	±.02	14 (transmitter) 12.2 (galvanometer)
Yawing velocity	Angular-velocity recorder	$\frac{\text{radians}}{\text{sec}}$	±.01	±.01	9.5
Yawing acceleration	Angular accelerometer	$\frac{\text{radians}}{\text{sec}^2}$	±.04	±.02	9.5 (transmitter) 12.5 (galvanometer)
Rolling velocity	Angular-velocity recorder	$\frac{\text{radians}}{\text{sec}}$	±.08	±.05	25.5
Rolling acceleration	Angular accelerometer	$\frac{\text{radians}}{\text{sec}^2}$	±.40	±.10	25.5 (transmitter) 12.6 (galvanometer)
Angle of sideslip	Flow-direction recorder	degrees	±.3 (-4° to 12°) ±.7 (large angles)	±.50	18
Angle of attack	Flow-direction recorder	degrees	±.3 (-10° to 10°) ±.7 (large angles)	±.50	18
Time	Timer	seconds	0	±.6 in 60 sec (over-all) ±.1 (synchronization)	----------

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TABLE III

HISTORY AND SUMMARY OF FLIGHTS

Flight	Pilot	G-suit	Configuration	Mission	Take-off weight, lb	Take-off center-of-gravity location (gear up), percent M.A.C.	Remarks
1	A	Yes	External tip tanks; no external stores	Acrobatics	16,720	24.5	
2	B	No	----------do----------	Acrobatics and dive-bombing	18,130	25.2	
3	C	No	----------do----------	Acrobatics and dogfighting	16,790	24.6	
4	D	No	----------do----------	Acrobatics	18,130	25.2	Left tip tank failed to drain; tank contained 1,380 pounds of fuel
5	D	No	----------do----------	Acrobatics	18,150	25.2	
6	E	No	----------do----------	Acrobatics, dive-bombing, and ground and aerial gunnery	16,840	24.6	
7	D	No	----------do----------	Acrobatics, dive-bombing, and ground gunnery	16,890	24.6	
8	D	No	----------do----------	----------do----------	16,820	24.6	
9	F	No	----------do----------	Acrobatics	16,740	24.5	Right tip tank failed to drain; tank contained 750 pounds of fuel
10	G	No	----------do----------	Acrobatics, dive-bombing, and strafing	16,790	24.6	

TABLE III.- Concluded

HISTORY AND SUMMARY OF FLIGHTS

Flight	Pilot	G-suit	Configuration	Mission	Take-off weight, lb	Take-off center-of-gravity location (gear up), percent M.A.C.	Remarks
11	H	No	External tip tanks; no external stores	Acrobatics, dive-bombing, and strafing	16,770	24.5	
12	I	Yes	----------do----------	Acrobatics	16,840	24.6	
13	J	Yes	----------do----------	Acrobatics, dive-bombing, and ground gunnery	16,820	24.6	
14	K	No	----------do----------	Acrobatics, dive-bombing, and strafing	16,740	24.5	
15	E	Yes	----------do----------	Acrobatics and dive-bombing	16,720	24.5	
16	L	Yes	----------do----------	Acrobatics and strafing	16,790	24.6	
17	M	No	----------do----------	Acrobatics, dive-bombing, ground and aerial gunnery, and dogfighting	16,840	24.6	
18	L	No	----------do----------	Acrobatics, dive-bombing, and dogfighting	16,820	24.6	
19	N	No	No external tip tanks; no external stores	Acrobatics, dive-bombing, and strafing	14,940	23.6	
20	N	No	----------do----------	Acrobatics and dogfighting	14,940	23.6	

TABLE IV

MANEUVER CLASSIFICATION

	Figures
Type of maneuver:	
Take-offs	4 to 13
Turns	14 to 104
Chandelles	105 to 112
Wing-overs	113 to 118
Lazy eights	119 to 124
Aileron rolls	125 to 167
Barrel rolls	168 to 187
Snap rolls	188 to 190
Vertical recoveries	191 to 193
Pull-ups	194 to 202
Push-down	203
Immelmans	204 to 230
Loops	231 to 247
Split-S's	248 to 253
Cuban eights	254 to 256
Sideslips	257 to 260
Fishtails	261 to 266
Dives	267 to 272
Dive-bombing runs	273 to 308
Ground-gunnery and strafing runs	309 to 334
Stalls	335 to 344
Spins	345 to 347
Landings	348 to 357

Figure 1.- Three-quarter view of F-84G test airplane.

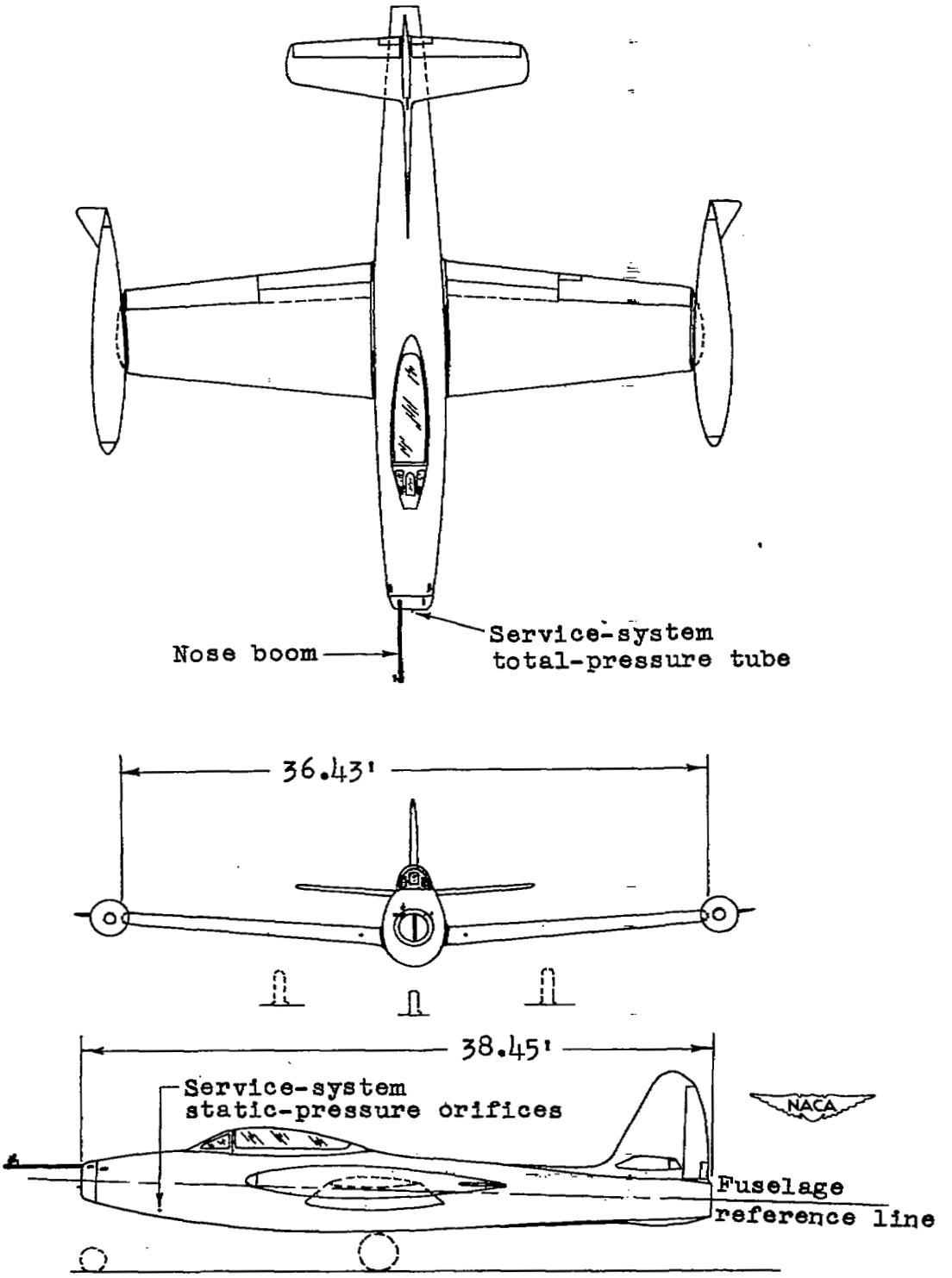

Figure 2.- Three-view drawing of F-84G test airplane.

[redacted]

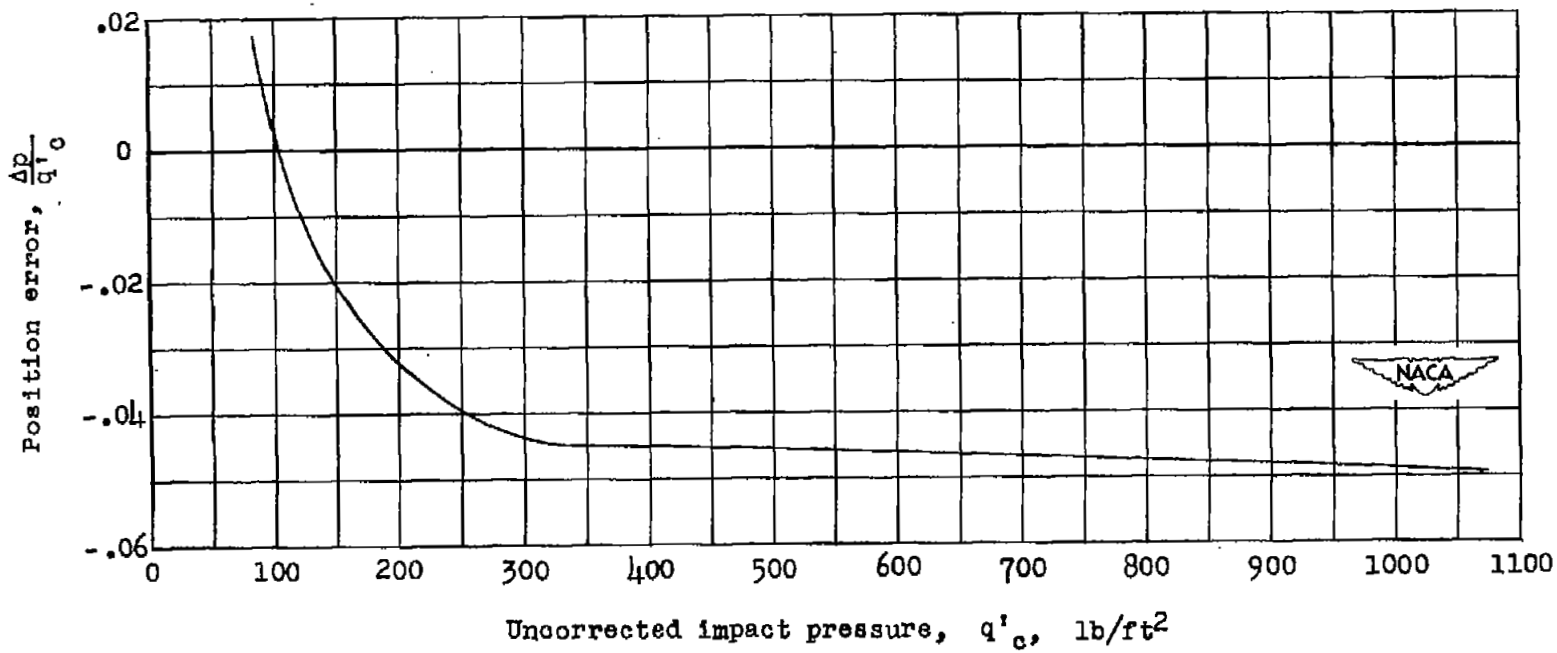

Figure 3.- Static-pressure position error for the F-84G airplane. Level flight; altitude, 290 feet; weight, 14,000 pounds.

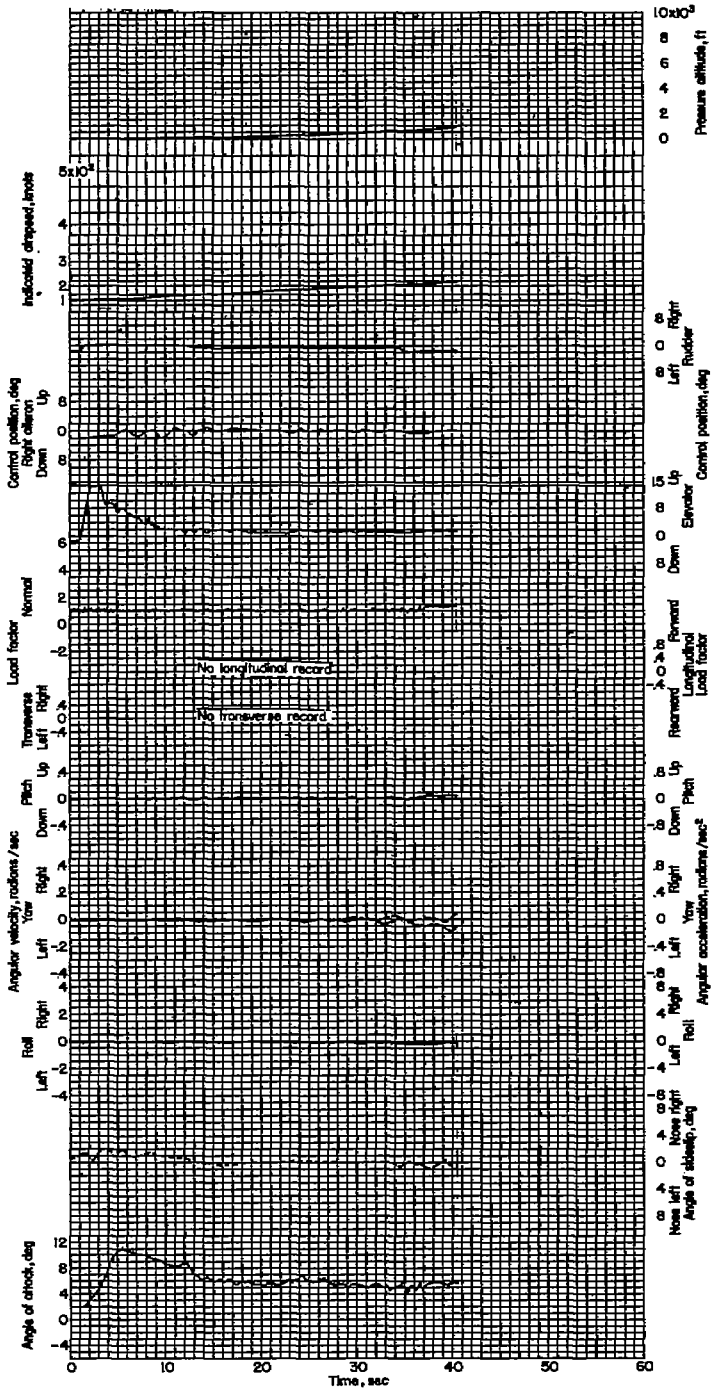

Figure 4.- Take-off. Airplane weight, 16,710 pounds; center of gravity at 24.5 percent M.A.C.; flight 1.

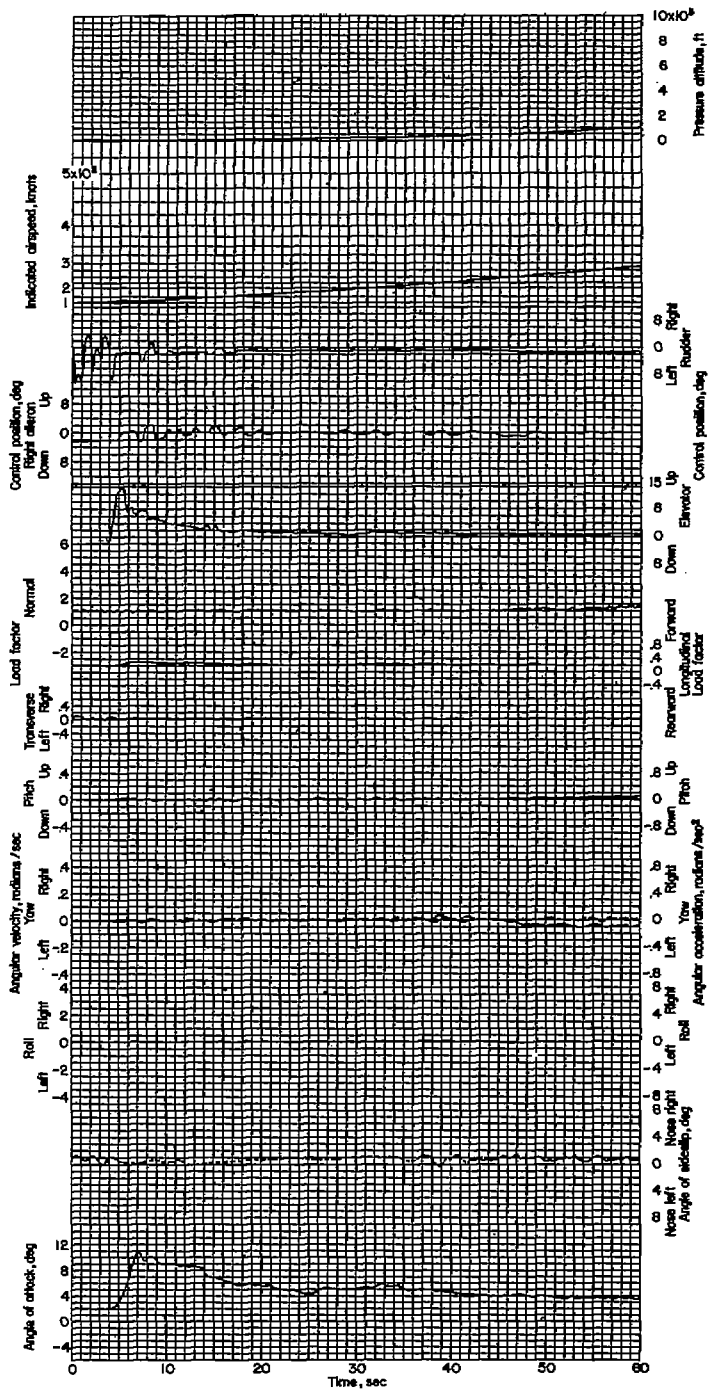

Figure 5.- Take-off. Airplane weight, 18,110 pounds; center of gravity at 25.2 percent M.A.C.; flight 2.

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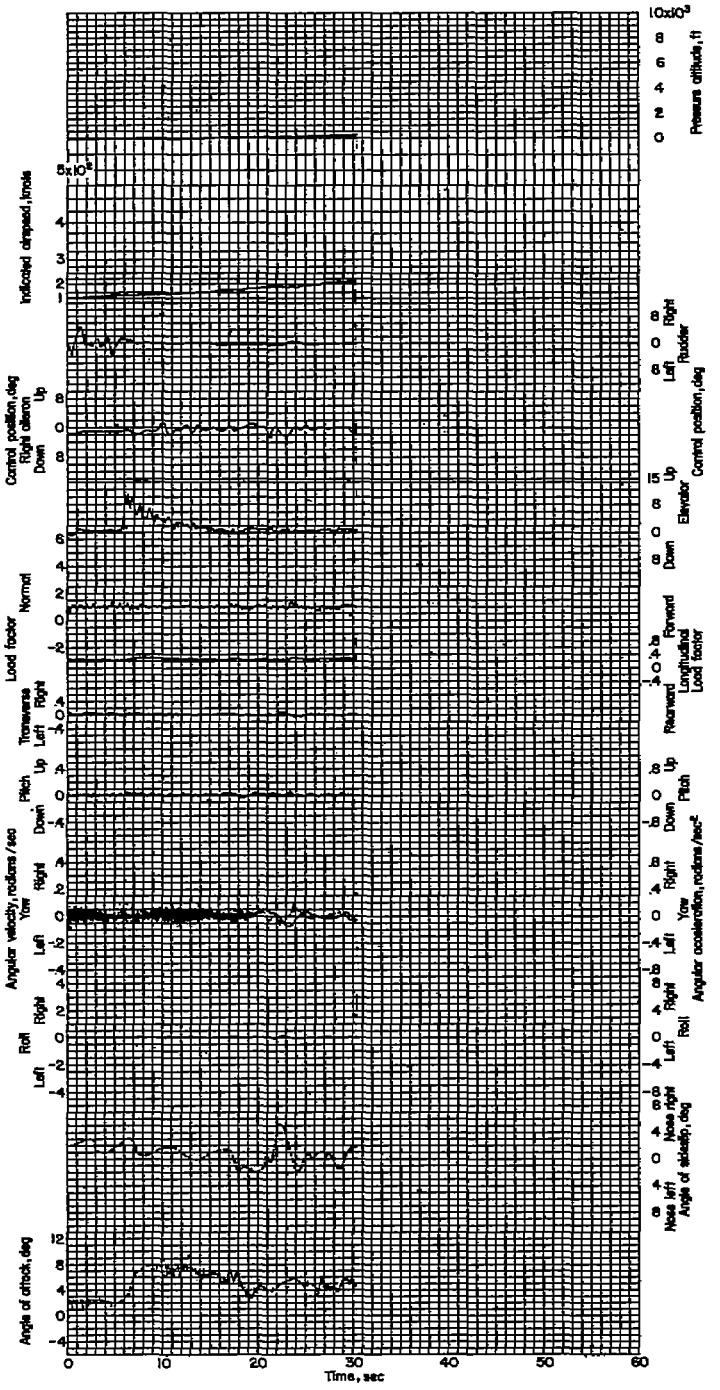


Figure 6.- Take-off. Airplane weight, 16,780 pounds; center of gravity at 24.6 percent M.A.C.; flight 3.

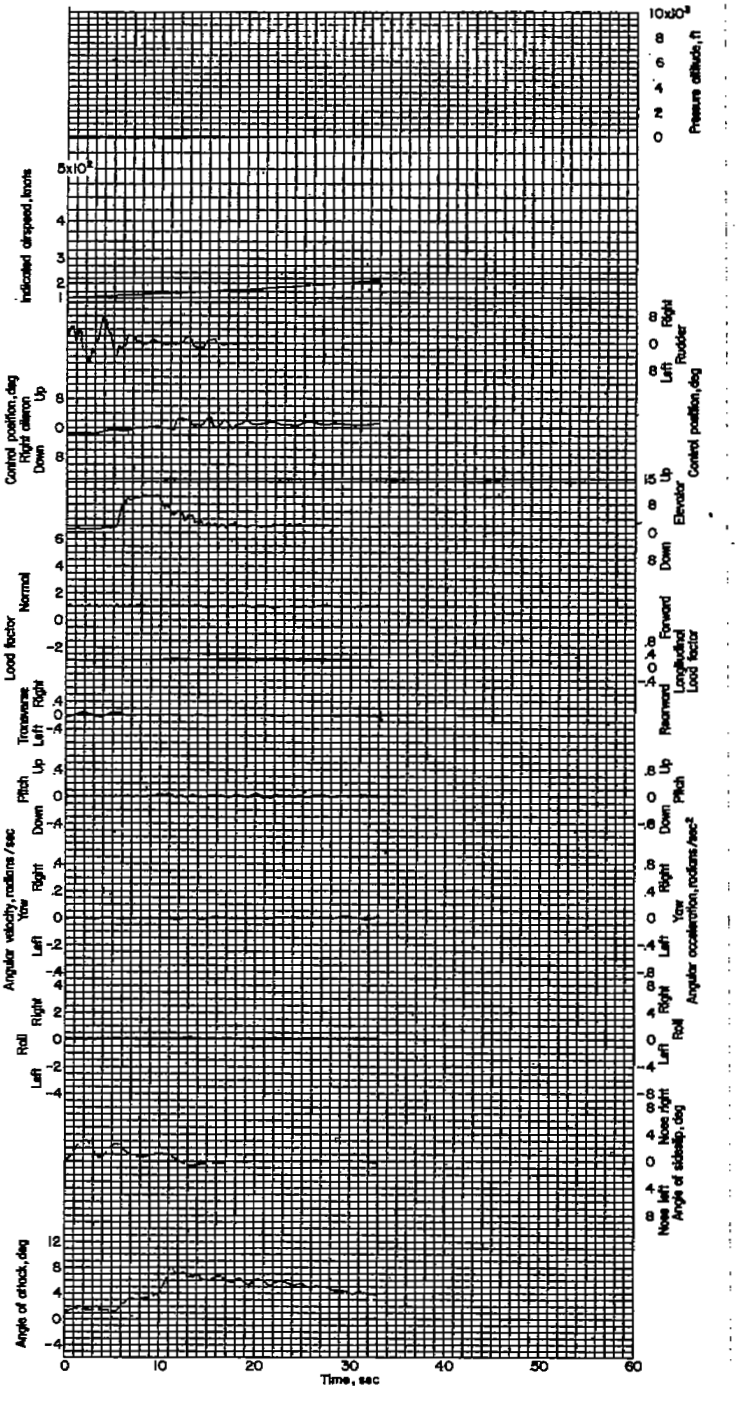


Figure 7.- Take-off. Airplane weight, 18,110 pounds; center of gravity at 25.2 percent M.A.C.; flight 4.

[redacted]

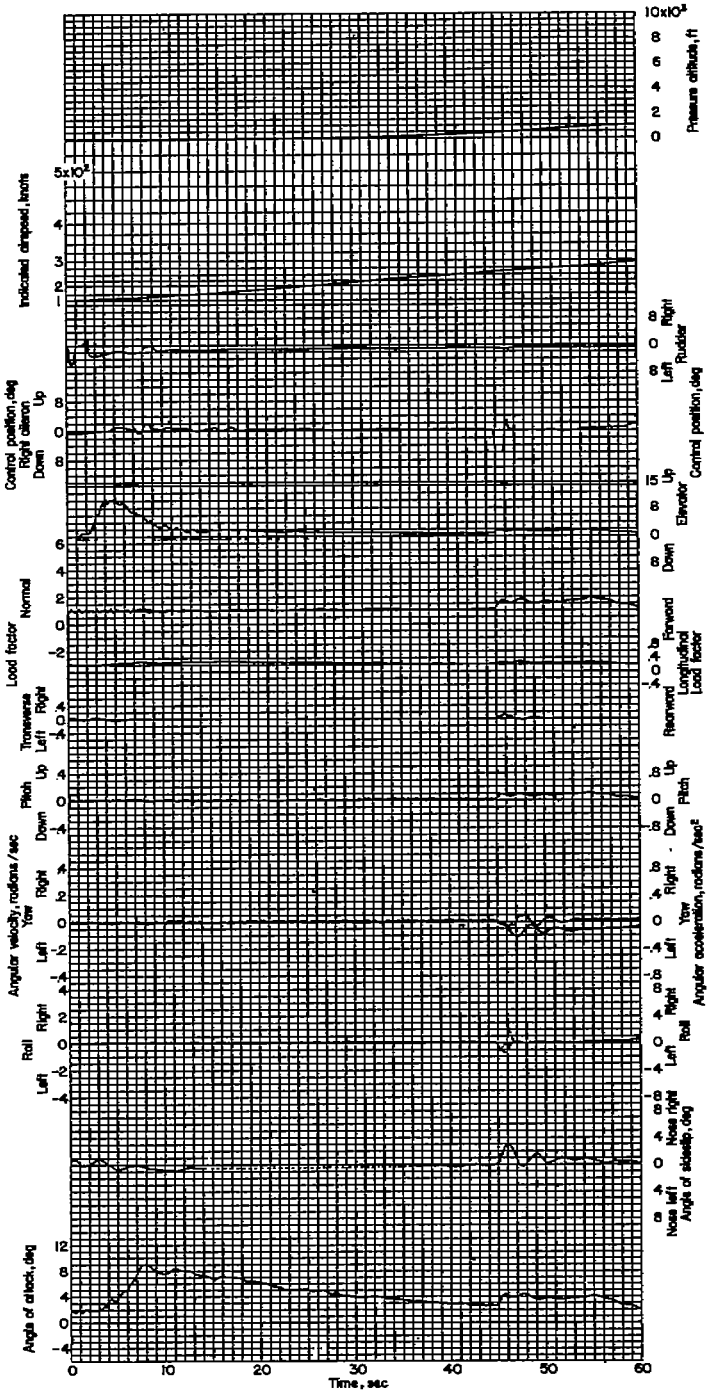


Figure 8.- Take-off. Airplane weight, 16,790 pounds; center of gravity at 24.6 percent M.A.C.; flight 8.

[redacted]

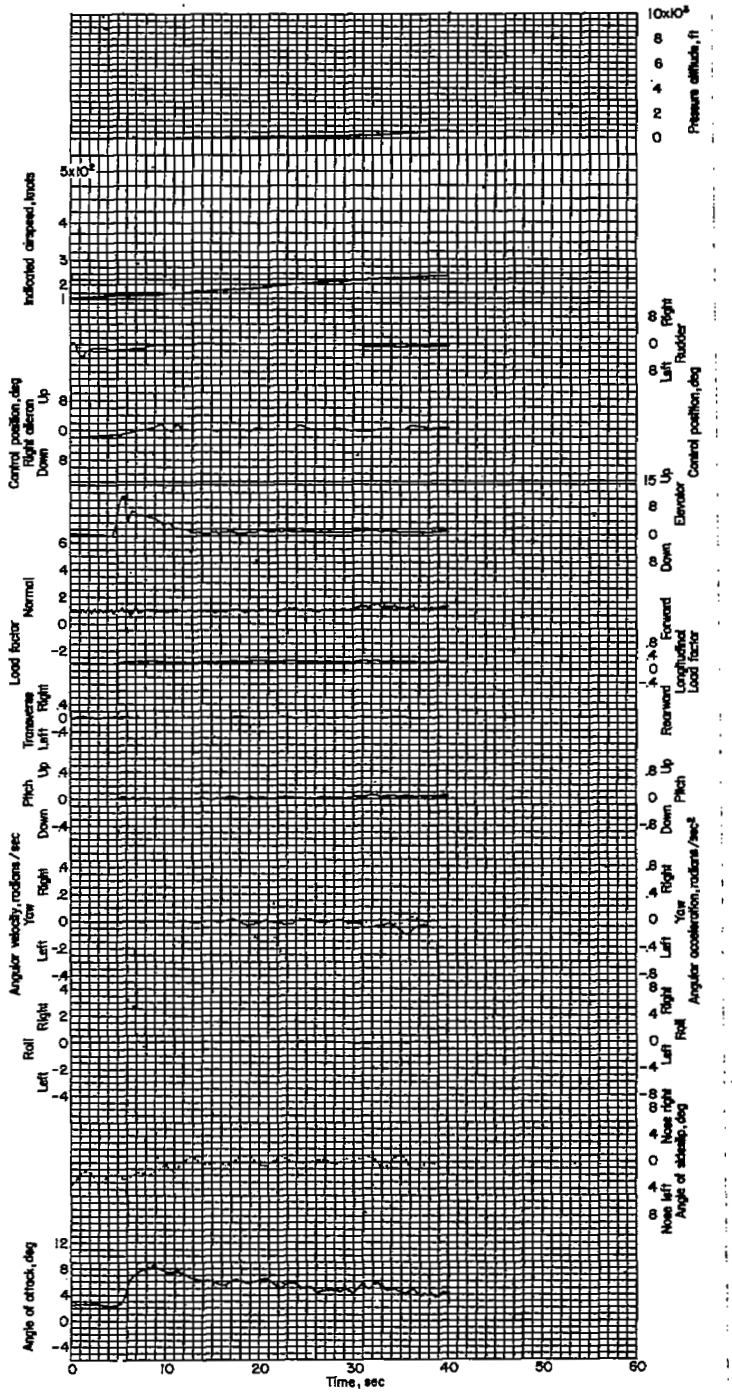


Figure 9.- Take-off. Airplane weight, 16,780 pounds; center of gravity at 24.6 percent M.A.C.; flight 10.

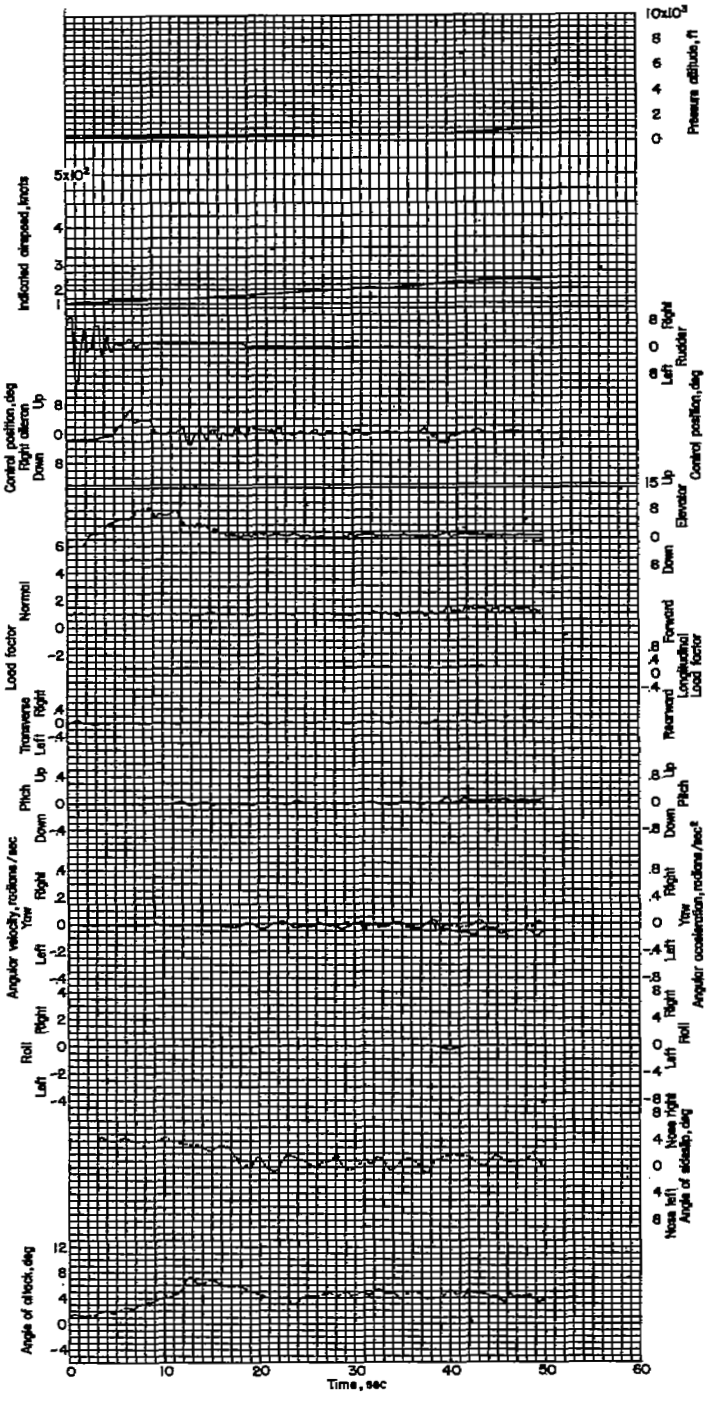


Figure 10.- Take-off. Airplane weight, 16,820 pounds; center of gravity at 24.6 percent M.A.C.; flight 12.

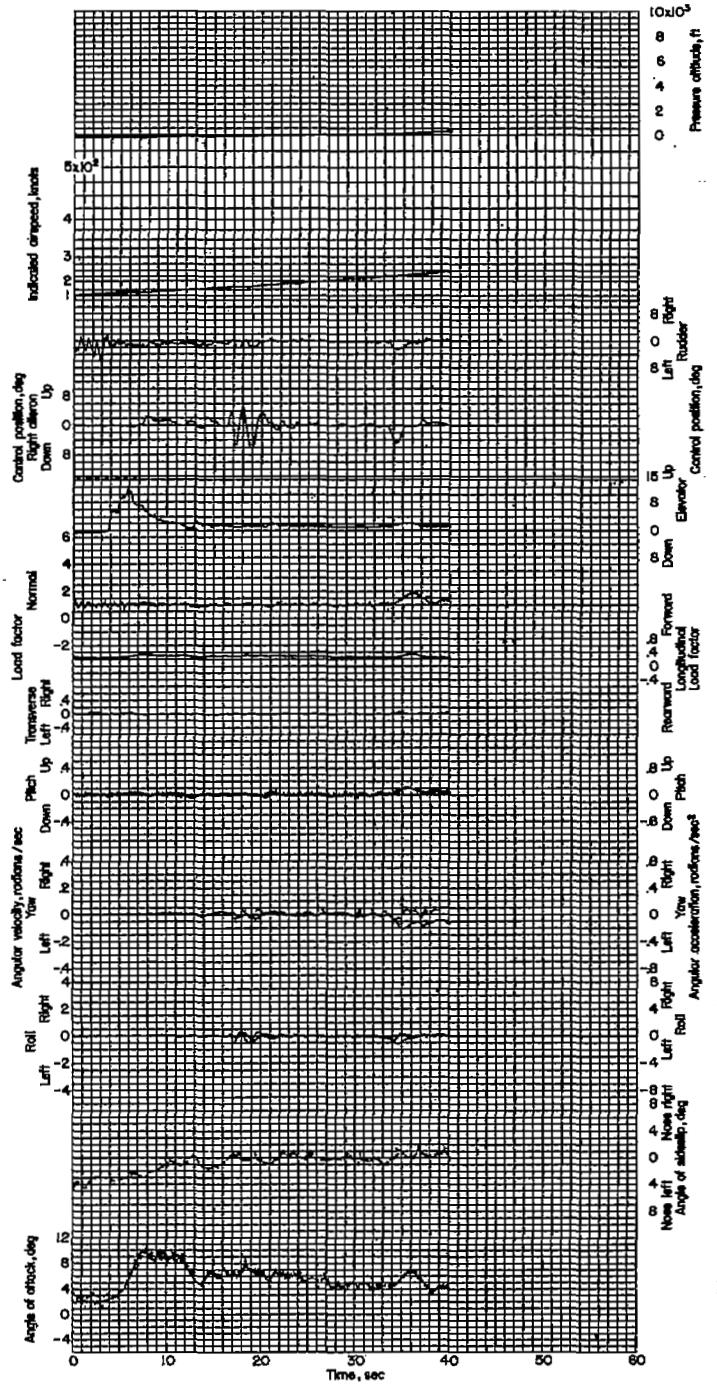


Figure 11.- Take-off. Airplane weight, 16,700 pounds; center of gravity at 24.5 percent M.A.C.; flight 15.

X

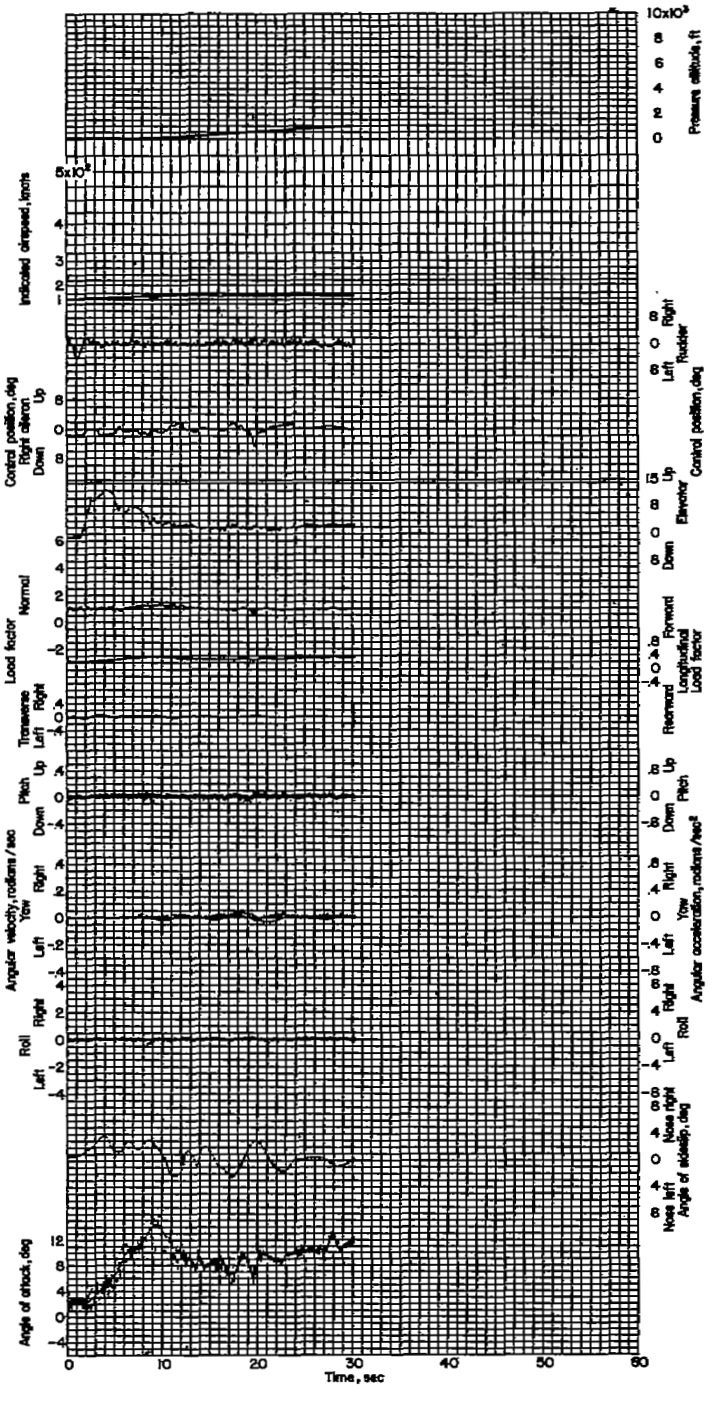


Figure 12.- Take-off. Airplane weight, 16,800 pounds; center of gravity at 24.6 percent M.A.C.; flight 18.

[redacted]

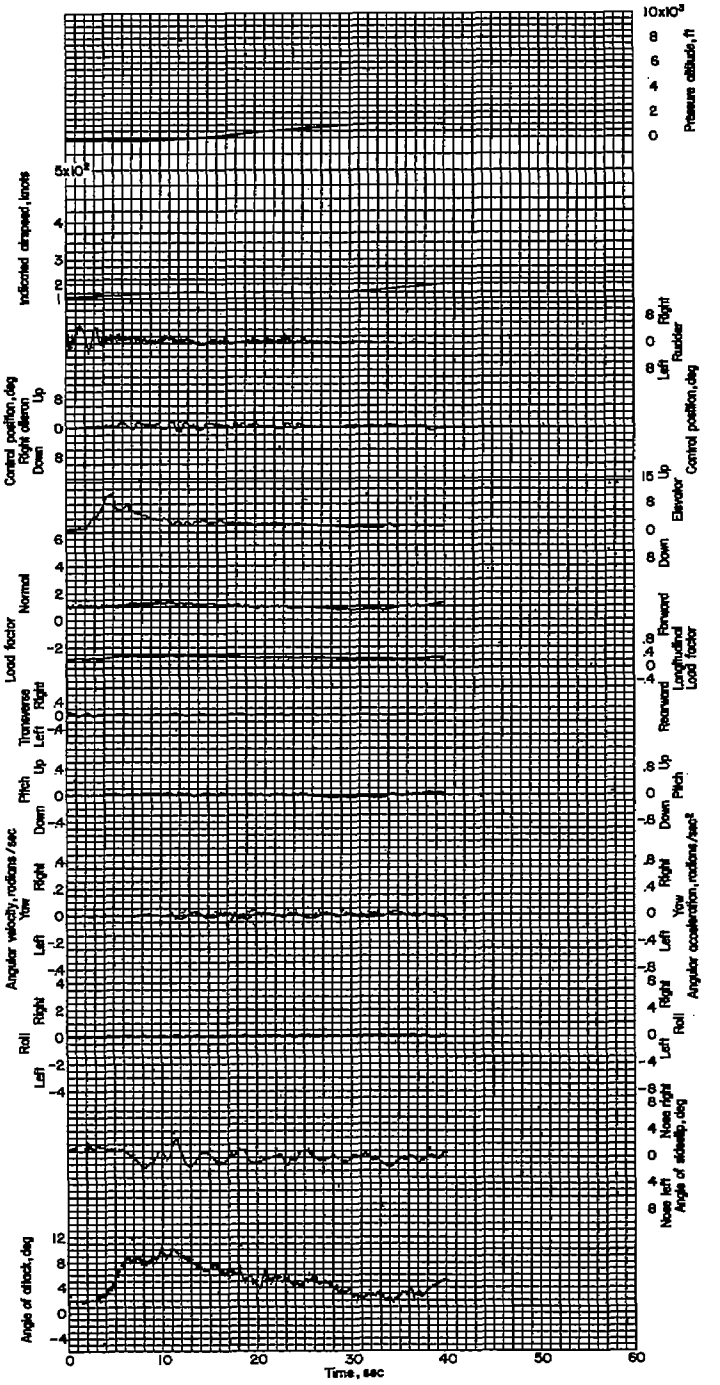


Figure 13.- Take-off. Airplane weight, 14,920 pounds; center of gravity at 23.6 percent M.A.C.; flight 20.

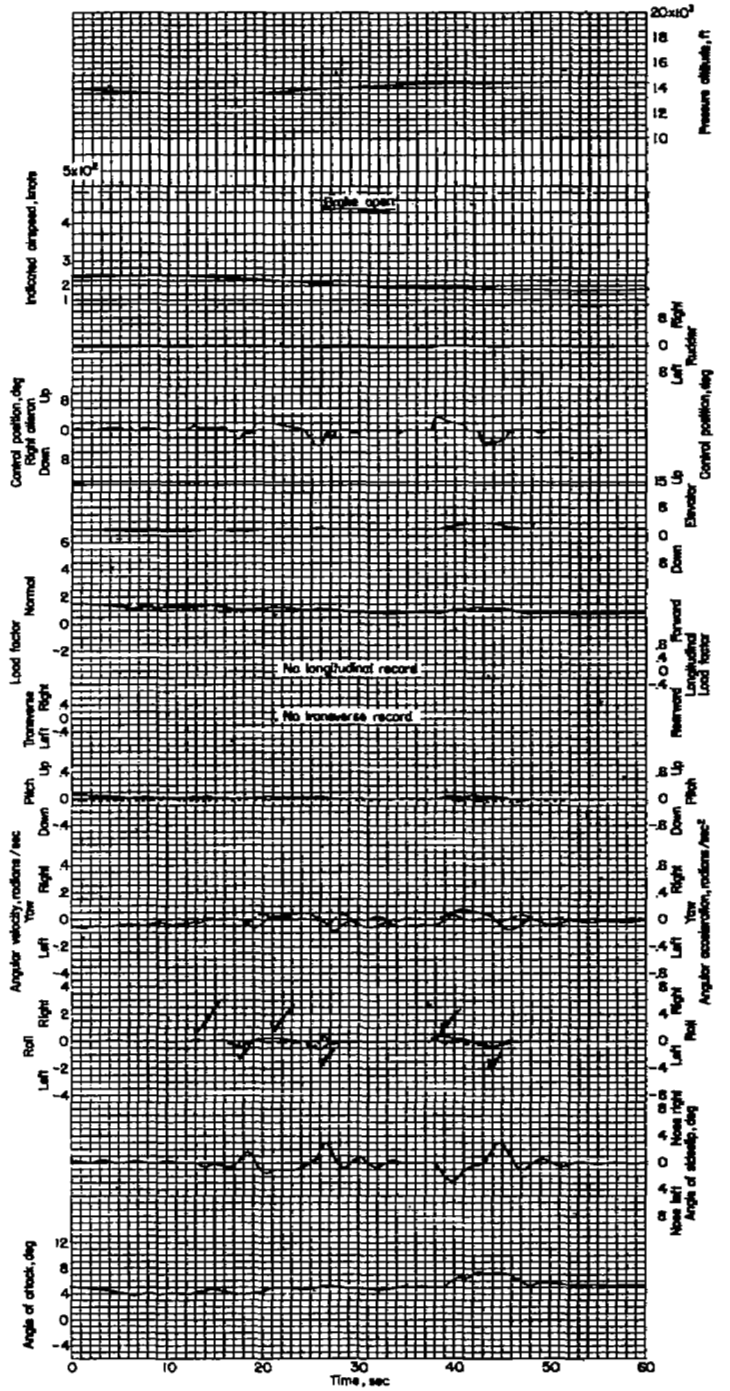


Figure 14.- Series of turns. Airplane weight, 15,330 pounds; center of gravity at 23.9 percent M.A.C.; flight 1.

[redacted]

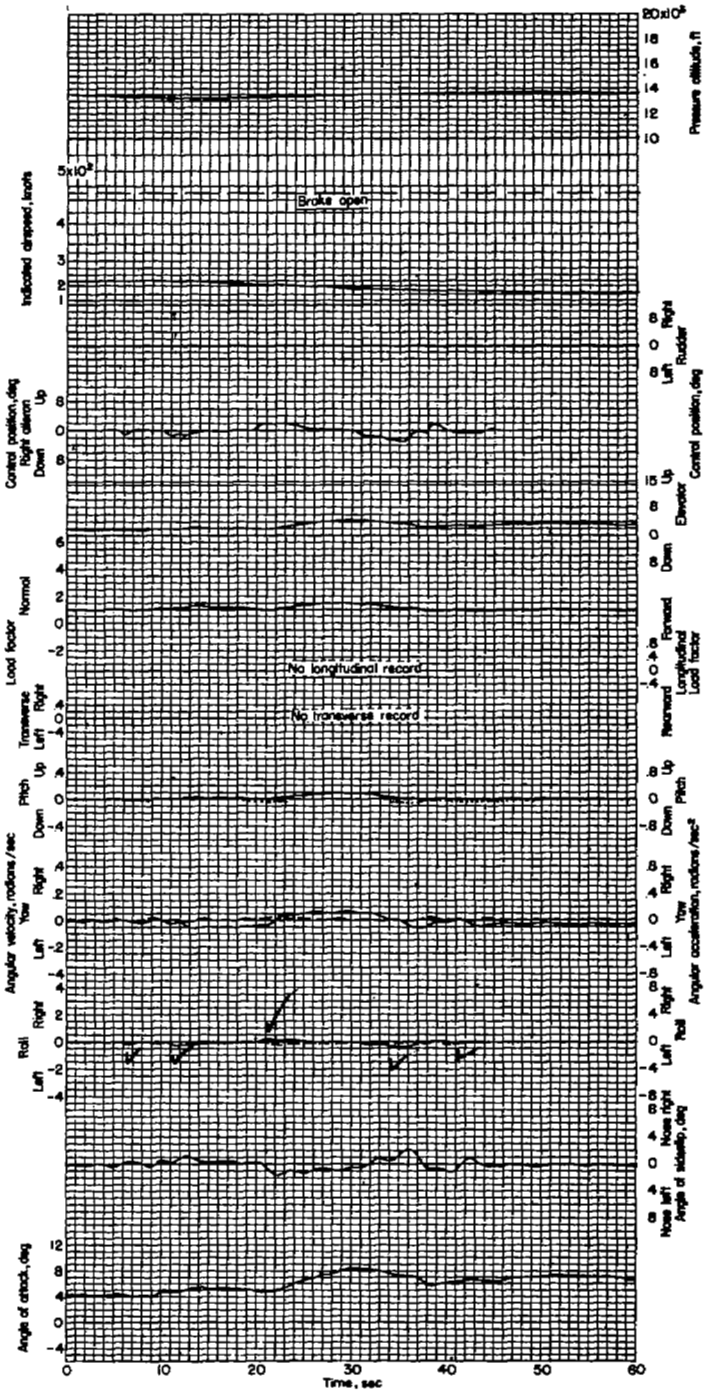
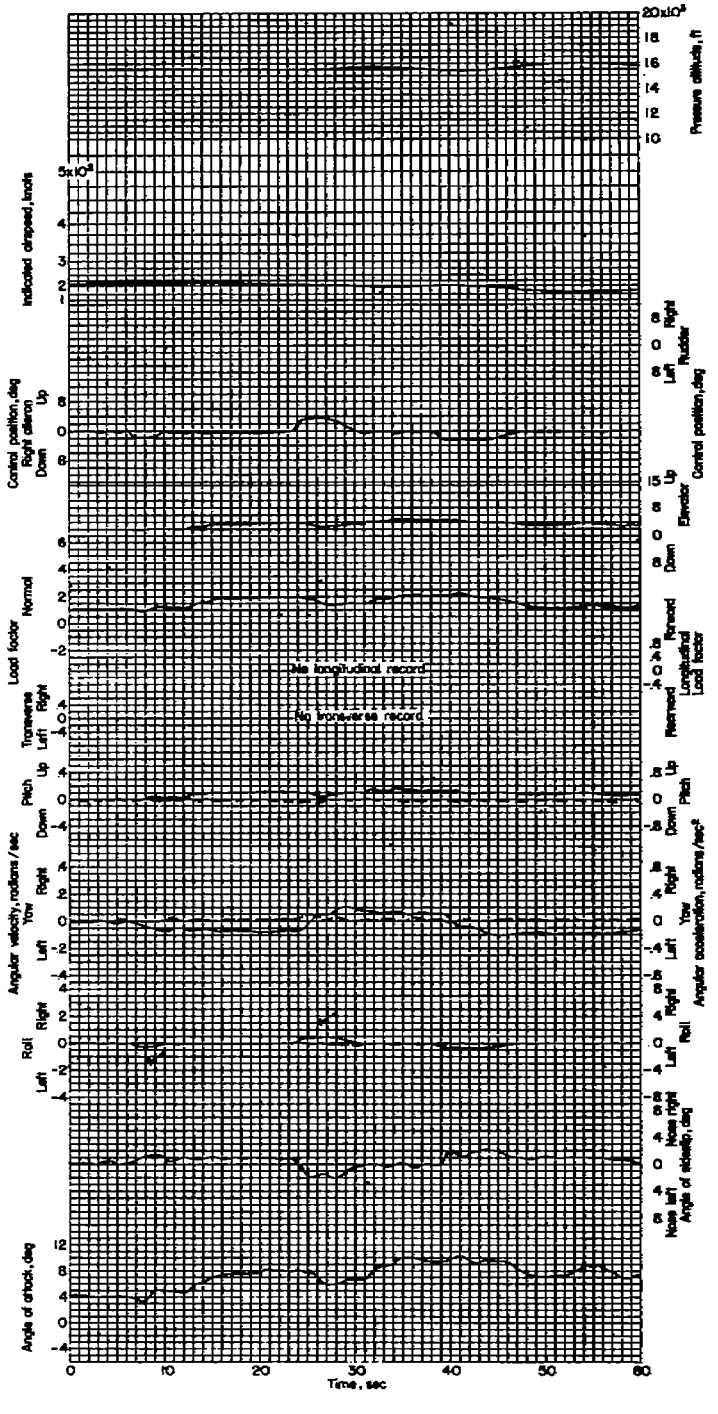


Figure 15.- Series of turns. Airplane weight, 15,280 pounds; center of gravity at 24.0 percent M.A.C.; flight 1.



(a)

Figure 16.- Series of turns. Airplane weight, 14,670 pounds; center of gravity at 24.8 percent M.A.C.; flight 1.

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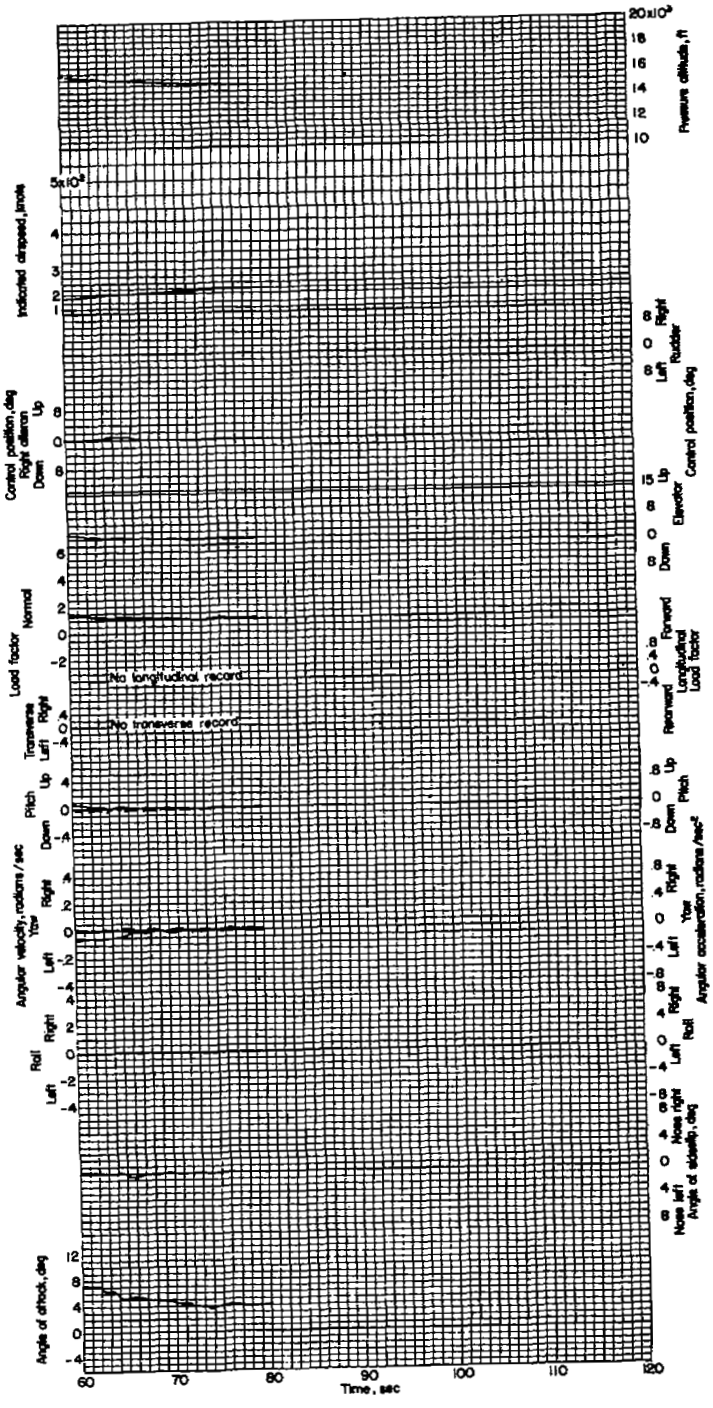

(b)

Figure 16.- Concluded.

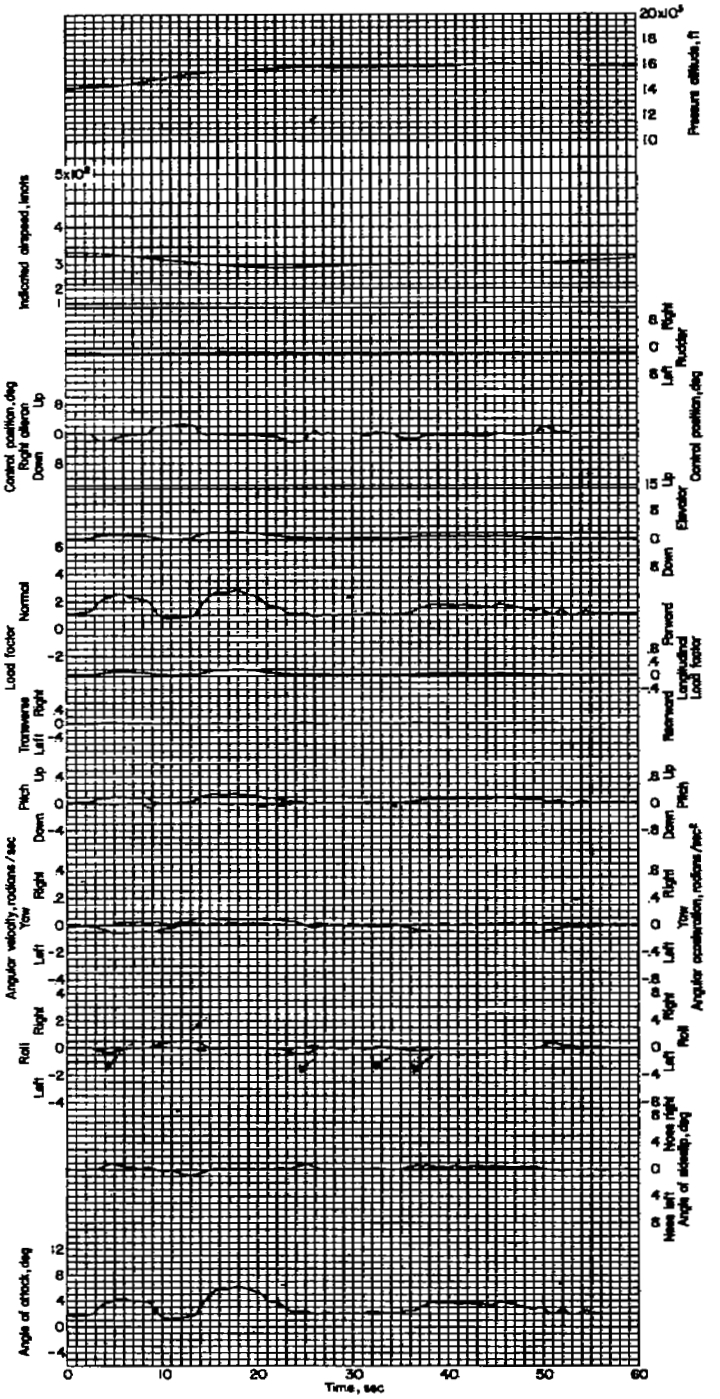

Figure 17.- Series of turns. Airplane weight, 17,310 pounds; center of gravity at 24.8 percent M.A.C.; flight 2.

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[redacted]

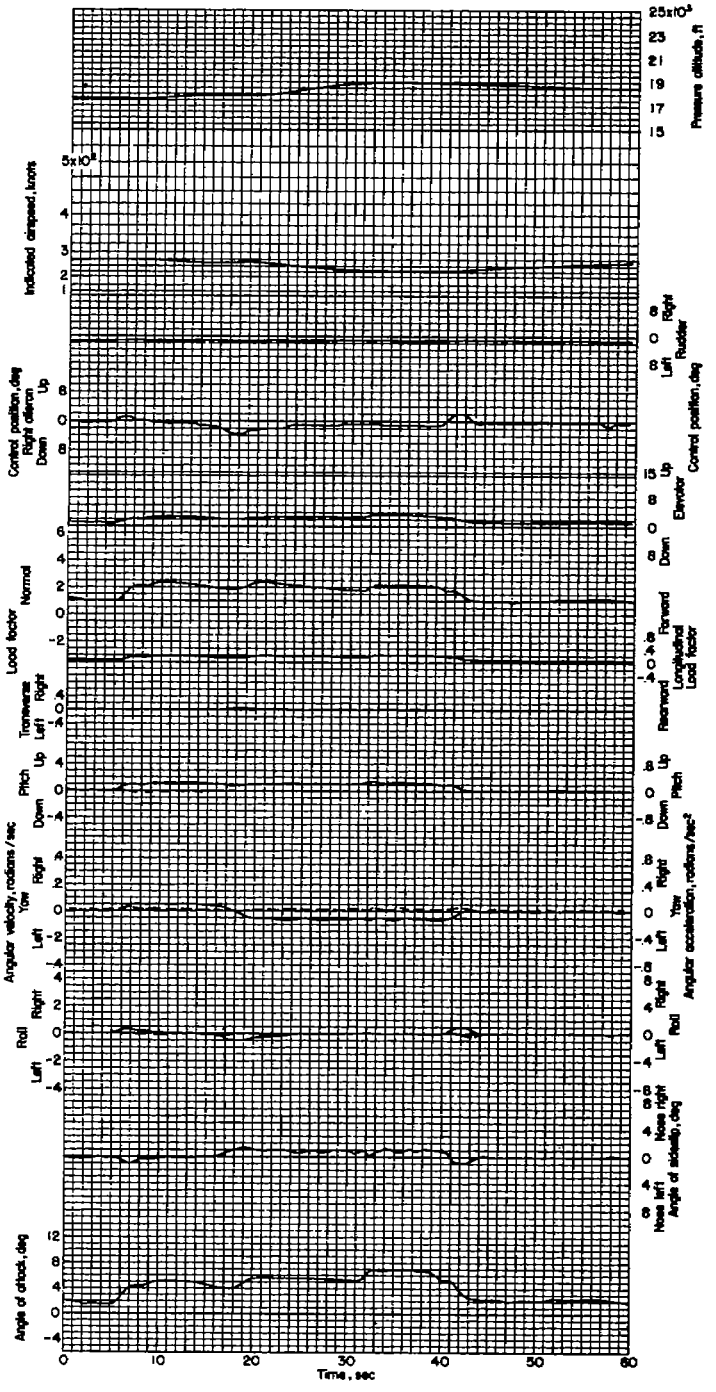


Figure 18.- Left turn. Airplane weight, 16,700 pounds; center of gravity at 24.5 percent M.A.C.; flight 2.

[redacted]

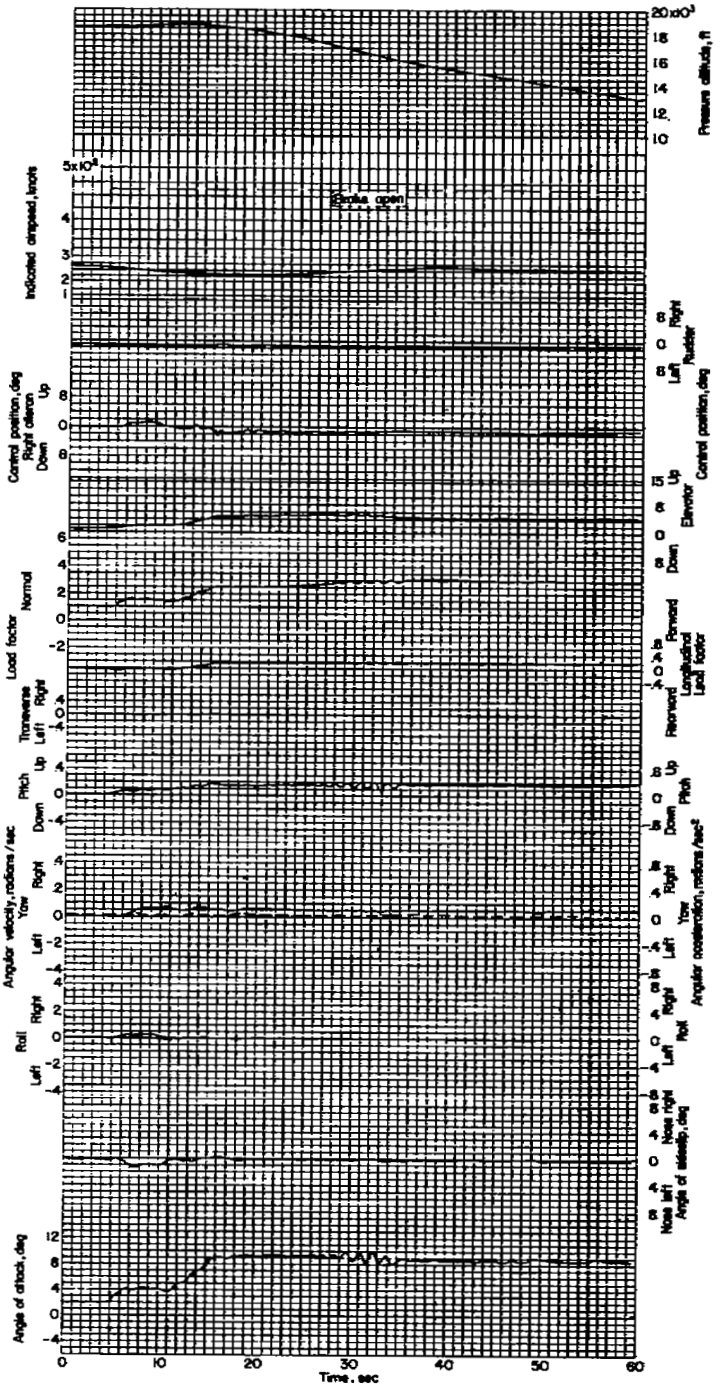
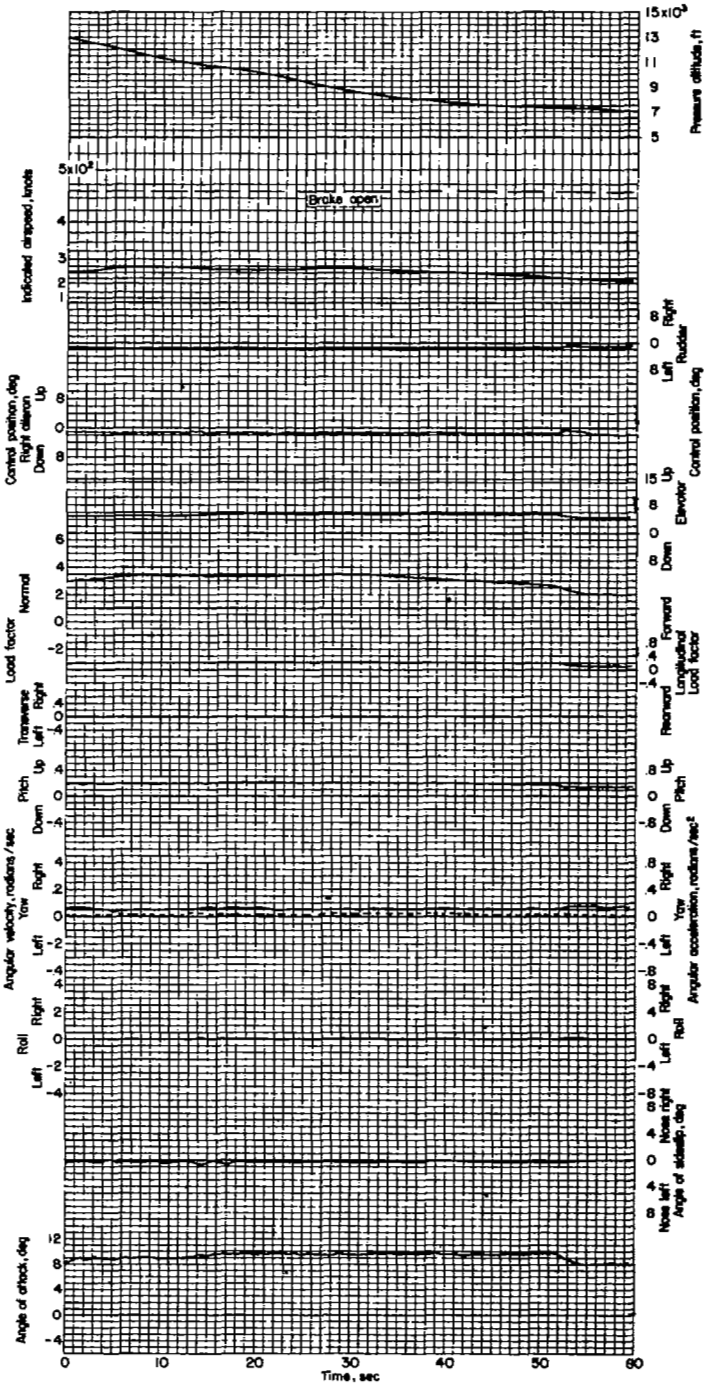


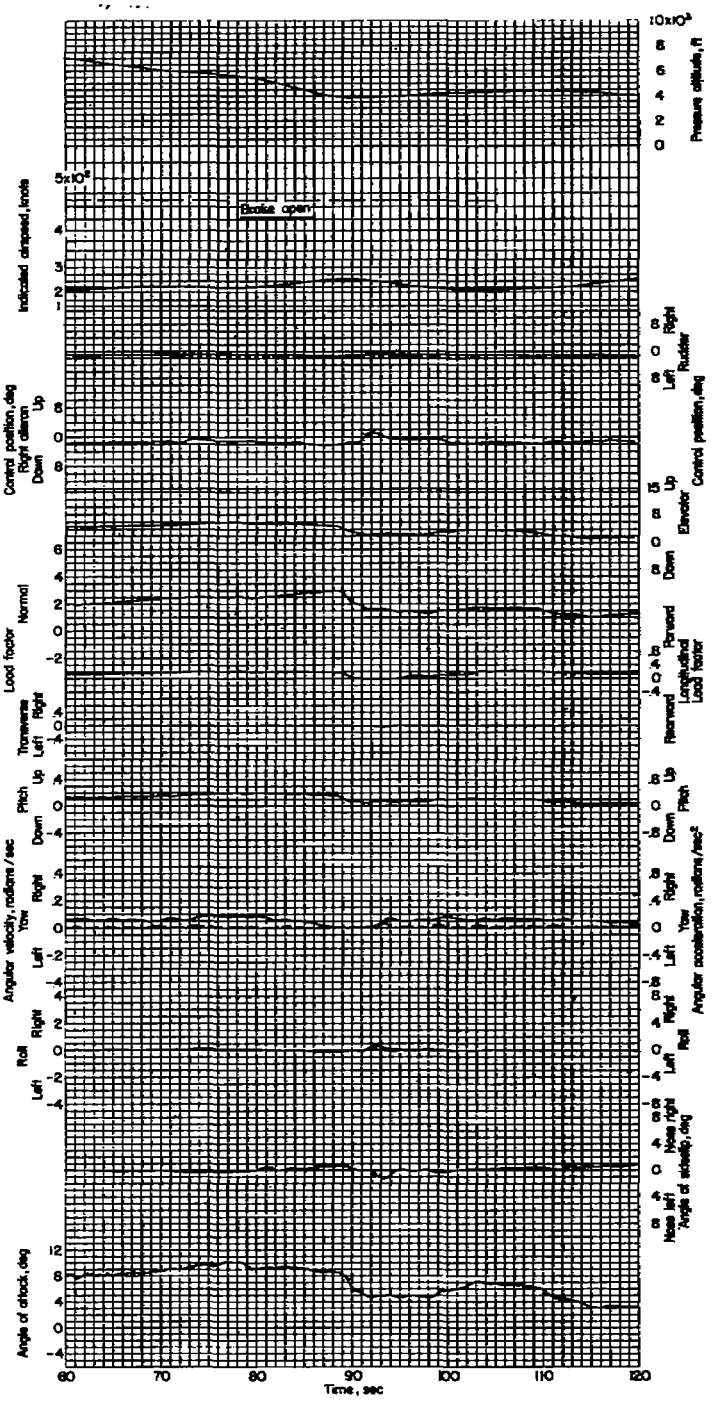
Figure 19.- Diving right turn. Airplane weight, 16,640 pounds; center of gravity at 24.5 percent M.A.C.; flight 2.



(a)

Figure 20.- Diving right turn. Airplane weight, 16,590 pounds; center of gravity at 24.5 percent M.A.C.; flight 2.

[redacted]



(b)

Figure 20.- Concluded.

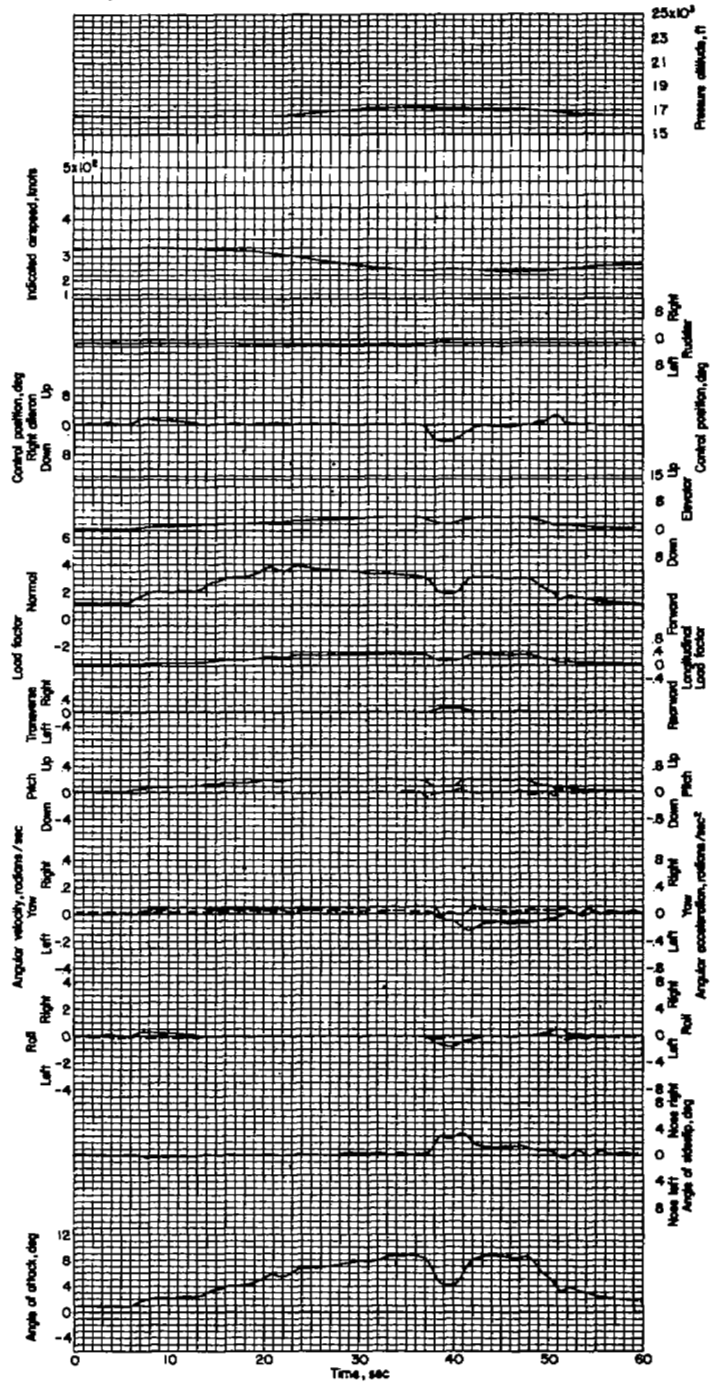


Figure 21.- Right and left turn. Airplane weight, 15,810 pounds; center of gravity at 24.0 percent M.A.C.; flight 2.

[redacted]

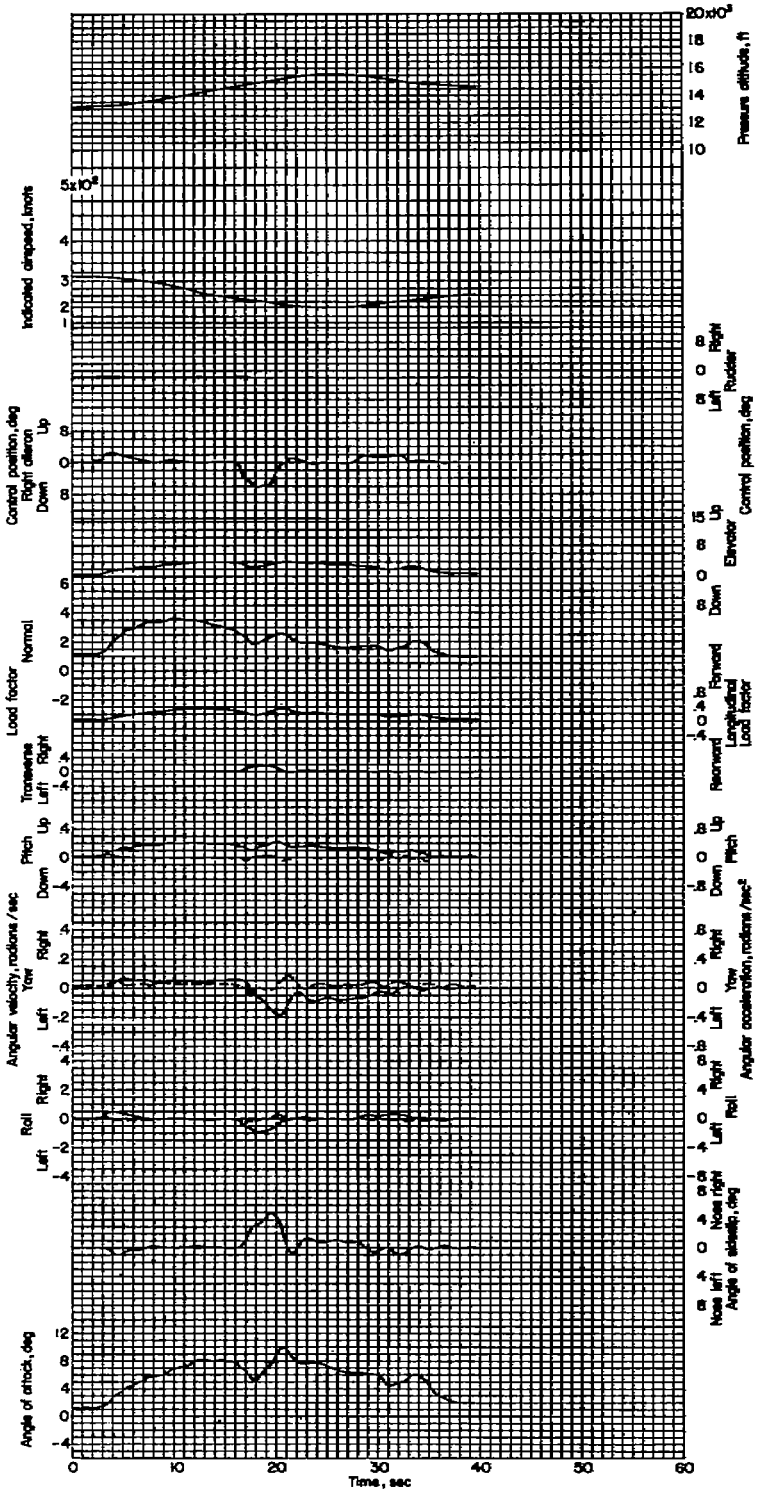
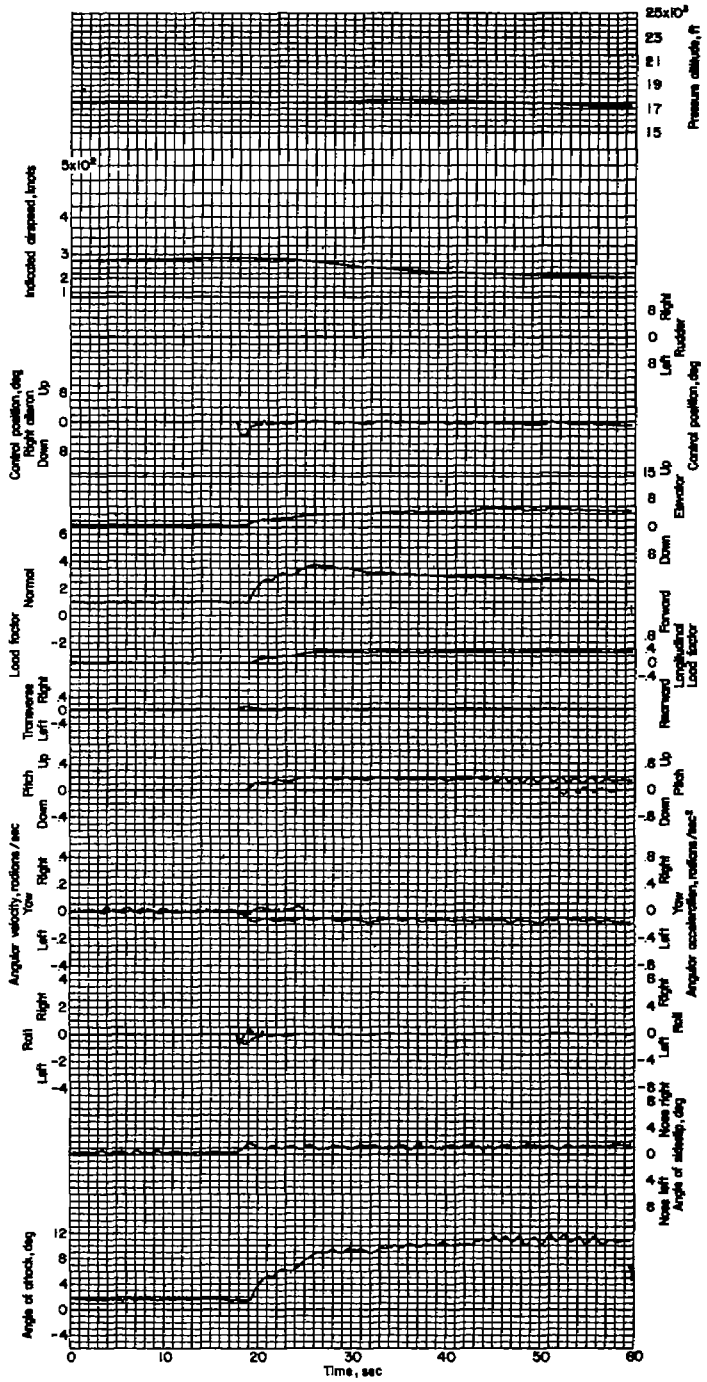


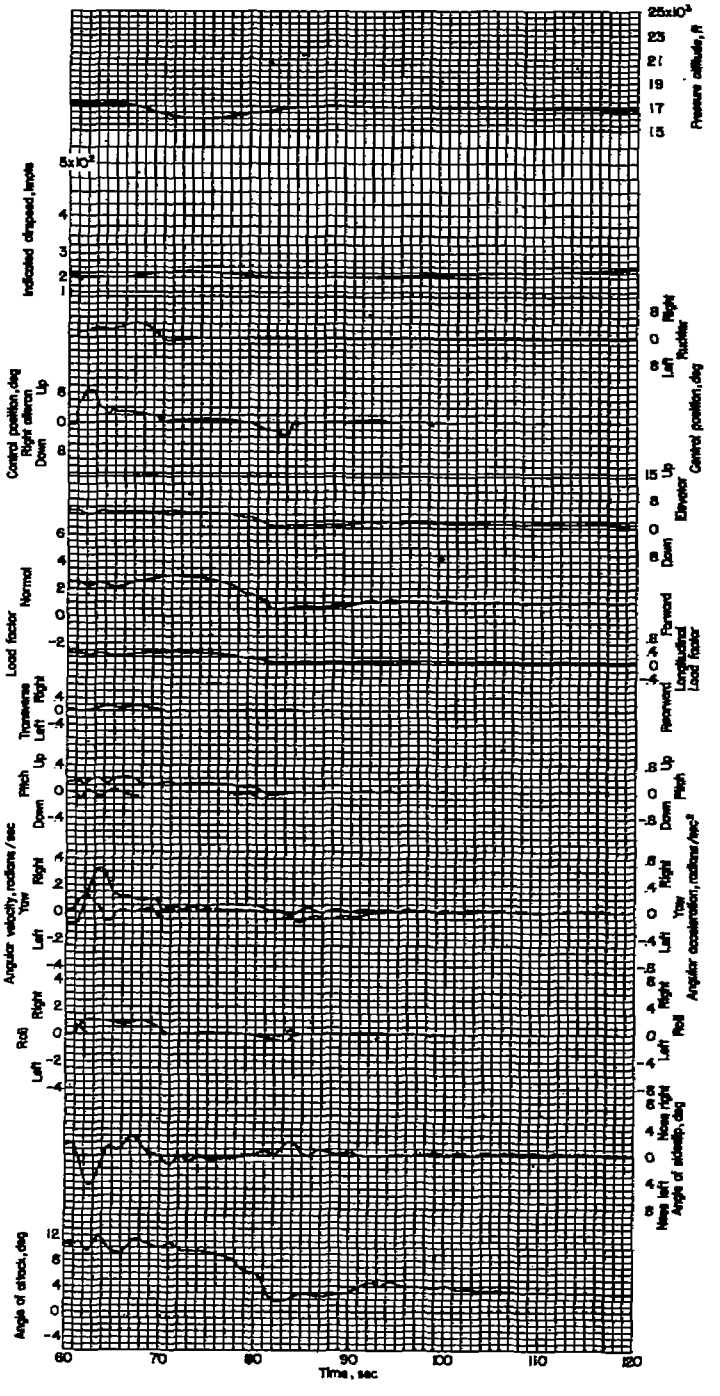
Figure 22.- Climbing right and left turn. Airplane weight, 15,570 pounds; center of gravity at 23.9 percent M.A.C.; flight 2.



(a)

Figure 23.- Left turn followed by right barrel roll. Airplane weight, 15,090 pounds; center of gravity at 24.2 percent M.A.C.; flight 3.

[redacted]



(b)

Figure 23.- Concluded.

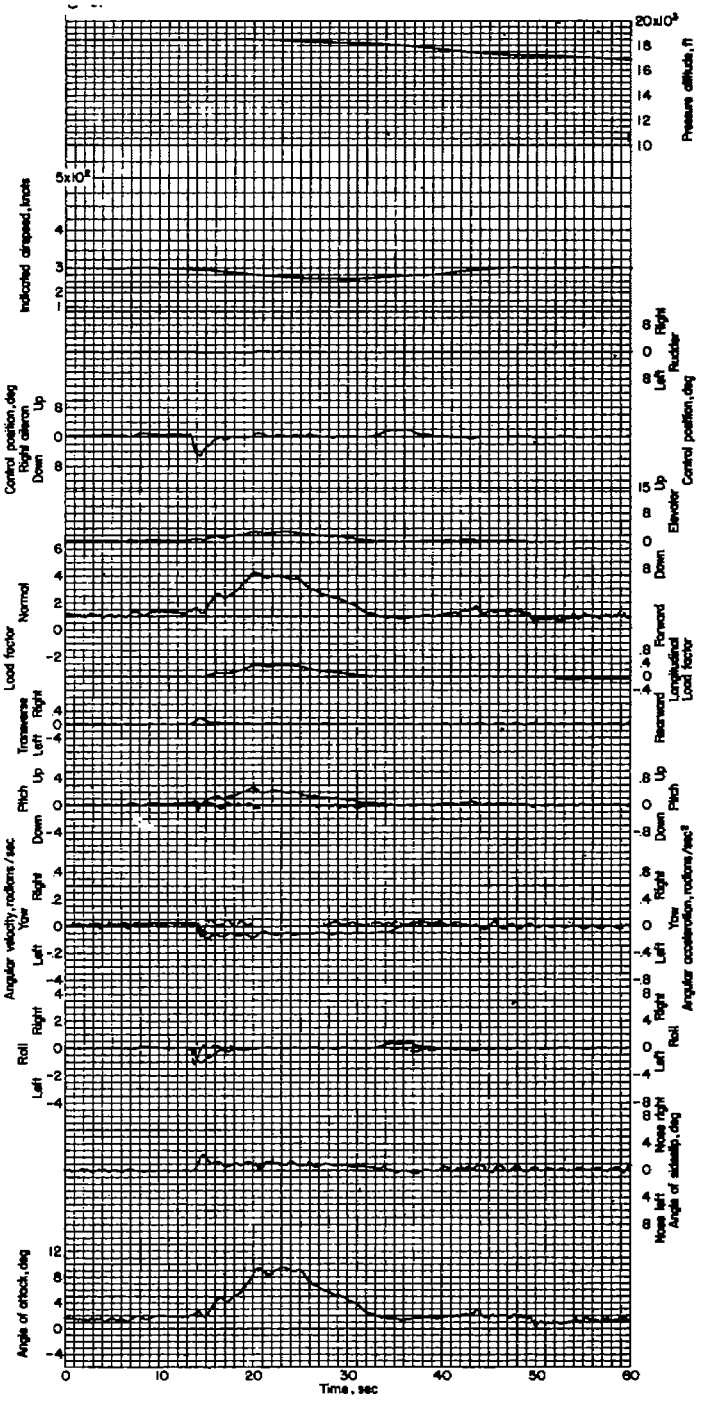
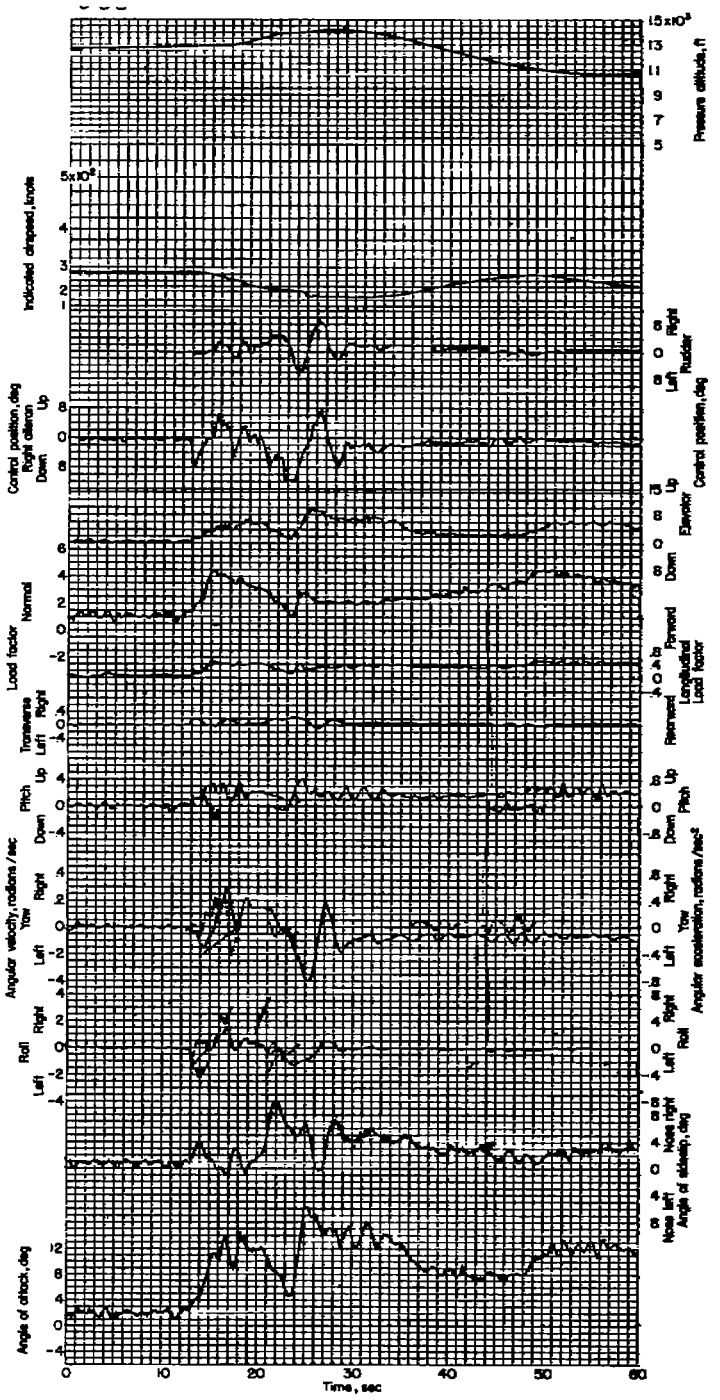


Figure 24.- Left turn. Airplane weight, 14,220 pounds; center of gravity at 25.4 percent M.A.C.; flight 3.

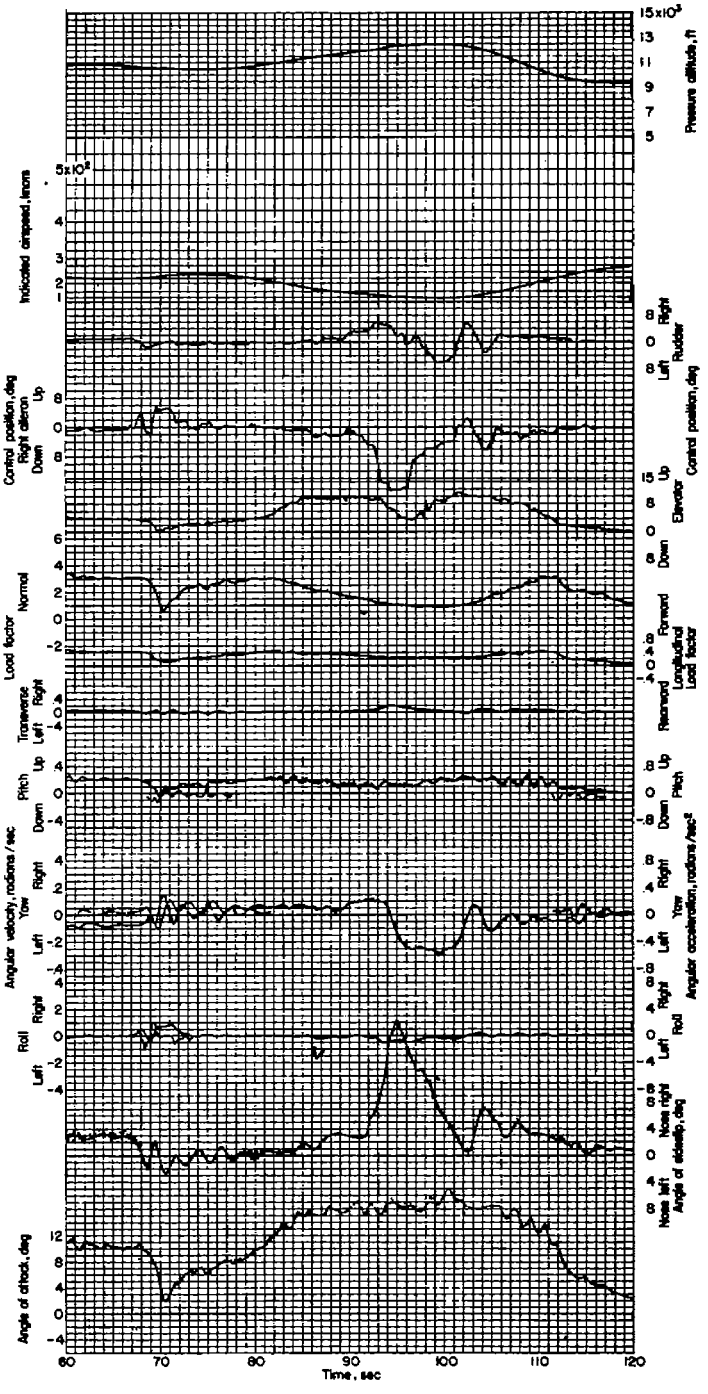
[redacted]



(a)

Figure 25.- Series of stall turns. Airplane weight, 14,000 pounds; center of gravity at 25.7 percent M.A.C.; flight 3.

[redacted]



(b)

Figure 25.- Concluded.

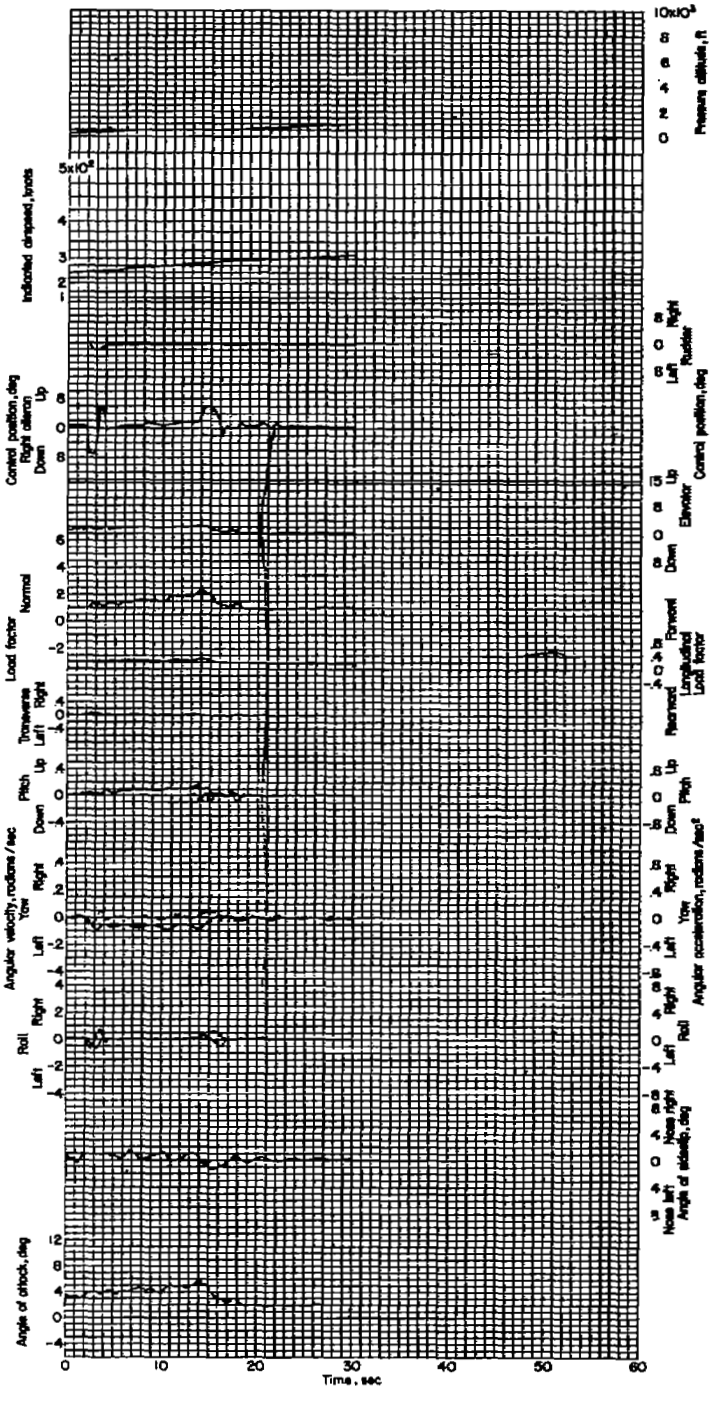
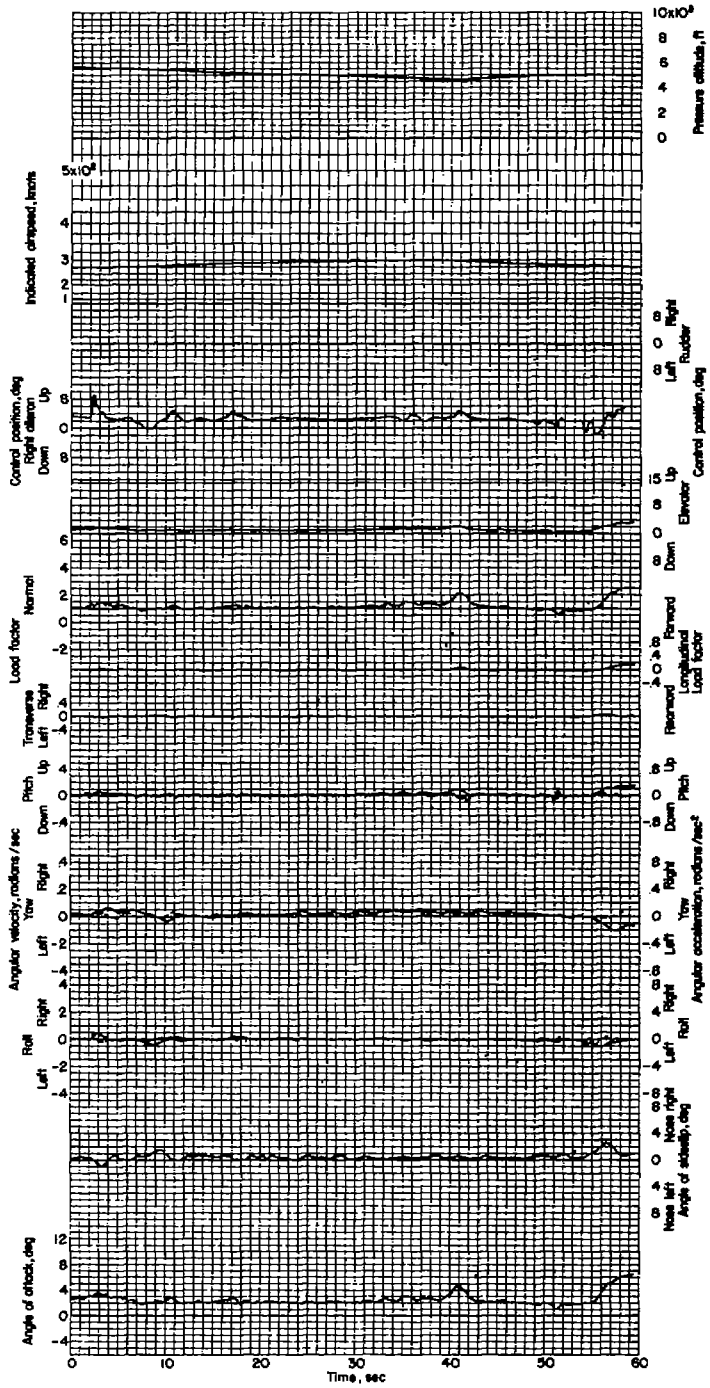


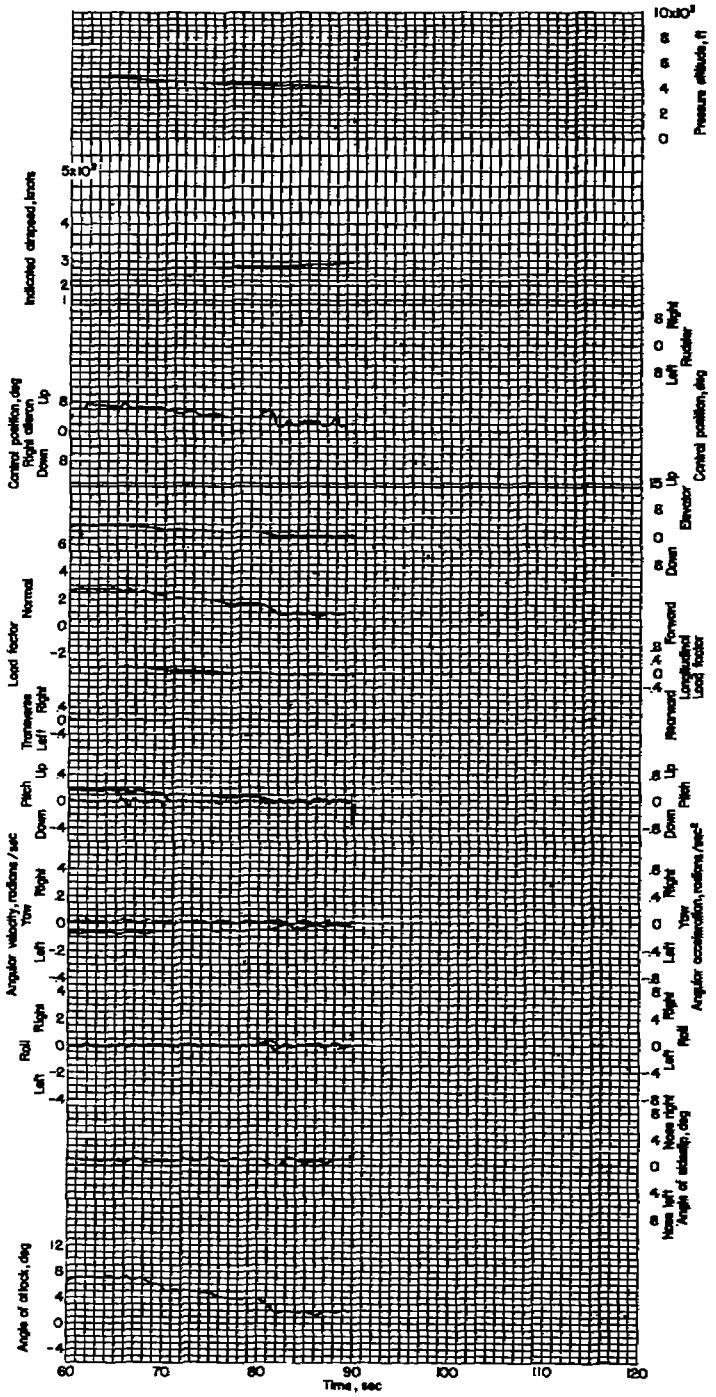
Figure 26.- Left turn. Airplane weight, 18,070 pounds; center of gravity at 25.2 percent M.A.C.; flight 4.



(a)

Figure 27.- Right and left turn. Airplane weight, 17,250 pounds; center of gravity at 24.8 percent M.A.C.; flight 4.

[redacted]



(b)

Figure 27.- Concluded.

[redacted]

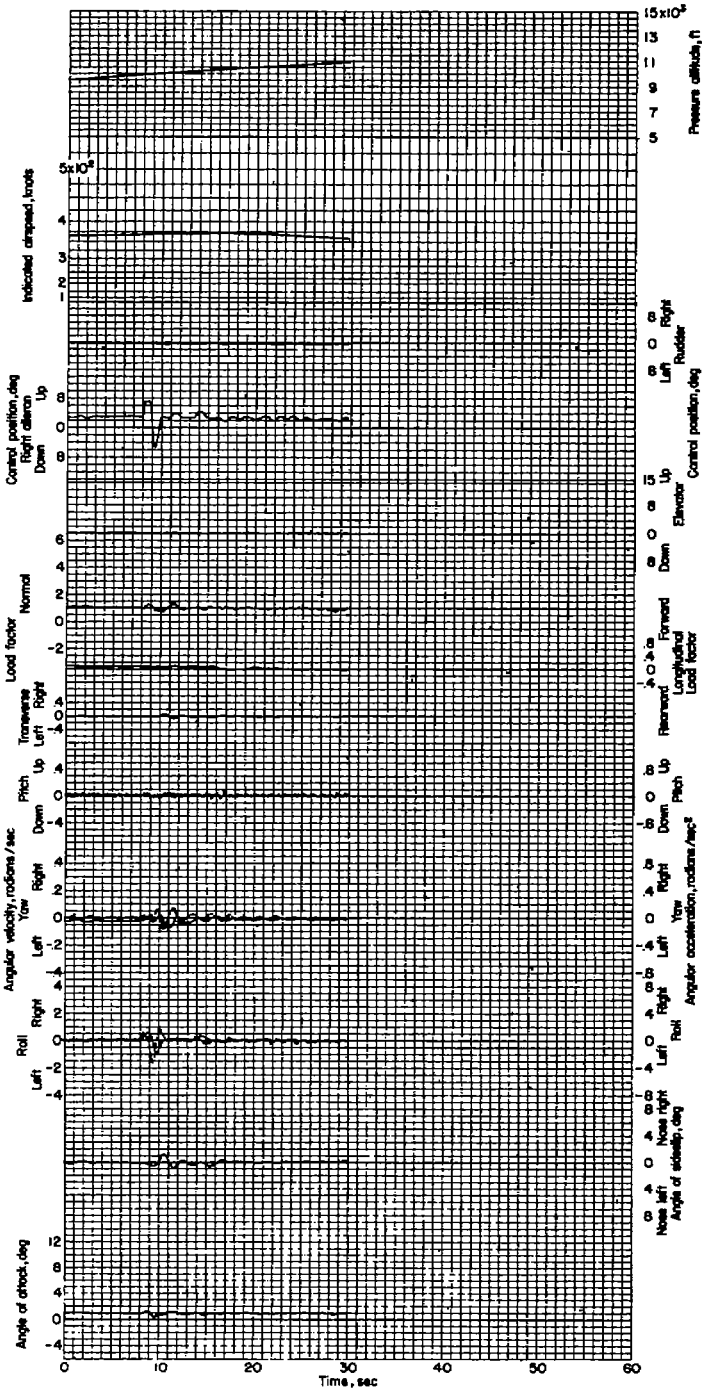


Figure 28.- Right and left bank. Airplane weight, 16,980 pounds; center of gravity at 24.7 percent M.A.C.; flight 4.

[redacted]

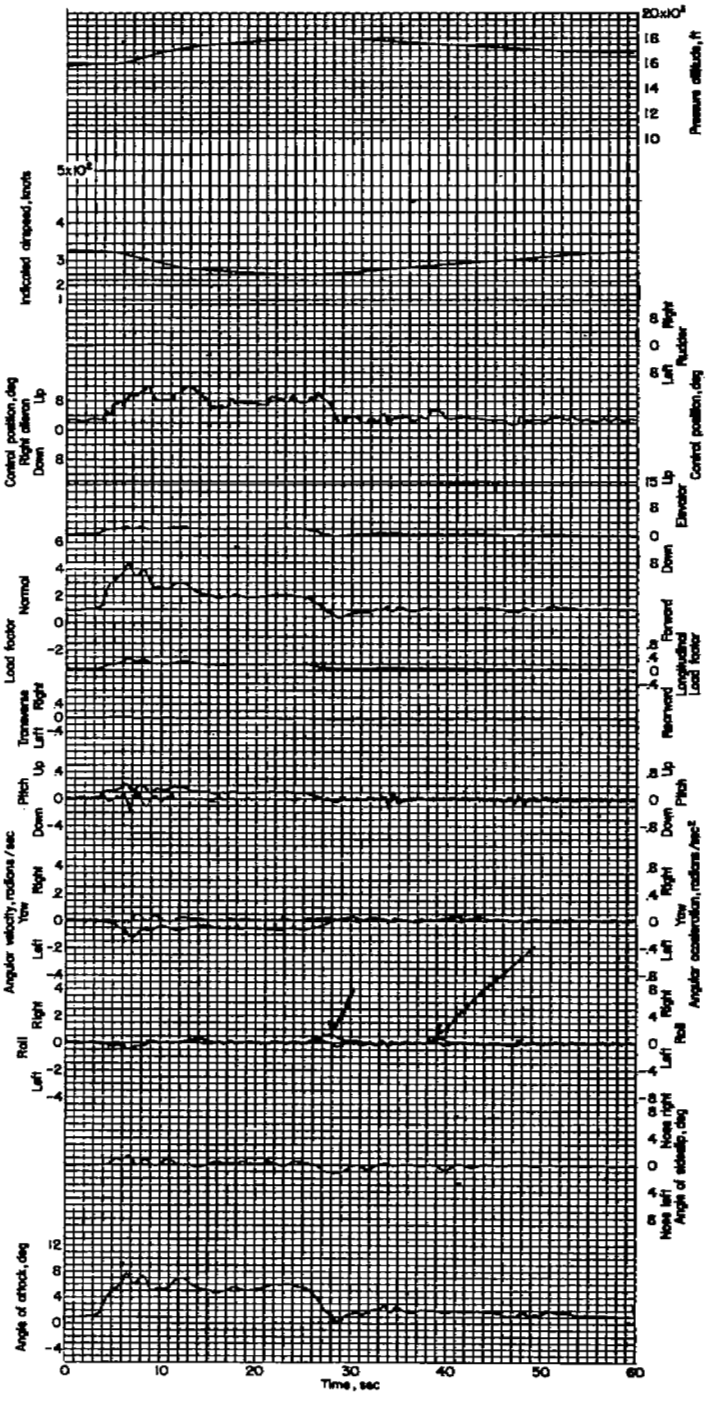


Figure 29.- Left turn. Airplane weight, 16,810 pounds; center of gravity at 24.6 percent M.A.C.; flight 4.

[redacted]

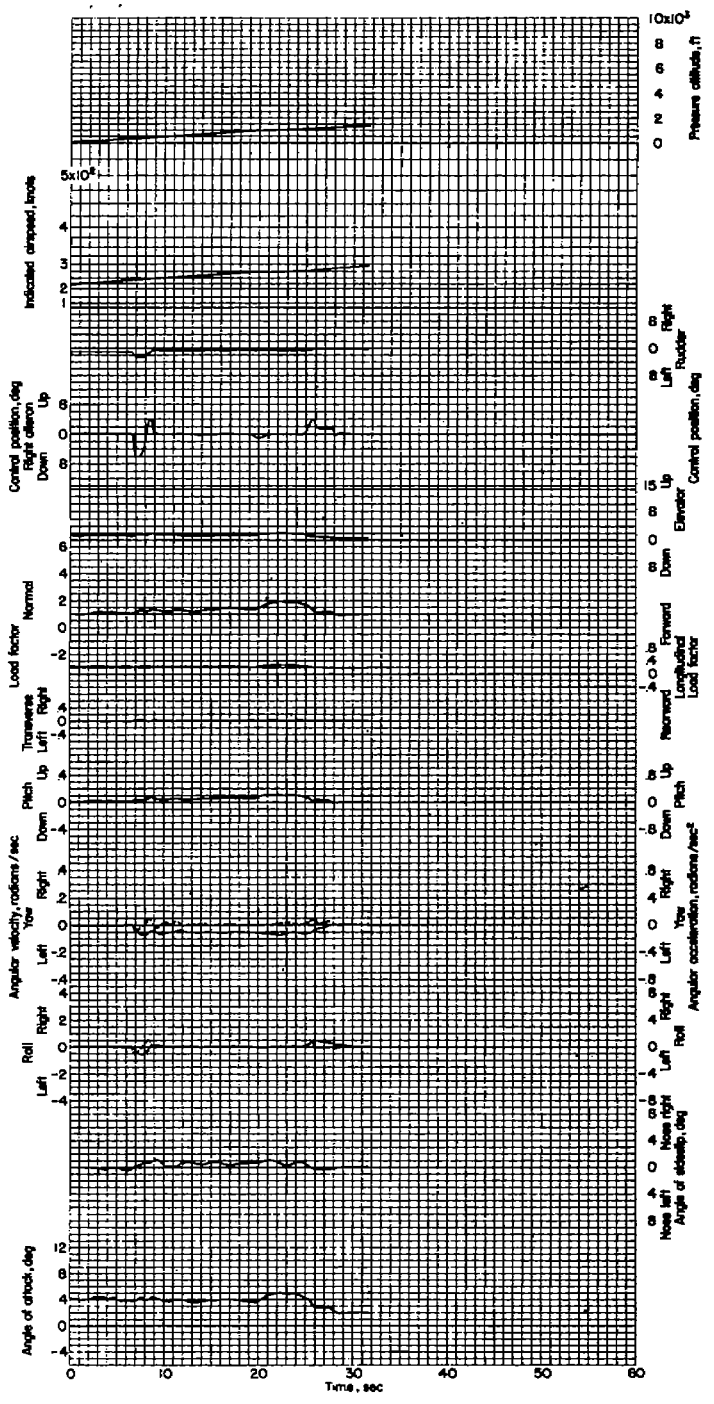
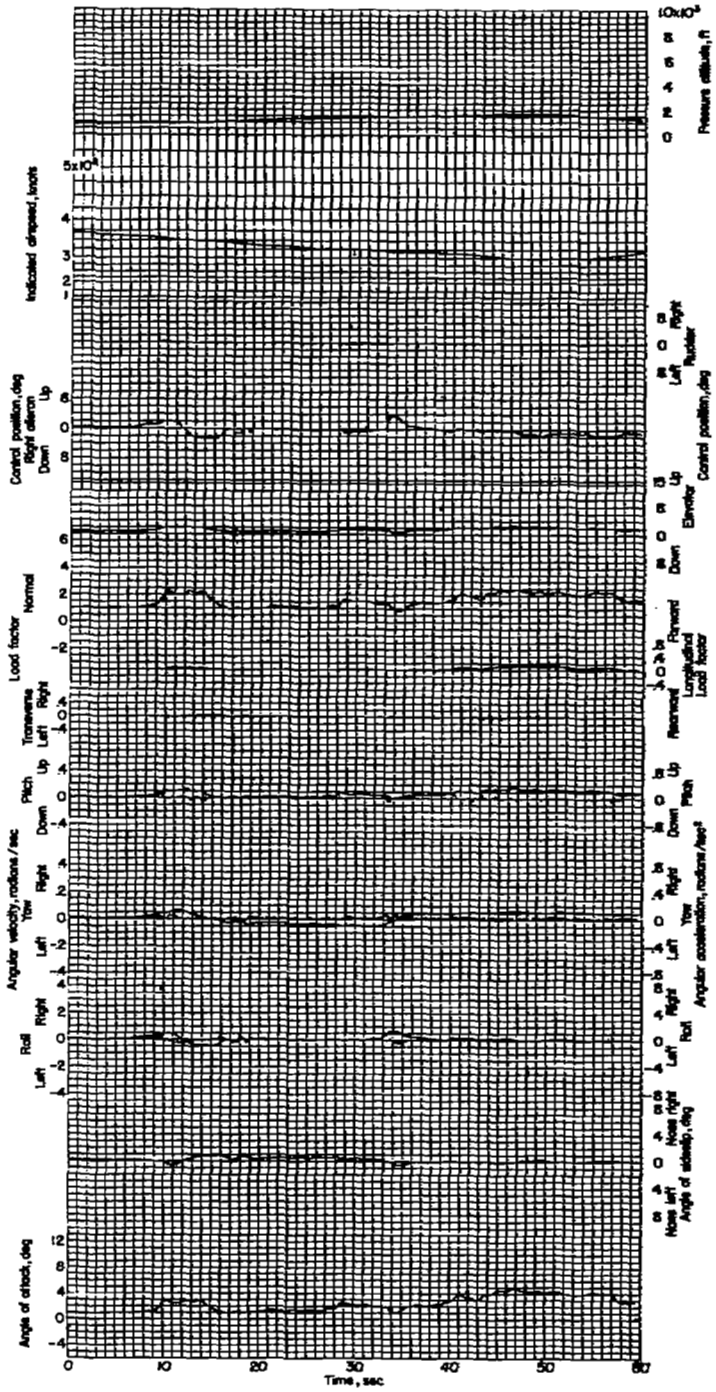


Figure 30.- Left turn. Airplane weight, 18,090 pounds; center of gravity at 25.2 percent M.A.C.; flight 5.

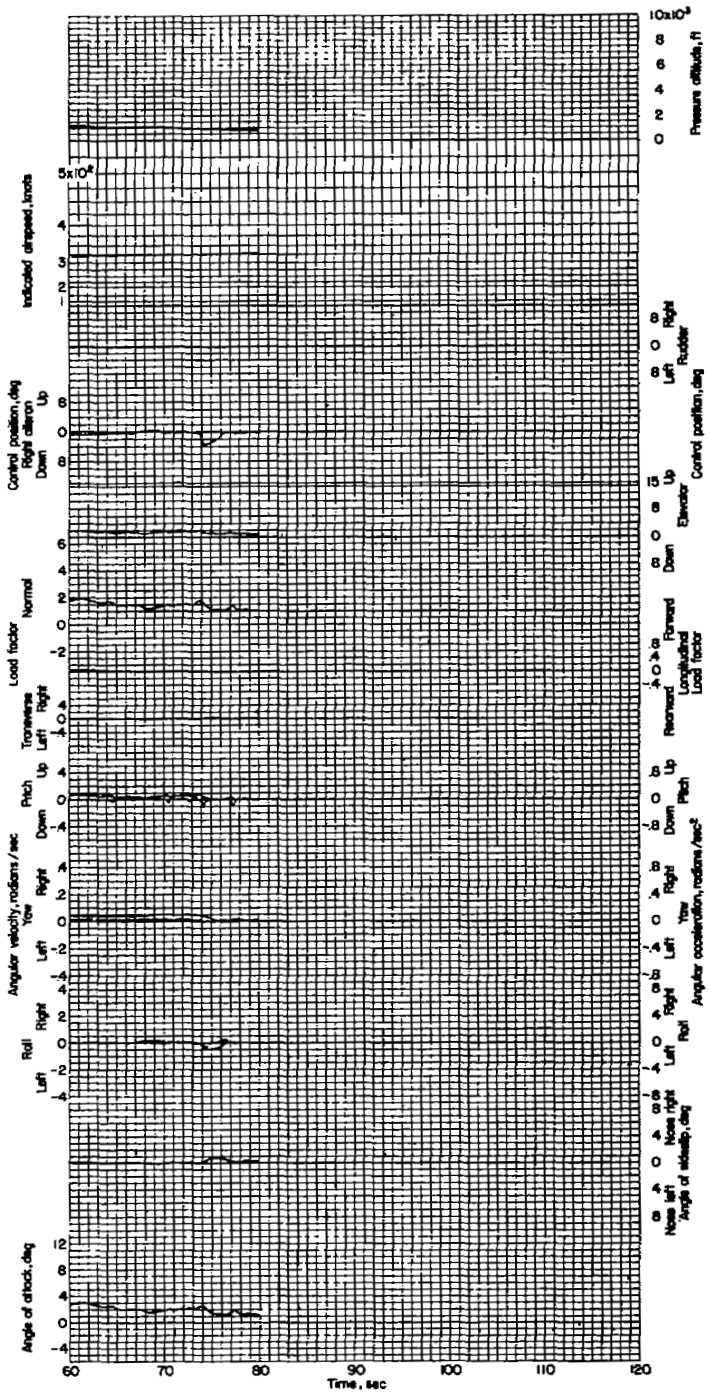
[redacted]



(a)

Figure 31.- Series of turns. Airplane weight, 16,450 pounds; center of gravity at 24.4 percent M.A.C.; flight 5.

[redacted]



(b)

Figure 31.- Concluded.

[redacted]

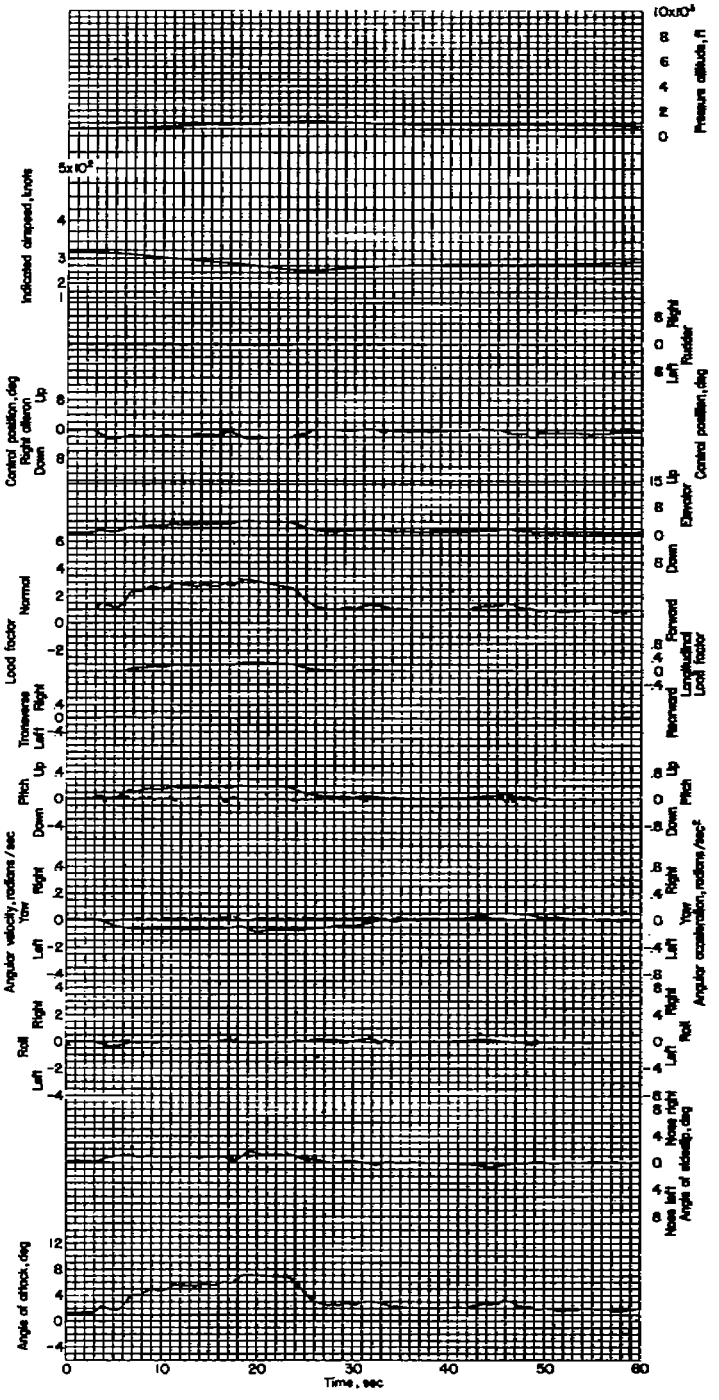
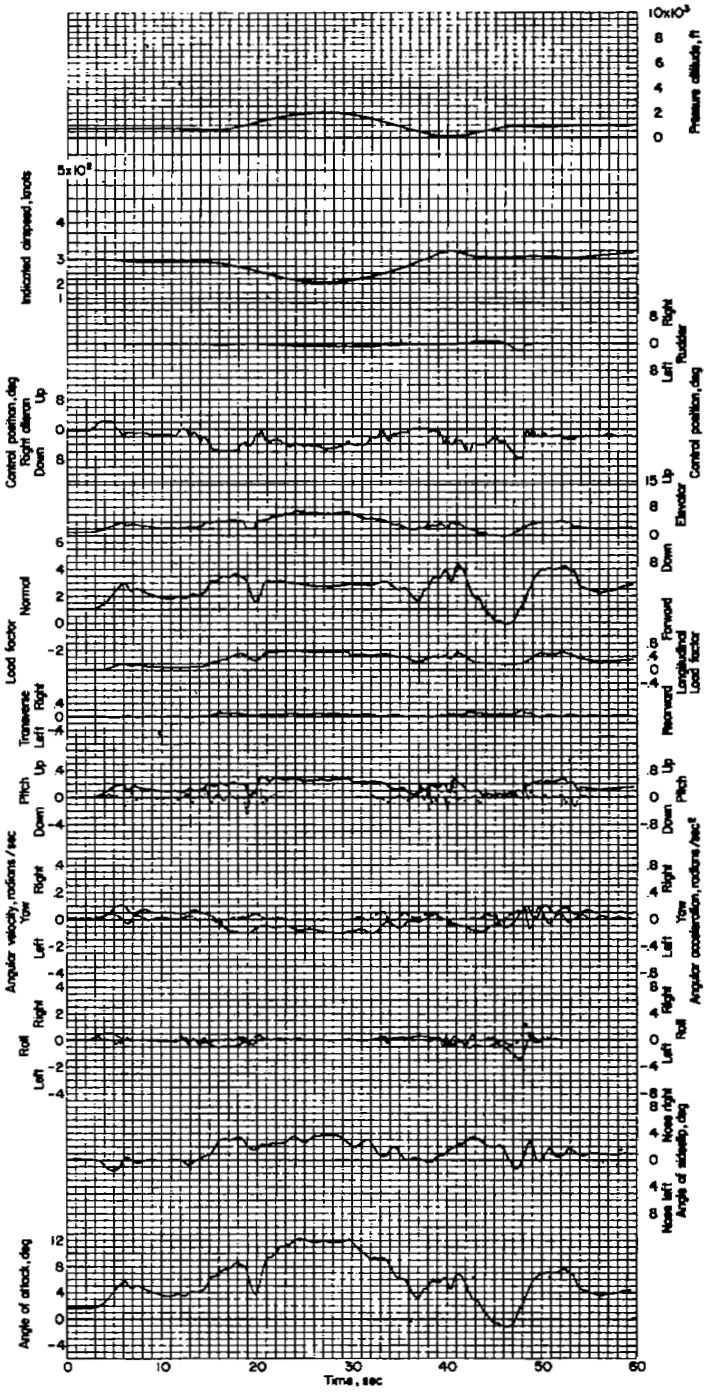


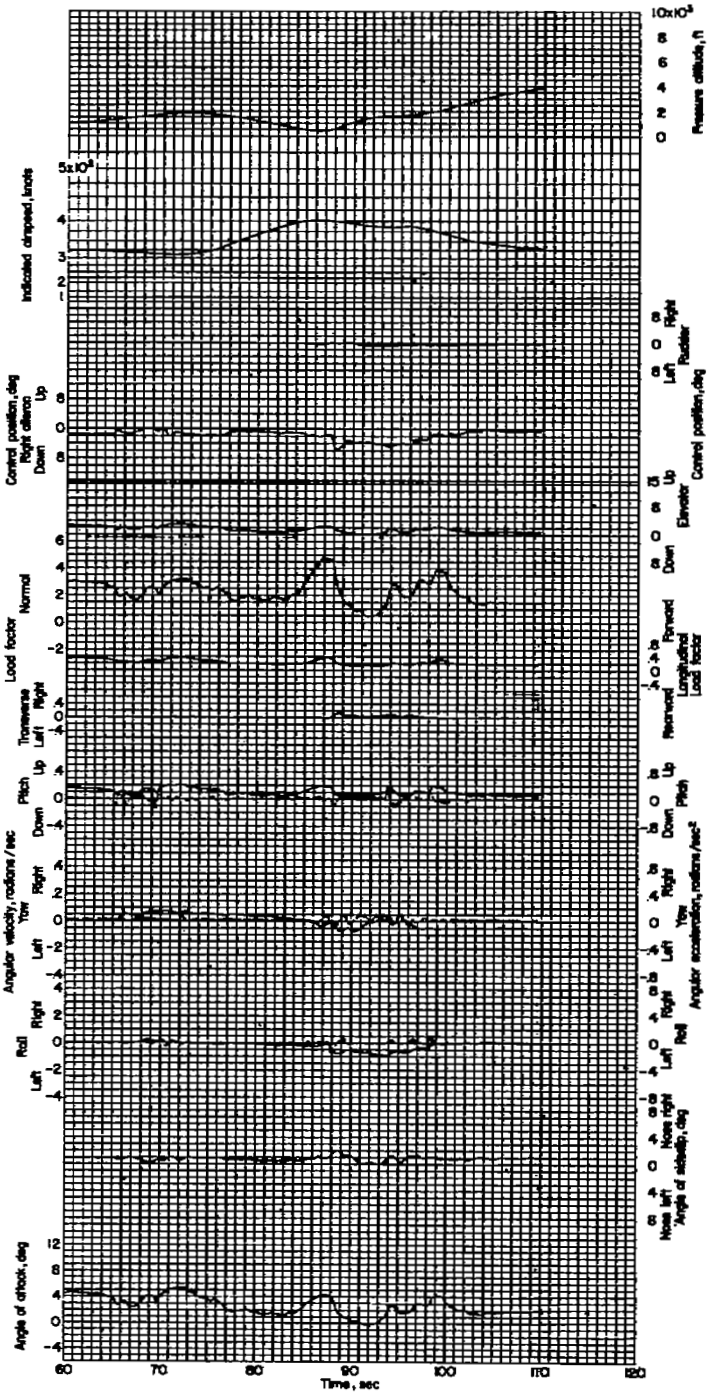
Figure 32.- Left turn. Airplane weight, 16,190 pounds; center of gravity at 24.2 percent M.A.C.; flight 5.



(a)

Figure 33.- Series of turns followed by left aileron roll. Airplane weight, 16,080 pounds; center of gravity at 24.1 percent M.A.C.; flight 5.

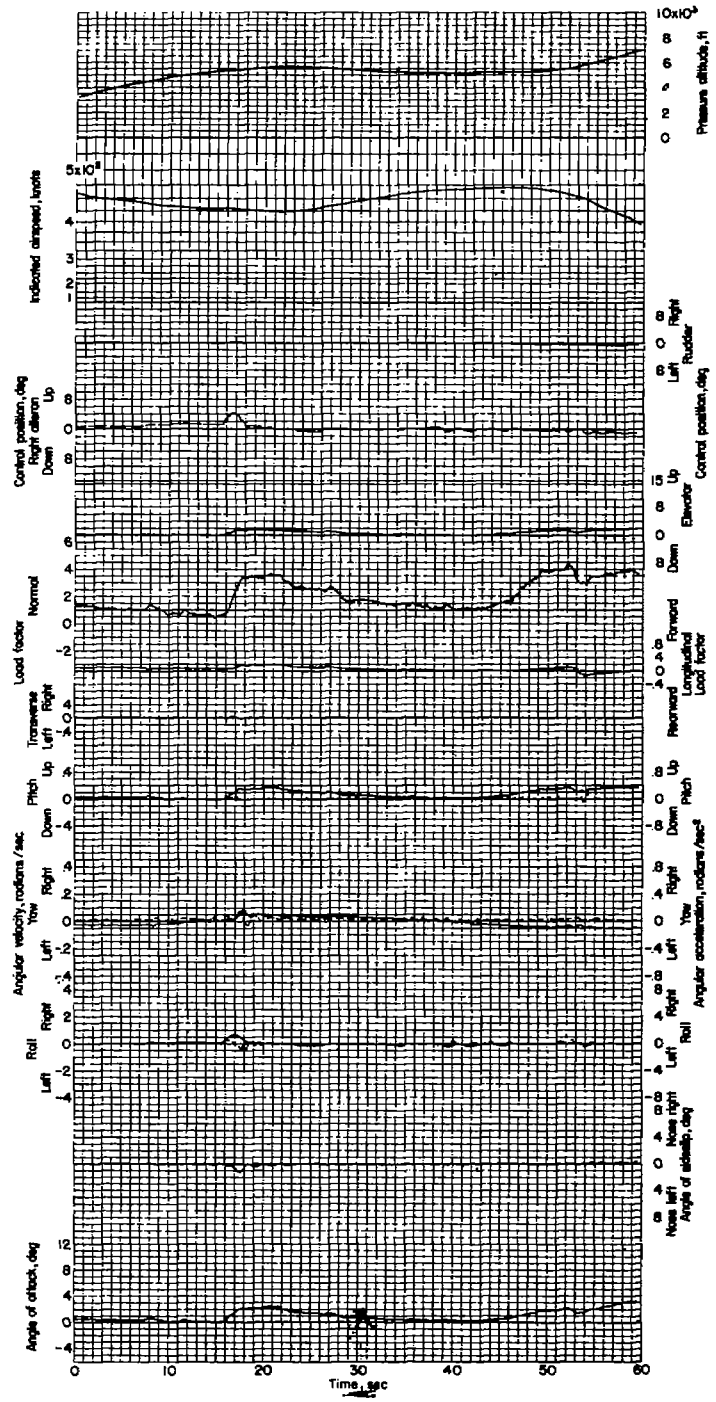
[redacted]



(b)

Figure 33.- Concluded.

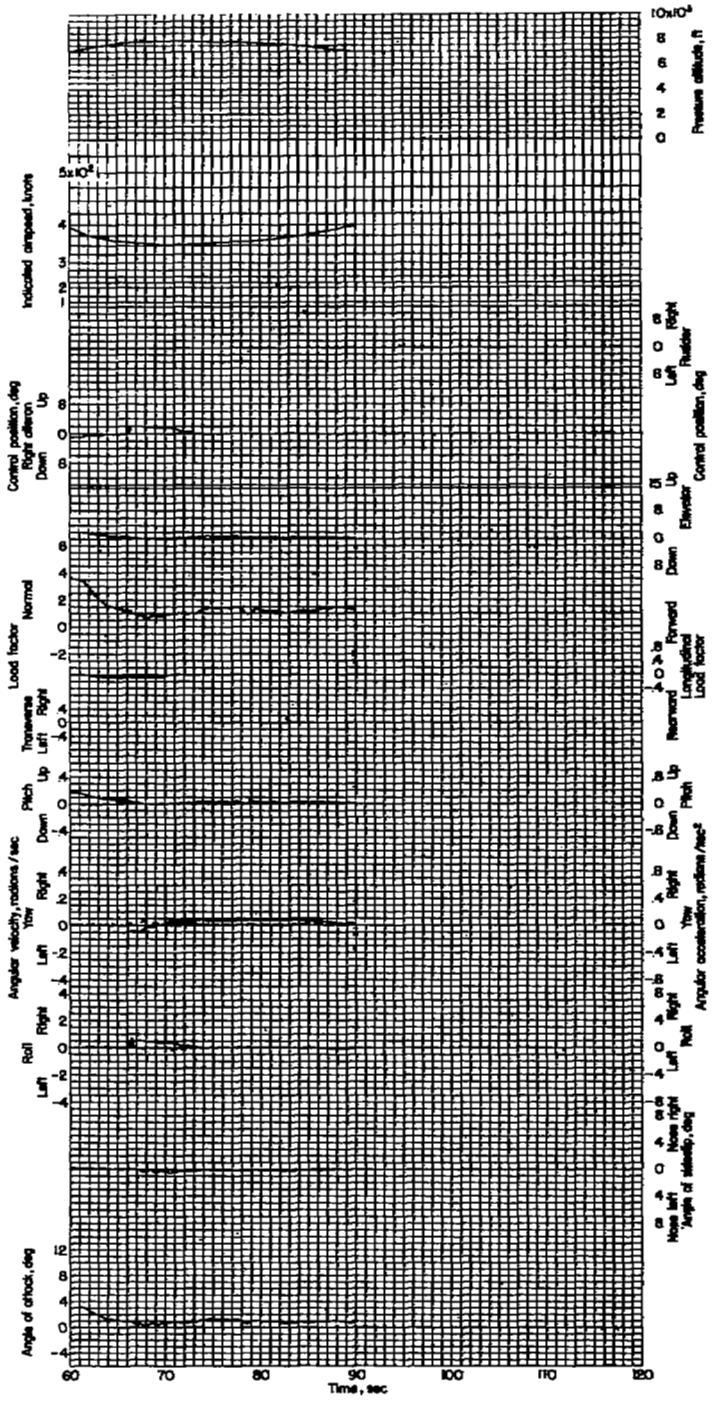
[redacted]



(a)

Figure 34.- Series of turns. Airplane weight, 15,920 pounds; center of gravity at 24.1 percent M.A.C.; flight 5.

[redacted]



(b)

Figure 34.- Concluded.

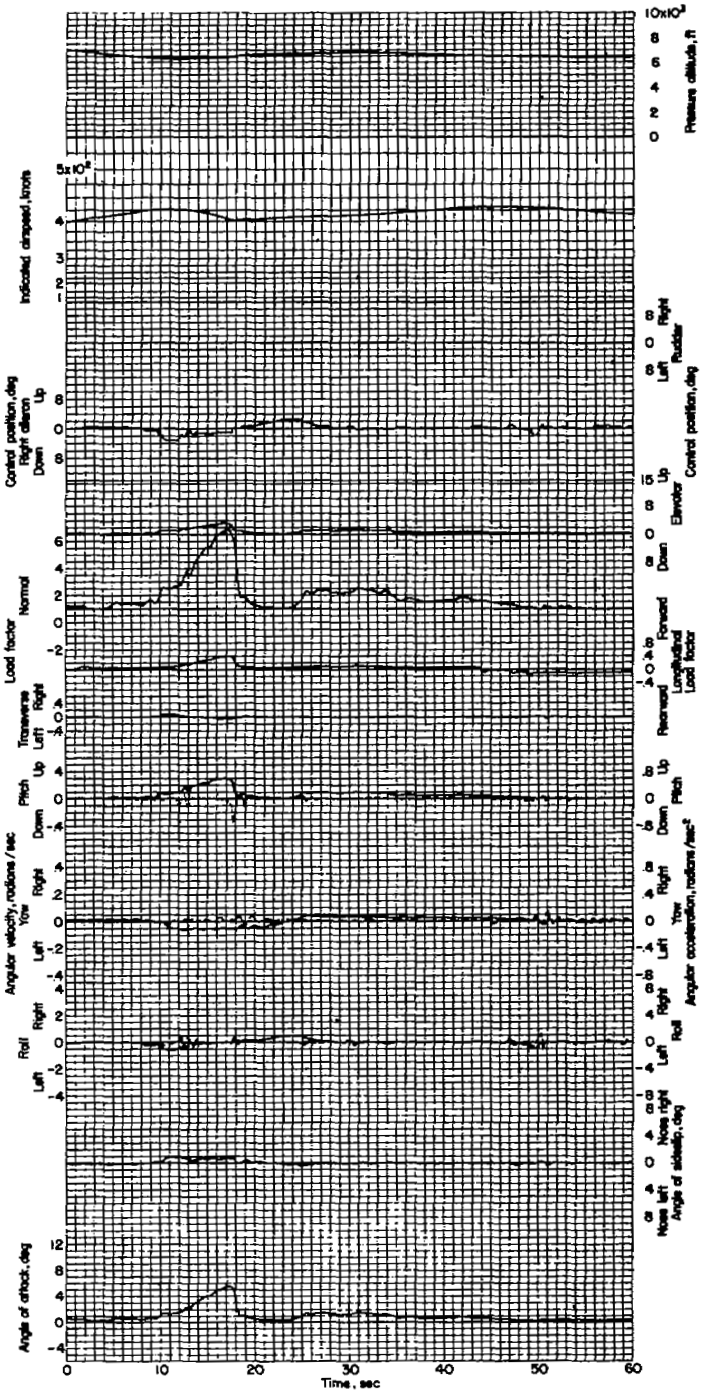
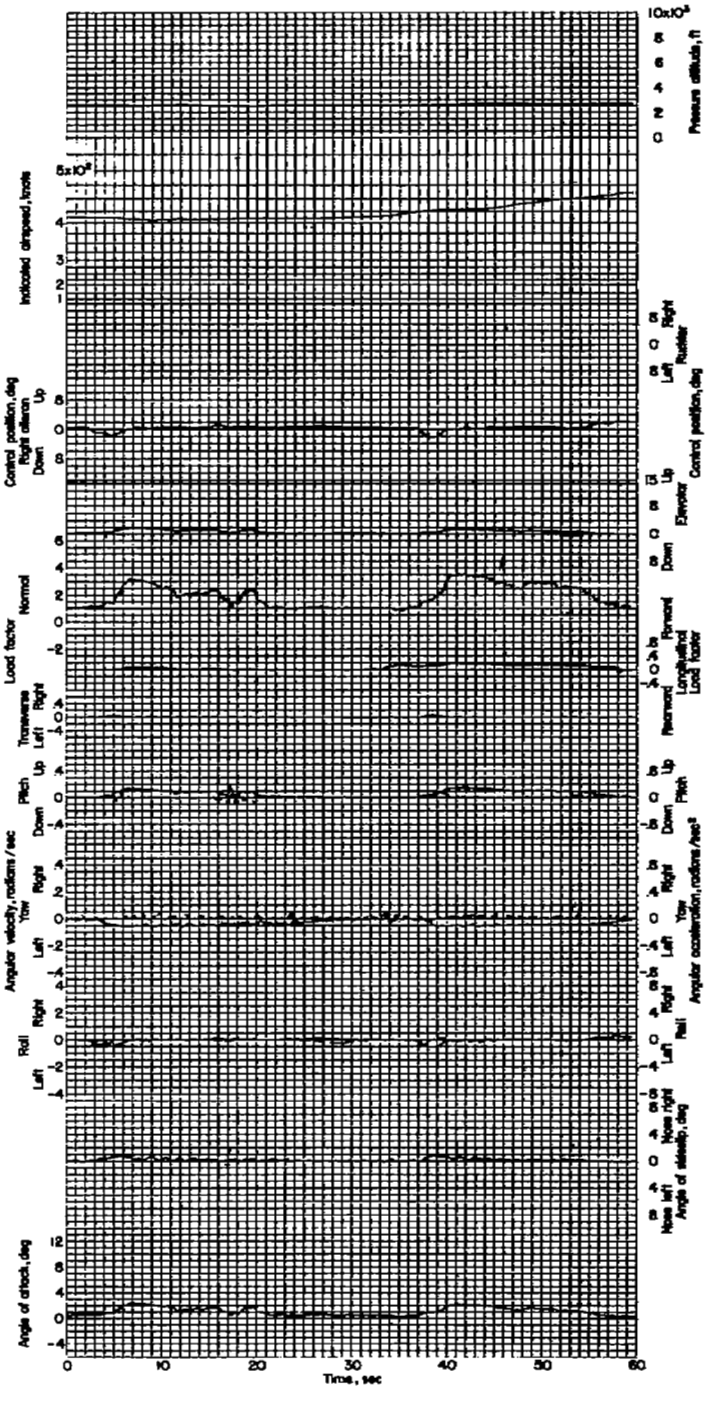


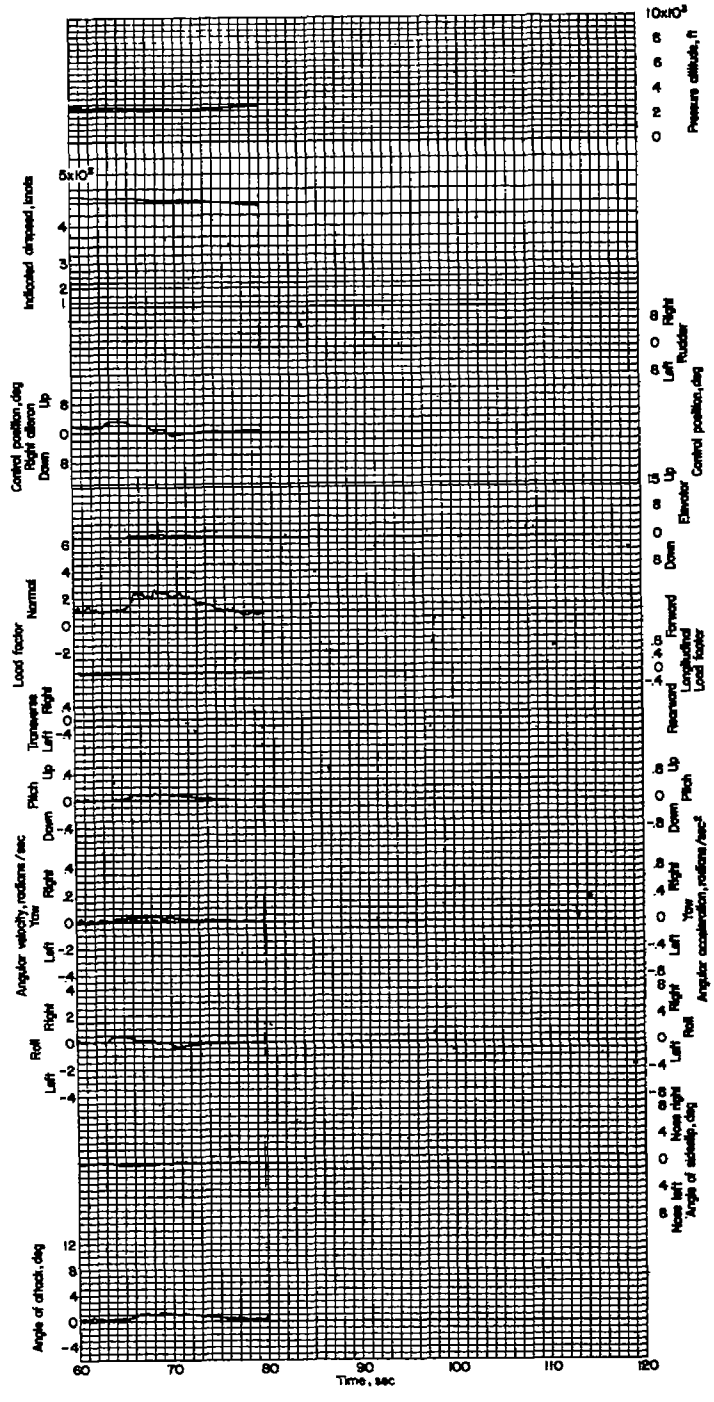
Figure 35.- Left turn. Airplane weight, 15,850 pounds; center of gravity at 24.0 percent M.A.C.; flight 5.

[redacted]



(a)

Figure 36.- Left turns. Airplane weight, 15,130 pounds; center of gravity at 24.2 percent M.A.C.; flight 5.



(b)

Figure 36.- Concluded.

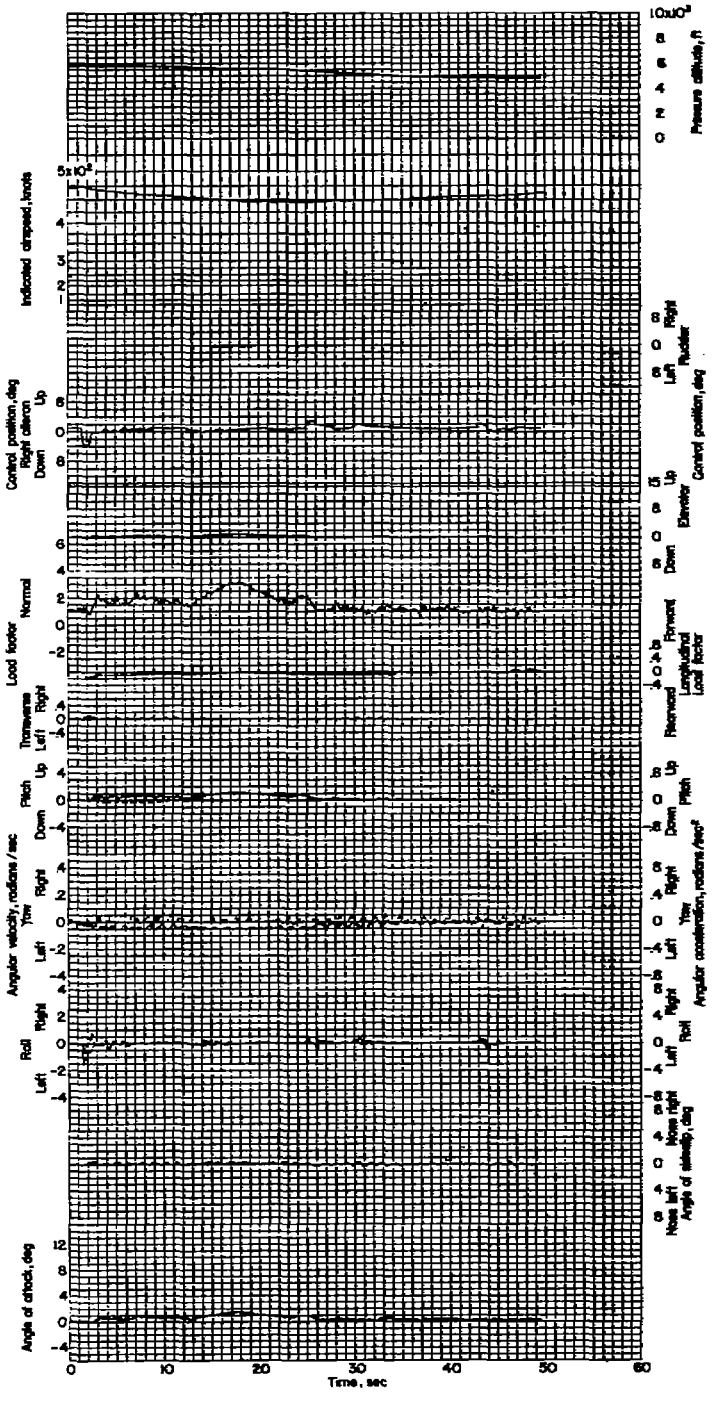


Figure 37.- Left turn. Airplane weight, 14,720 pounds; center of gravity at 24.7 percent M.A.C.; flight 5.

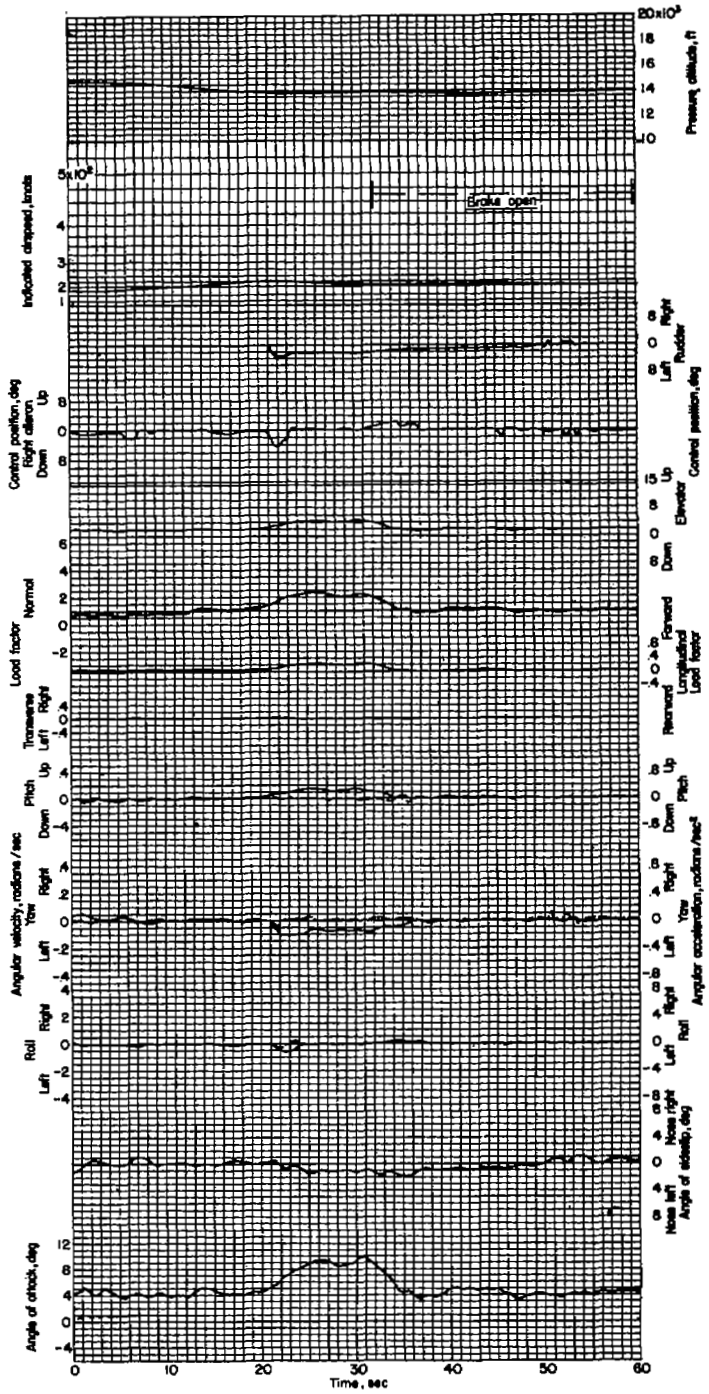


Figure 38.- Left turn. Airplane weight, 16,510 pounds; center of gravity at 24.4 percent M.A.C.; flight 6.

[redacted]

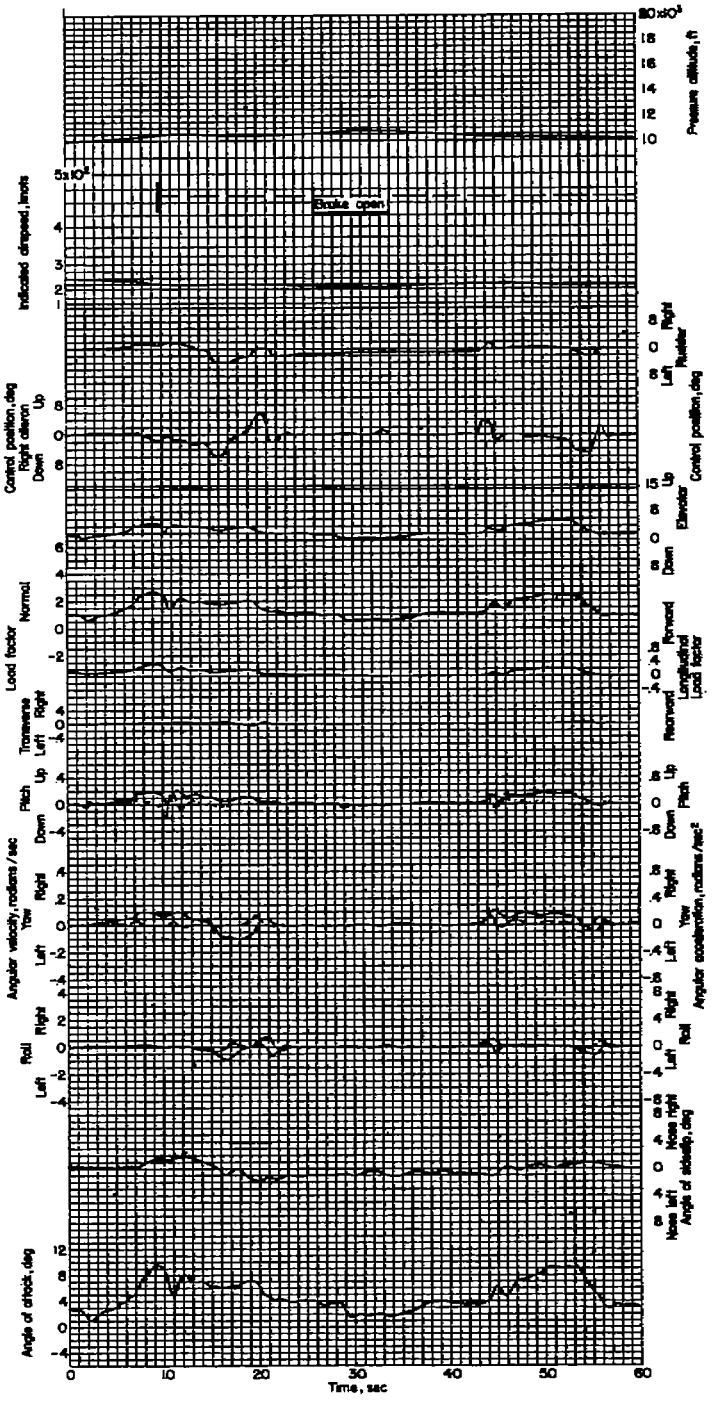
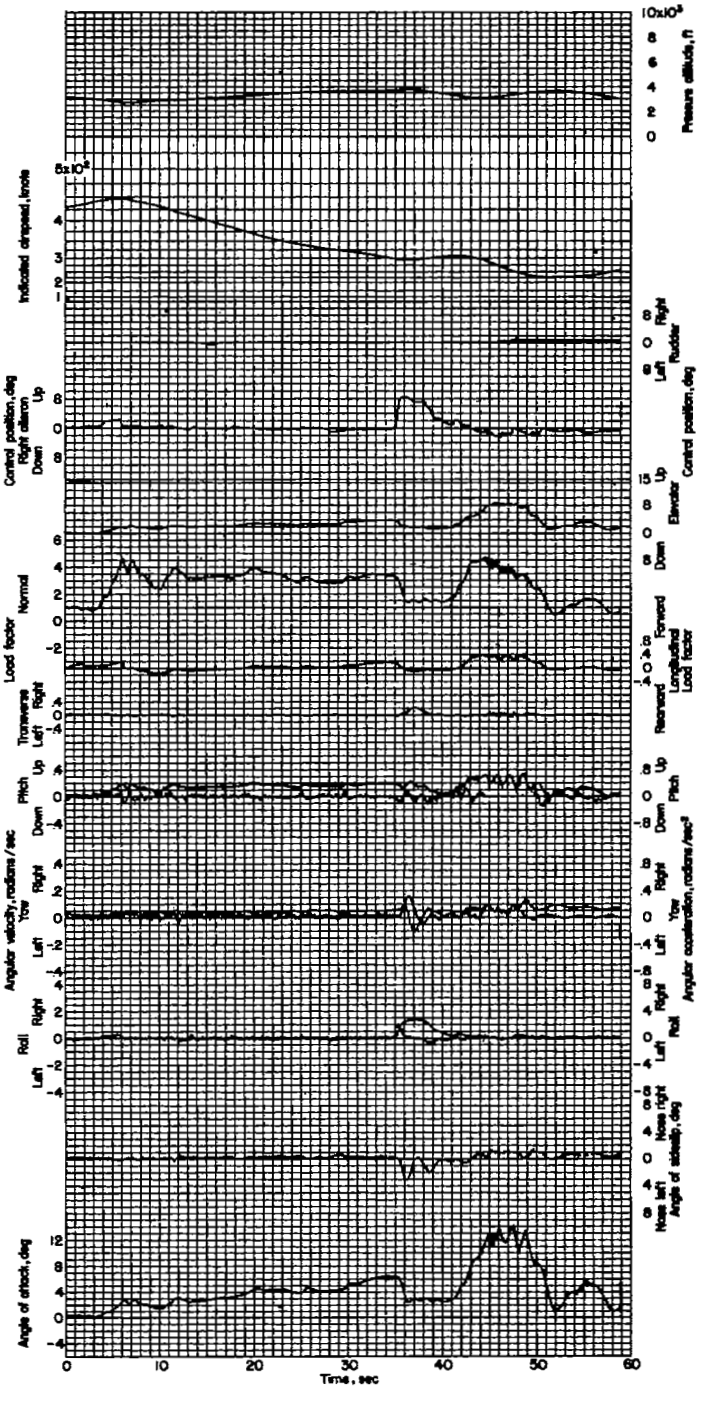
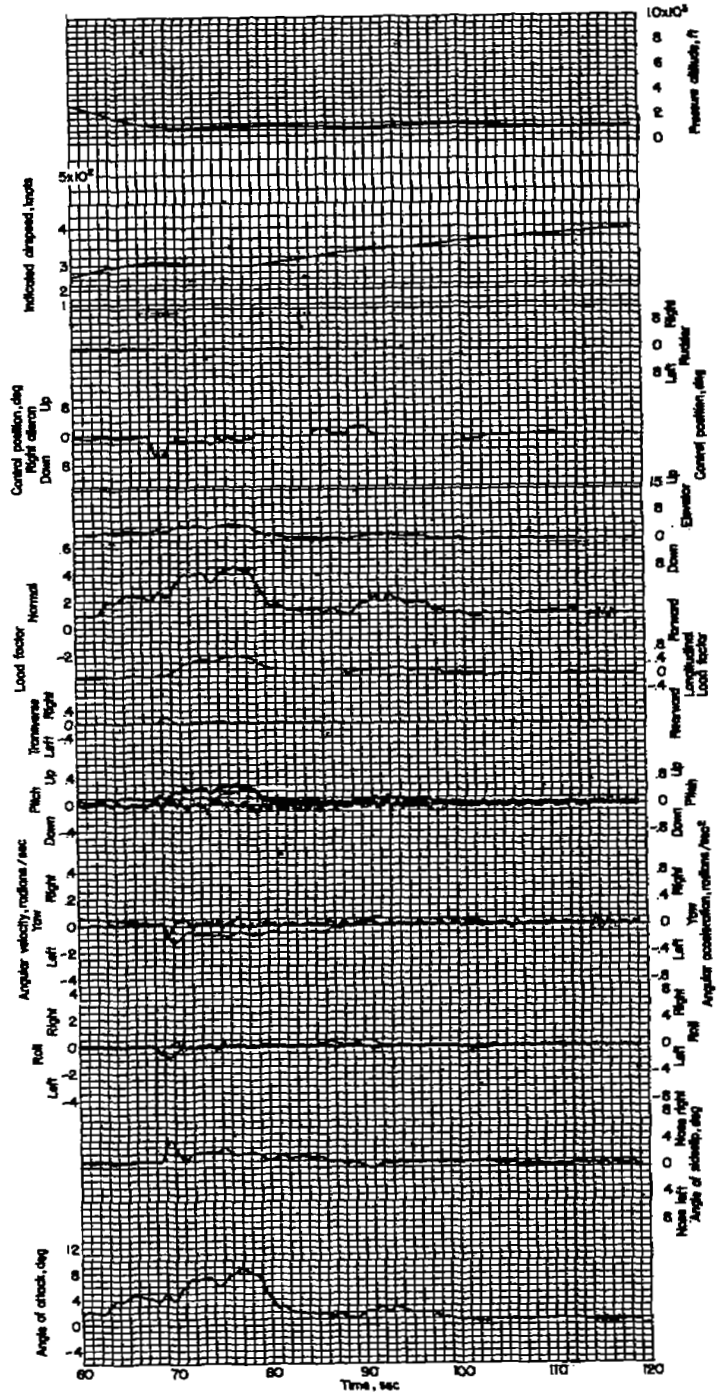


Figure 39.- Series of turns. Airplane weight, 16,200 pounds; center of gravity at 24.2 percent M.A.C.; flight 6.



(a)

Figure 40.- Right turn and right barrel roll into stall right turn followed by left and right turn. Airplane weight, 15,940 pounds; center of gravity at 24.1 percent M.A.C.; flight 7.



(b)

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Figure 40.- Concluded.

[redacted]

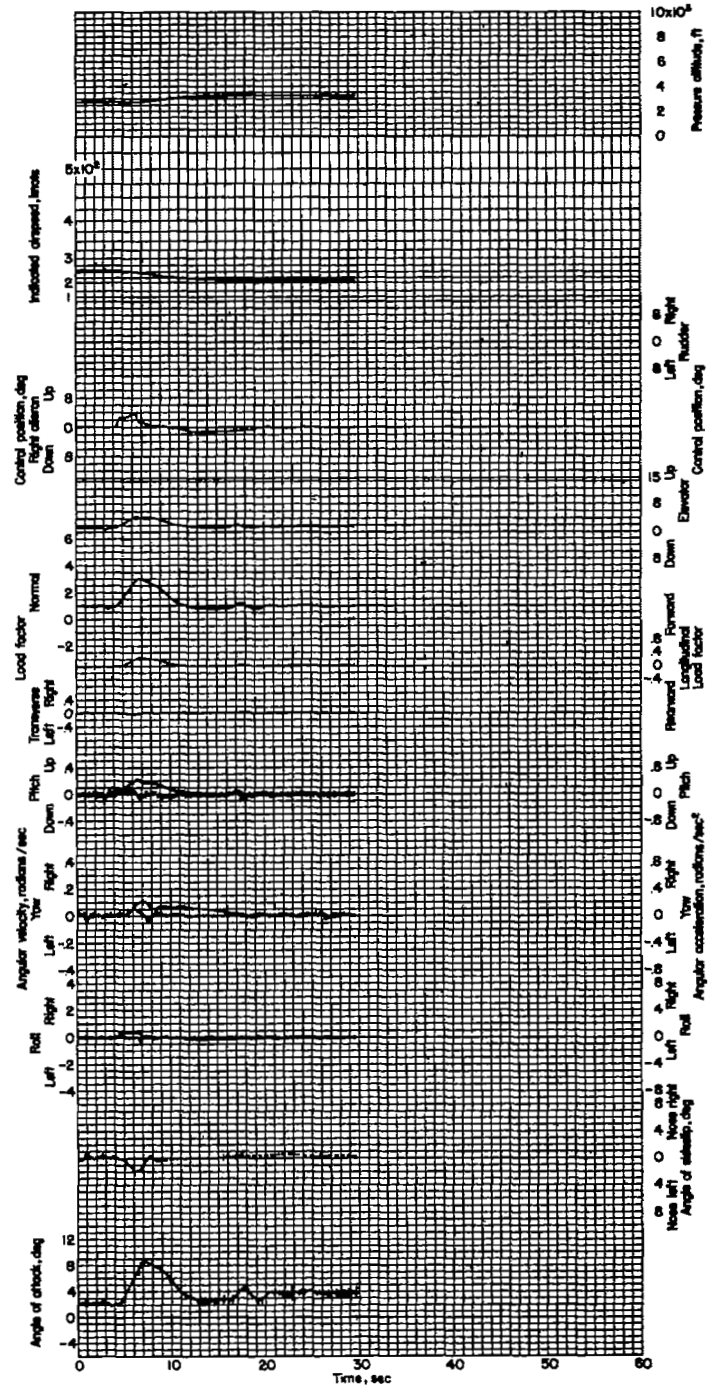


Figure 41.- Right turn. Airplane weight, 15,010 pounds; center of gravity at 24.3 percent M.A.C.; flight 7.

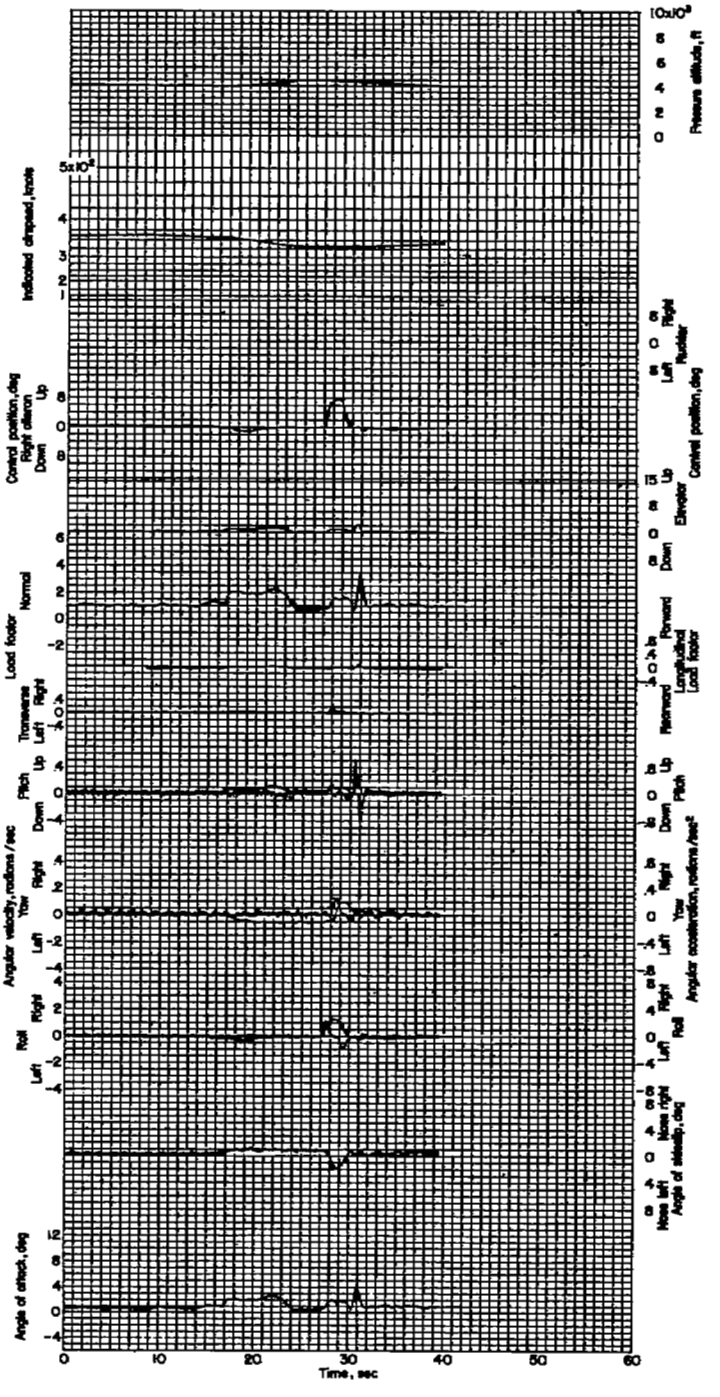


Figure 42.- Left and right turn. Airplane weight, 14,820 pounds; center of gravity at 24.6 percent M.A.C.; flight 7.

[redacted]

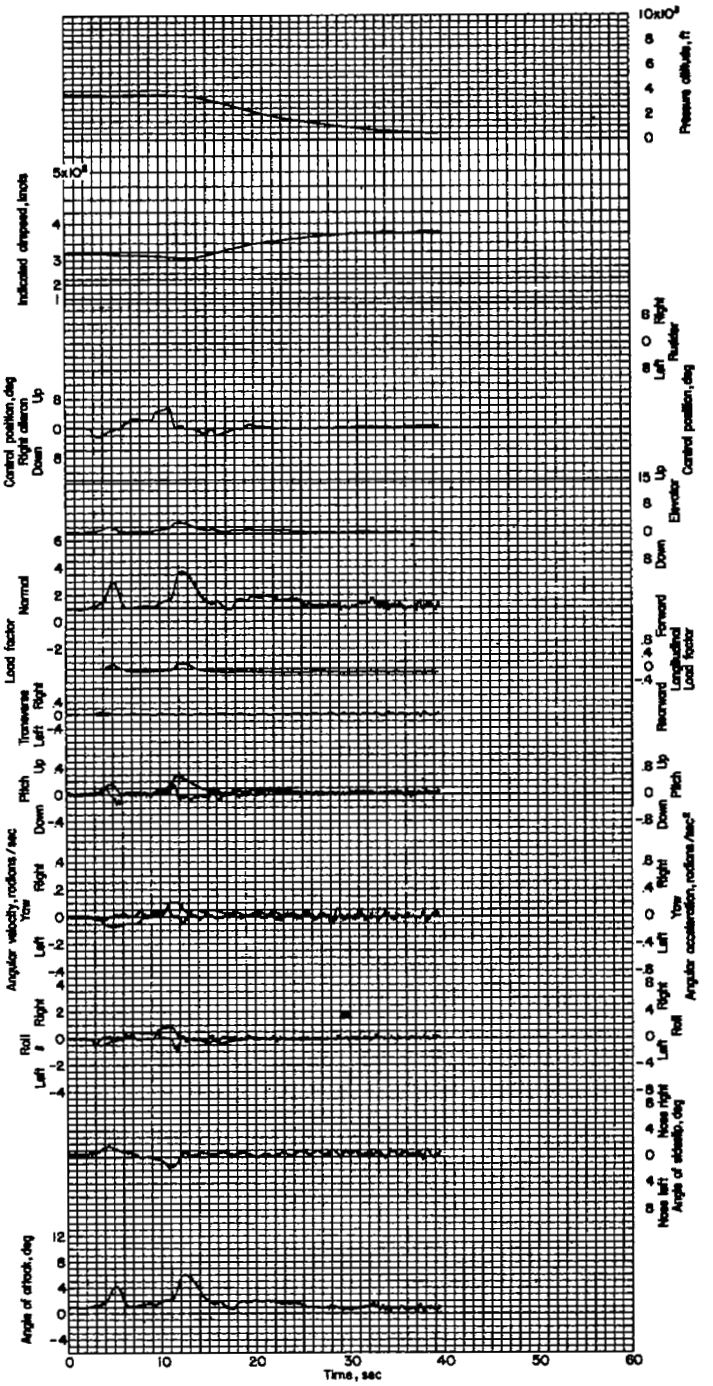
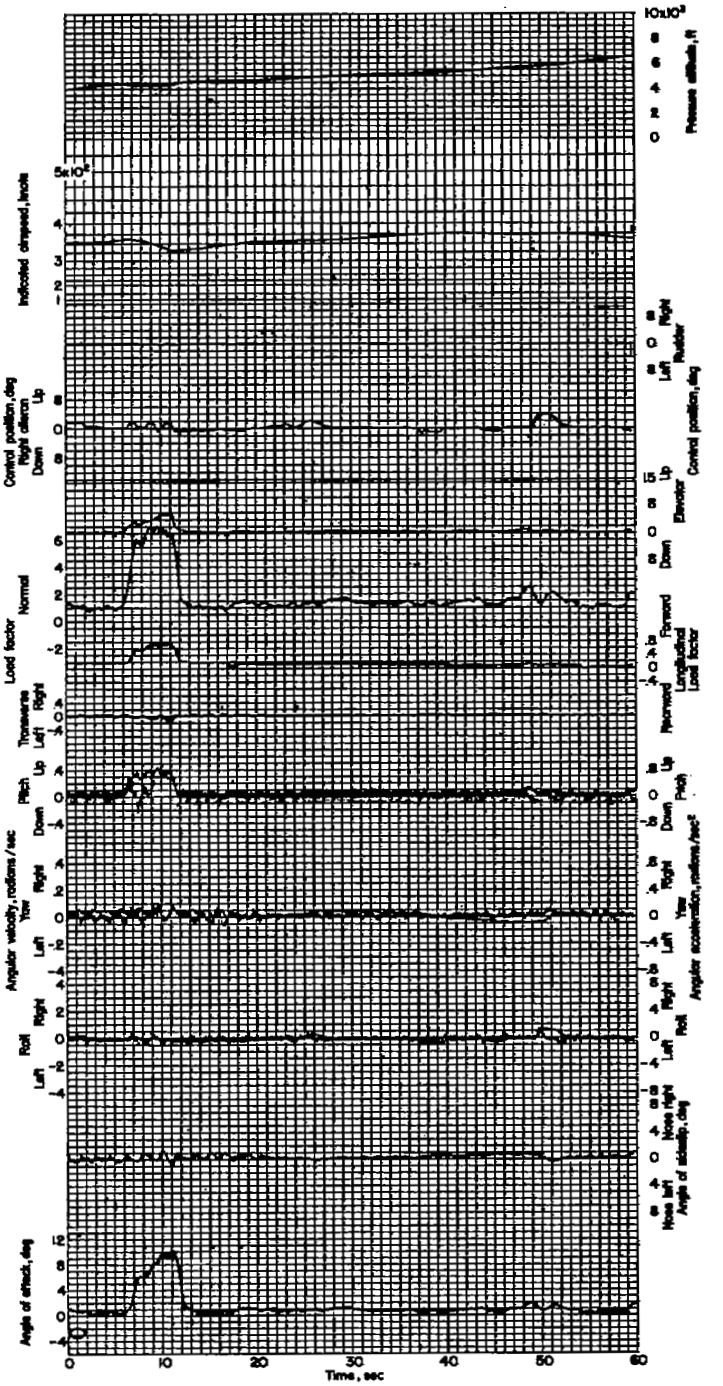


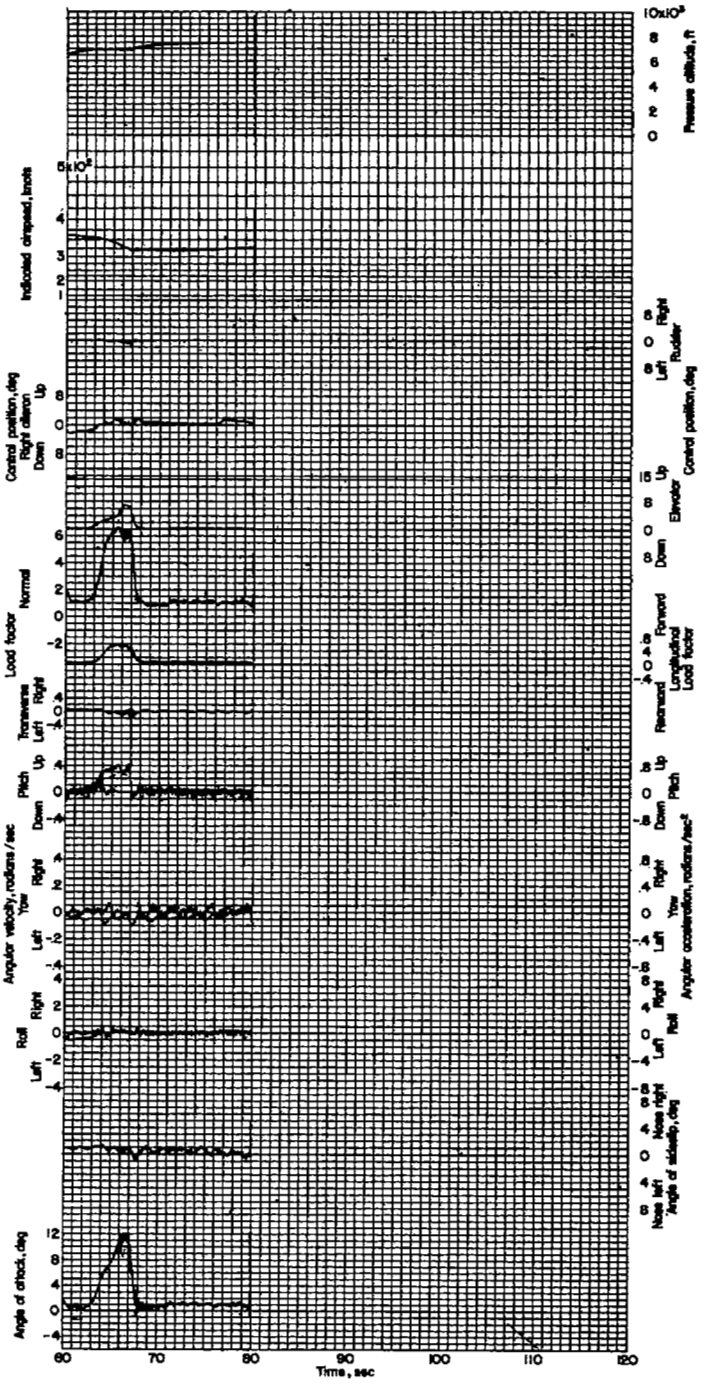
Figure 43.- Left and right turn. Airplane weight, 14,680 pounds; center of gravity at 24.8 percent M.A.C.; flight 7.

[redacted]



(a)

Figure 44.- Maximum performance turns. Airplane weight, 14,330 pounds; center of gravity at 25.3 percent M.A.C.; flight 7.



(b)

Figure 44.- Concluded.

[redacted]

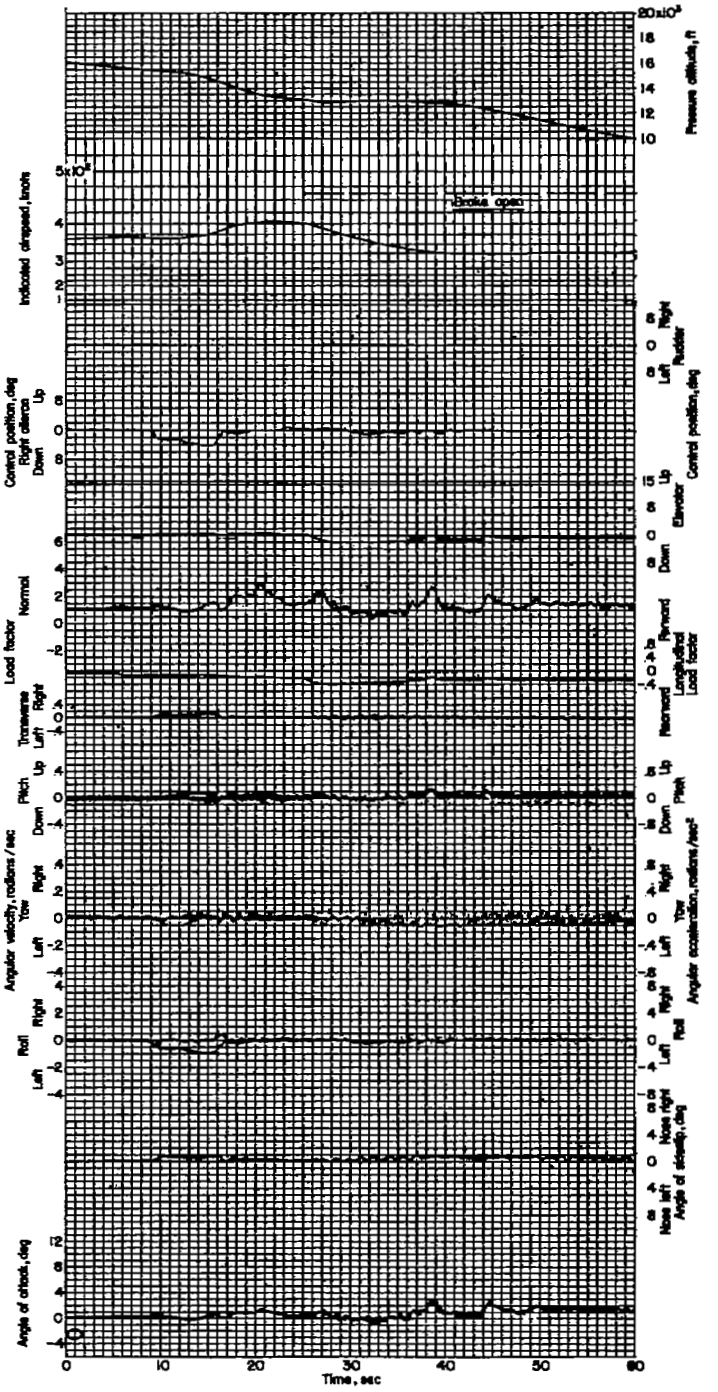


Figure 45.- Left aileron roll followed by diving left turn. Airplane weight, 13,940 pounds; center of gravity at 25.8 percent M.A.C.; flight 7.

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[redacted]

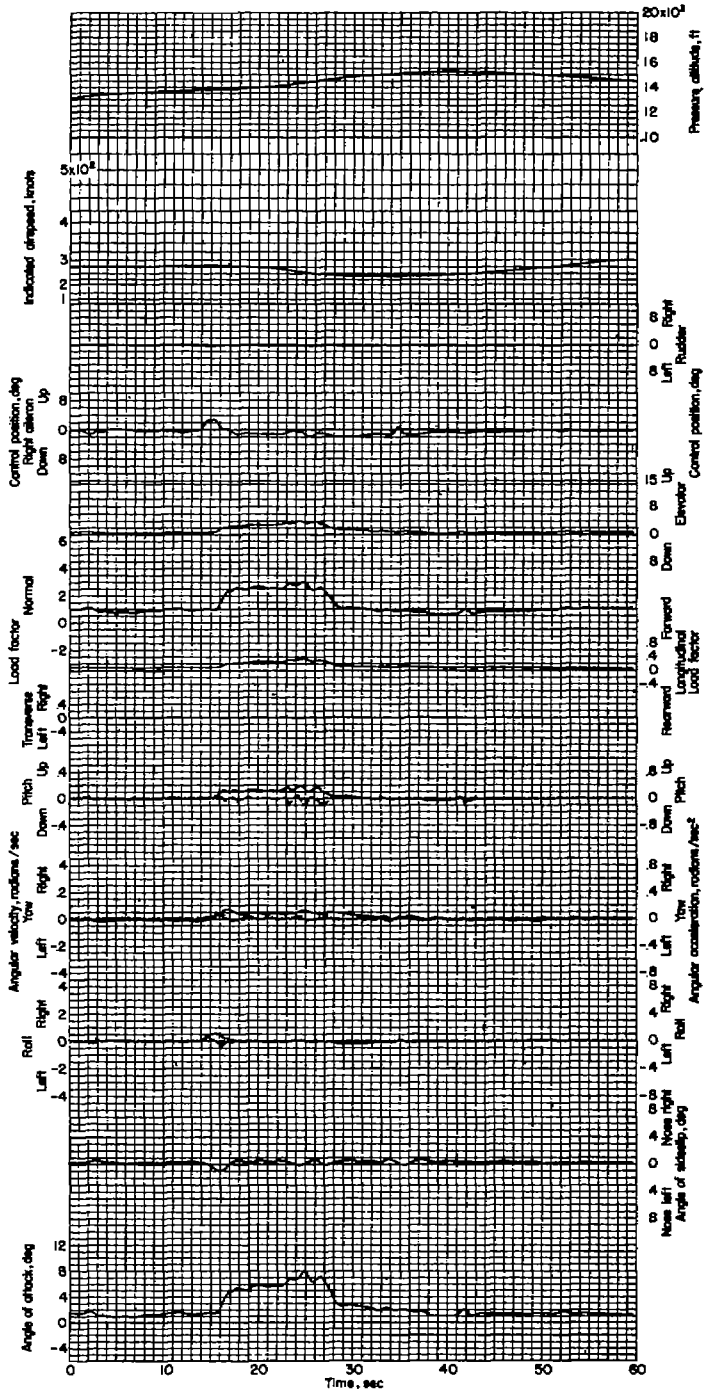


Figure 46.- Right turn. Airplane weight, 16,040 pounds; center of gravity at 24.2 percent M.A.C.; flight 8.

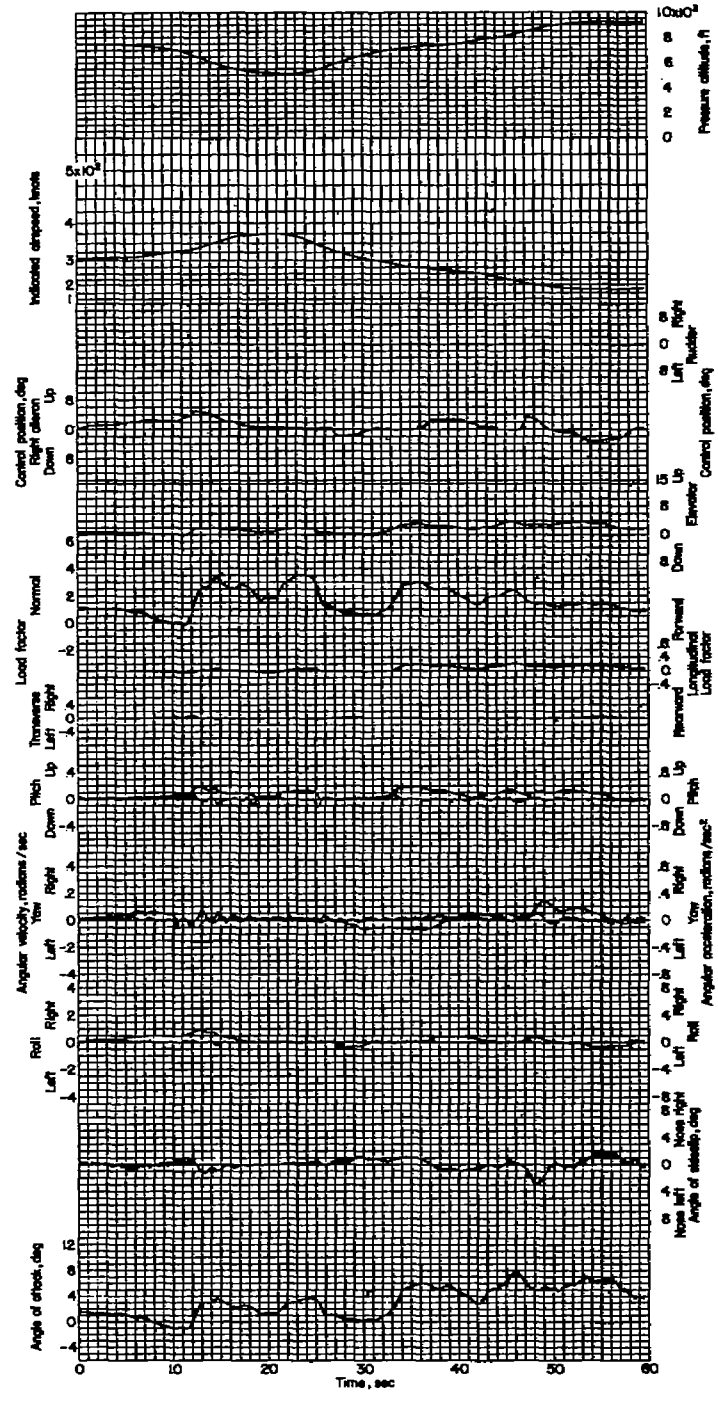
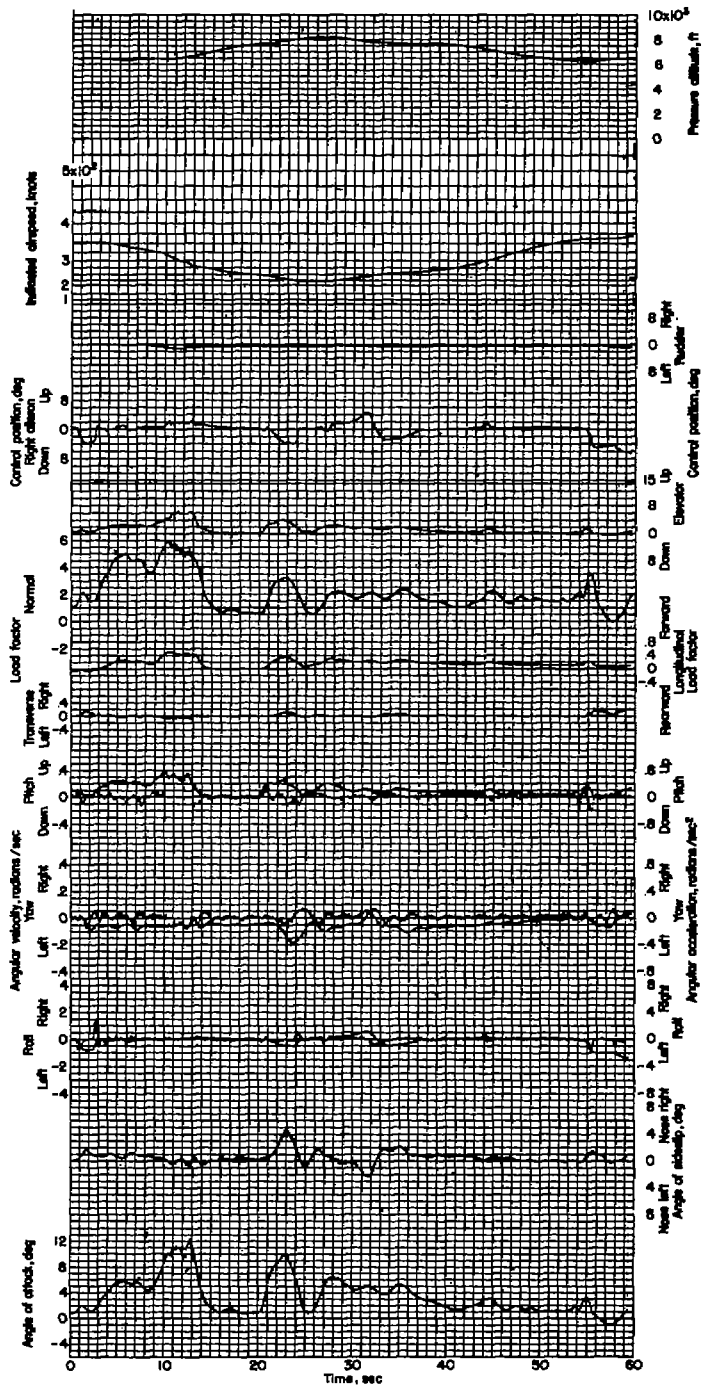


Figure 47.- Diving right aileron roll followed by pull-up into climbing left and right turn. Airplane weight, 14,790 pounds; center of gravity at 24.6 percent M.A.C.; flight 8.

NACA

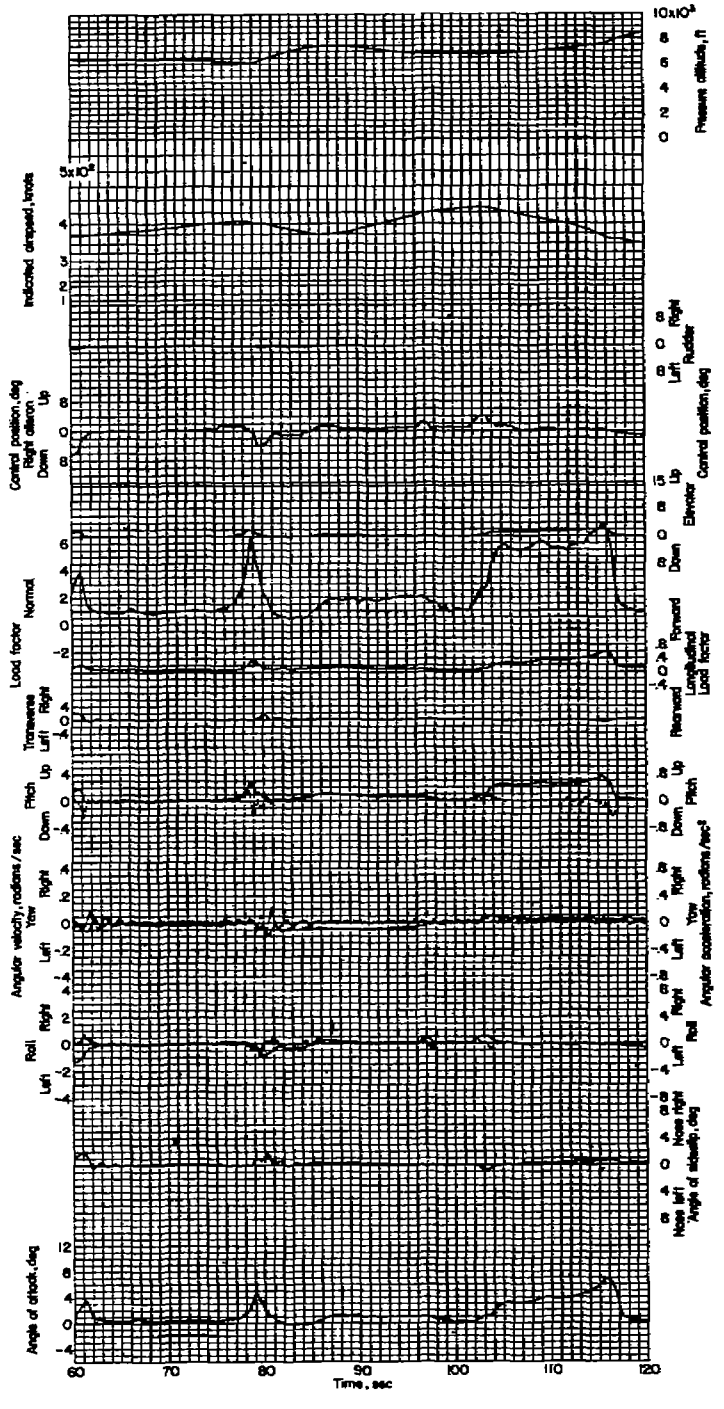
[redacted]



(a)

Figure 48.- Series of turns including left aileron roll. Airplane weight, 14,170 pounds; center of gravity at 25.5 percent M.A.C.; flight 8.

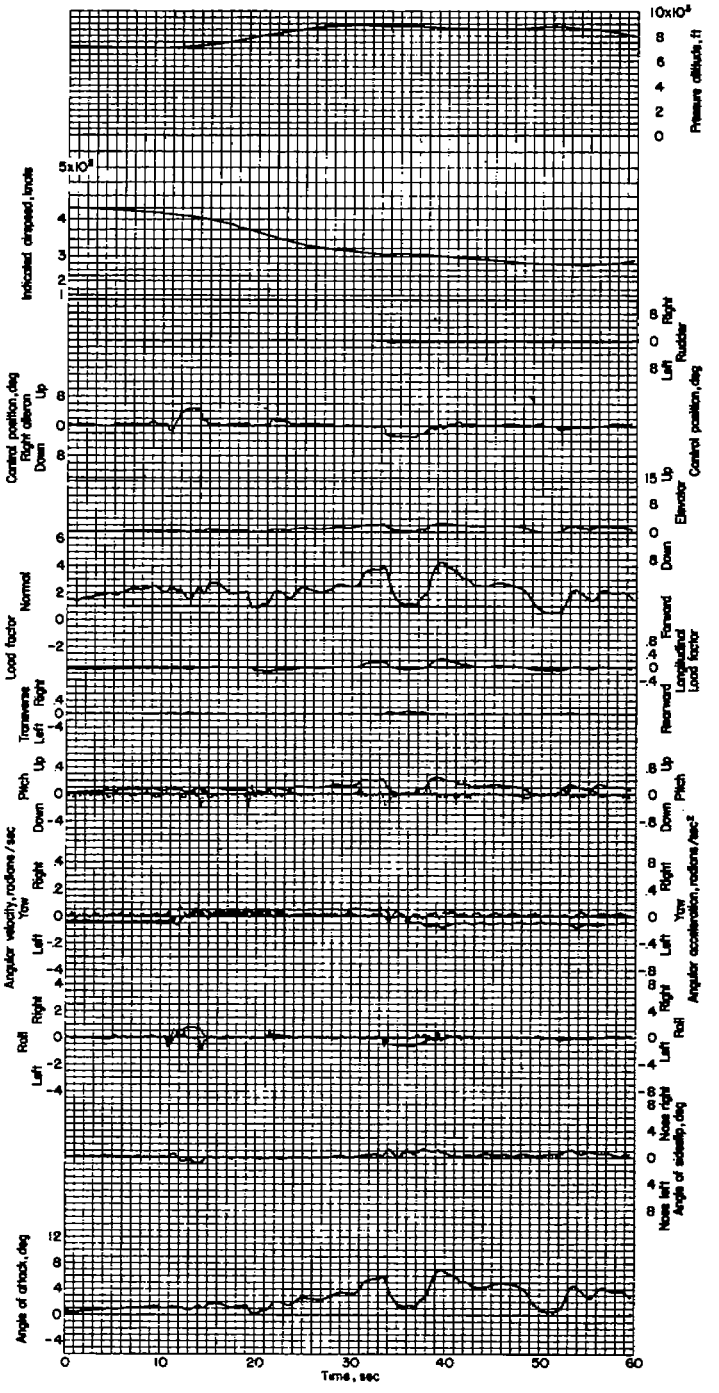
[redacted]



(b)

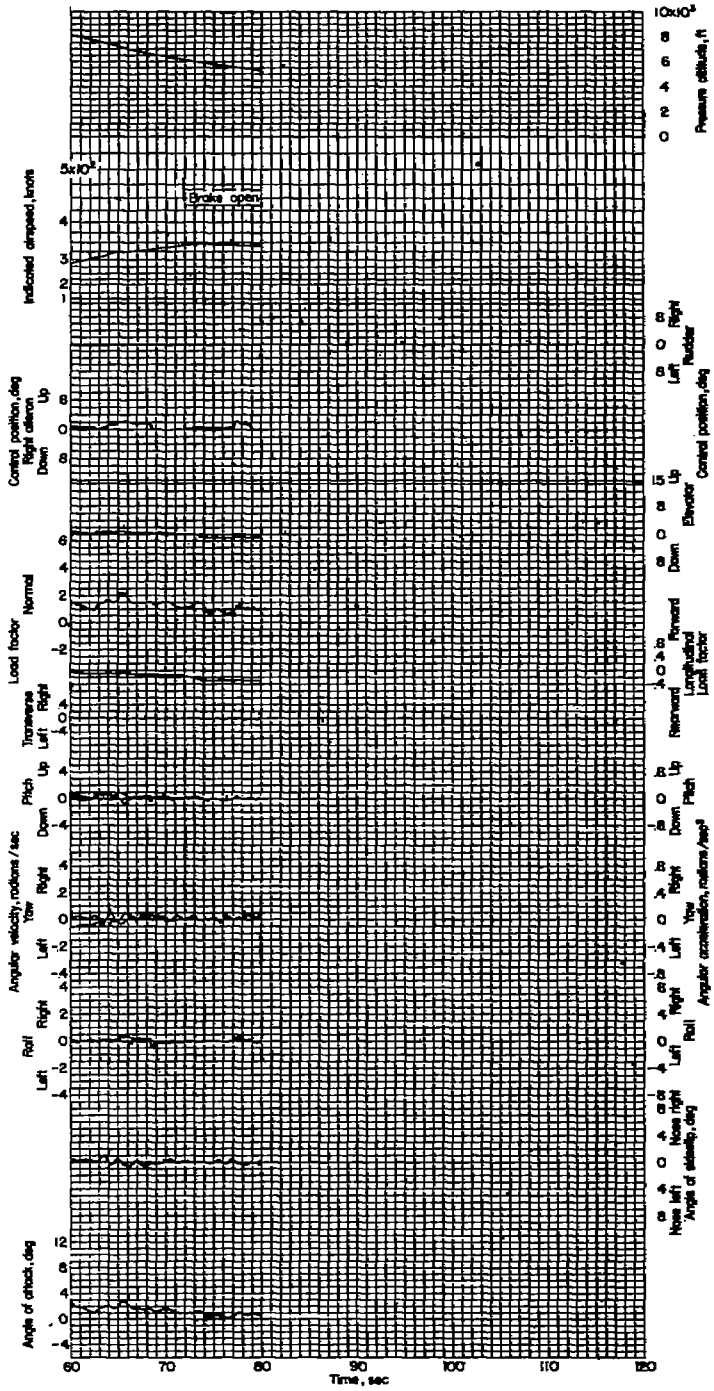
Figure 48.- Concluded.

[redacted]



(a)

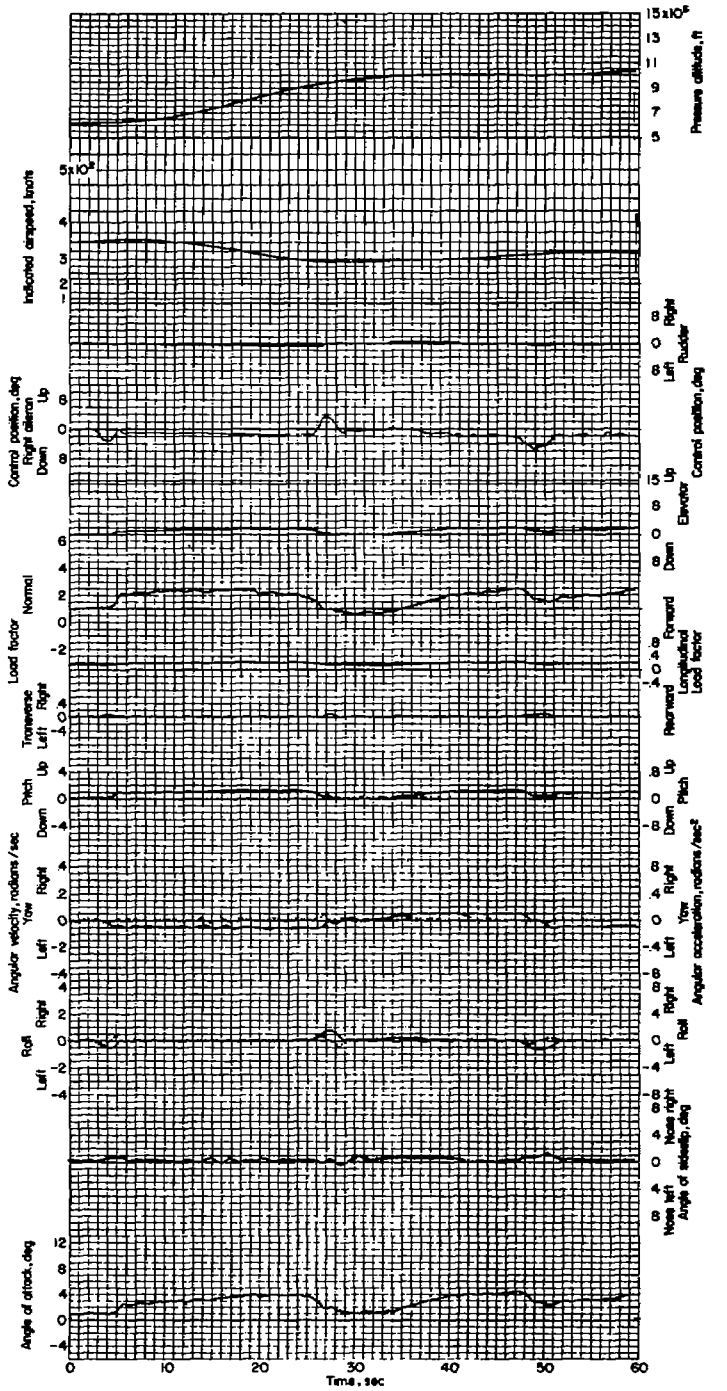
Figure 49.- Series of turns. Airplane weight, 14,040 pounds; center of gravity at 25.7 percent M.A.C.; flight 8.



(b)

Figure 49.- Concluded.

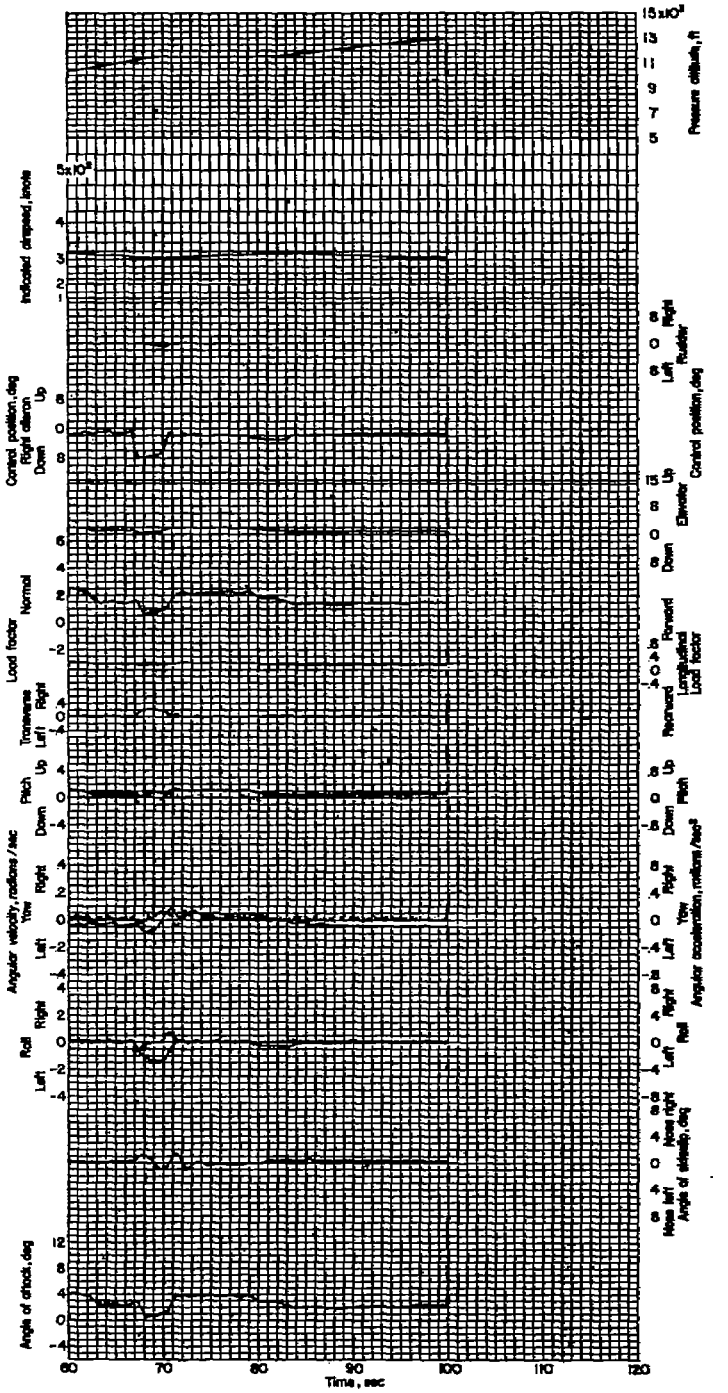
[redacted]



(a)

Figure 50.- Series of turns. Airplane weight, 16,600 pounds; center of gravity at 24.5 percent M.A.C.; flight 9.

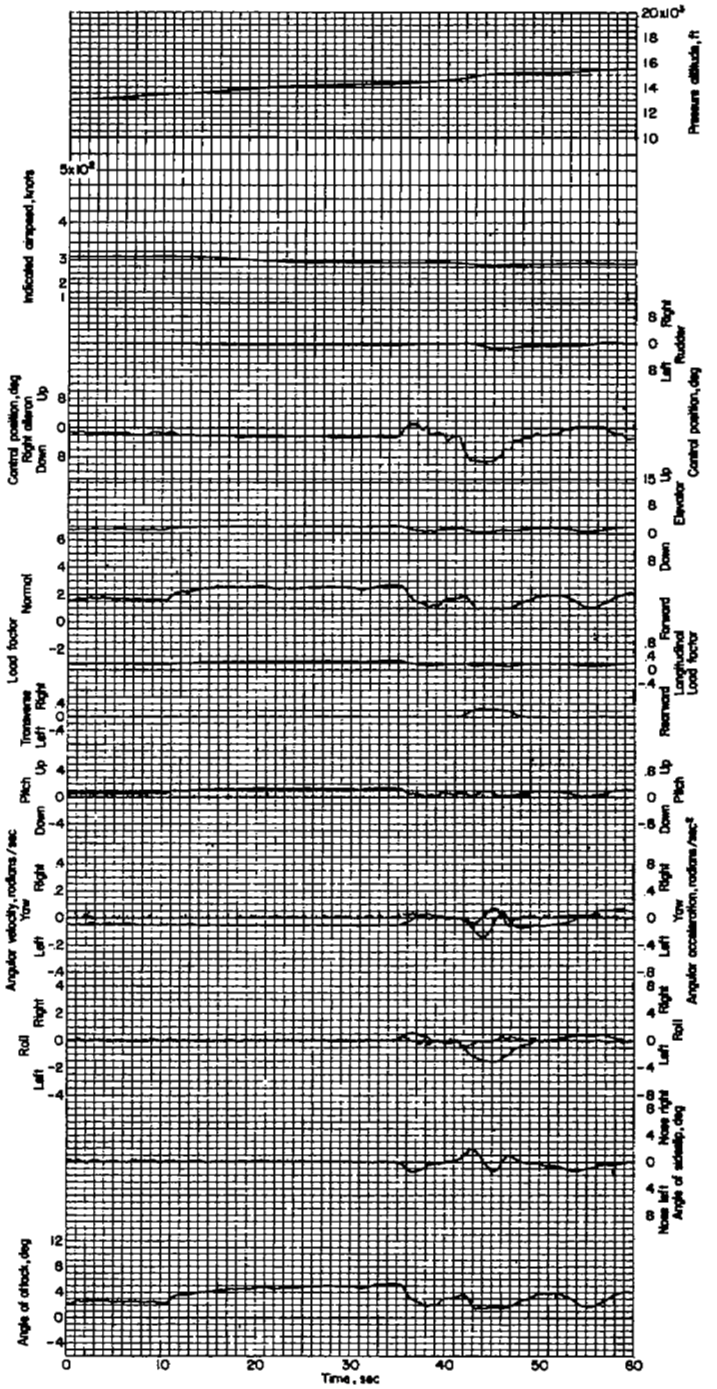
[redacted]



(b)

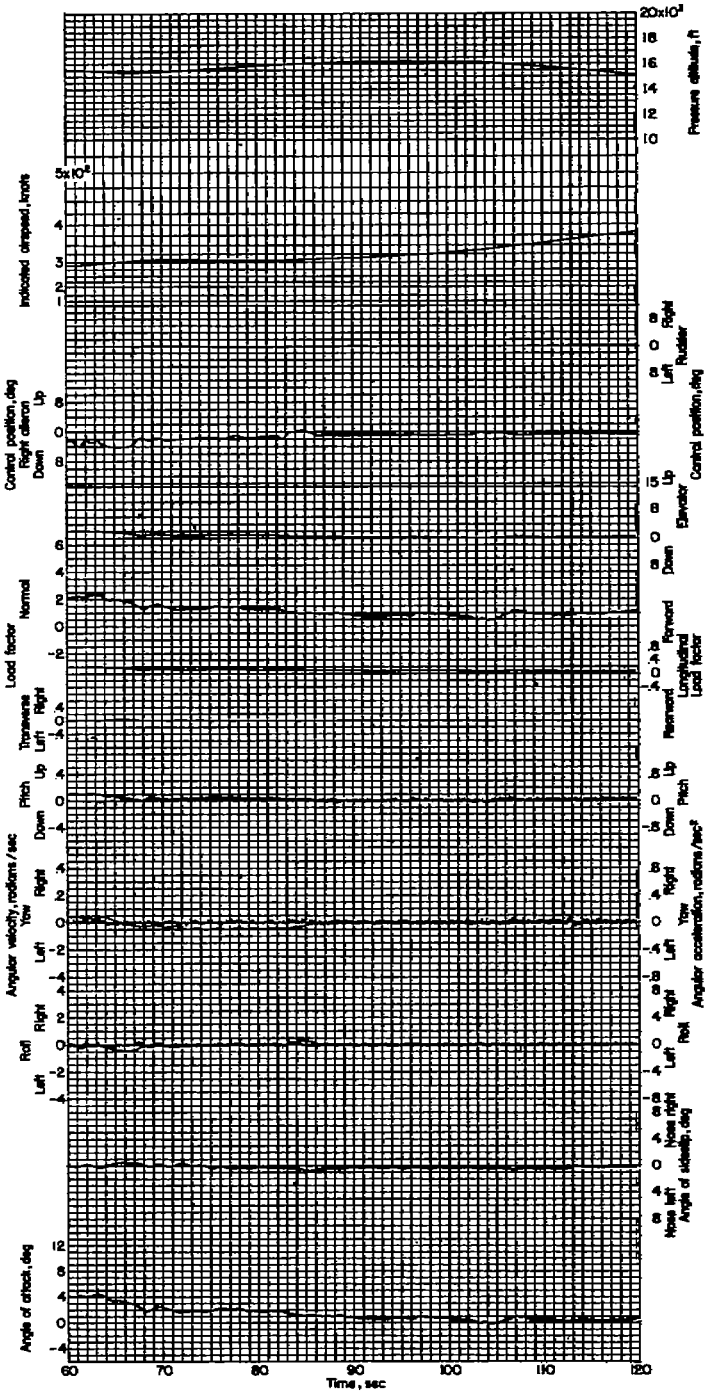
Figure 50.- Concluded.

[redacted]



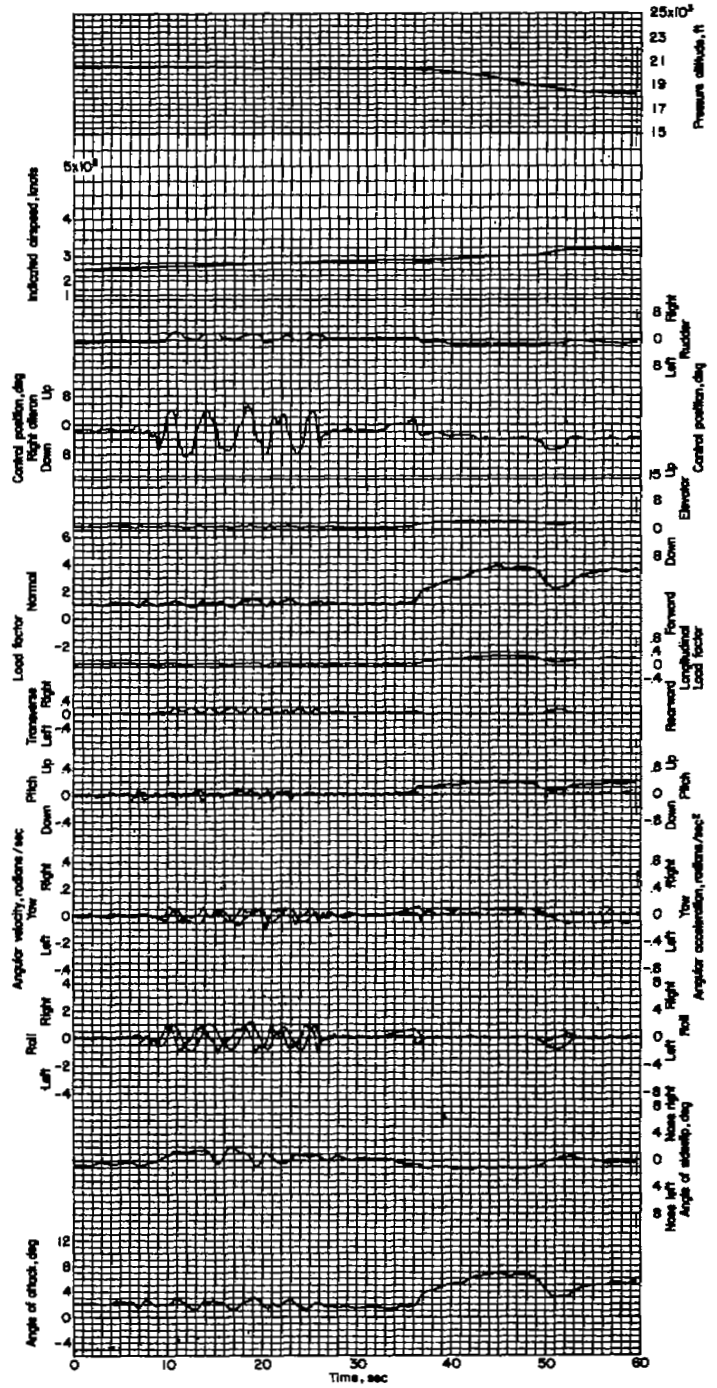
(a)

Figure 51.- Series of turns including left aileron roll. Airplane weight, 16,520 pounds; center of gravity at 24.4 percent M.A.C.; flight 9.



(b)

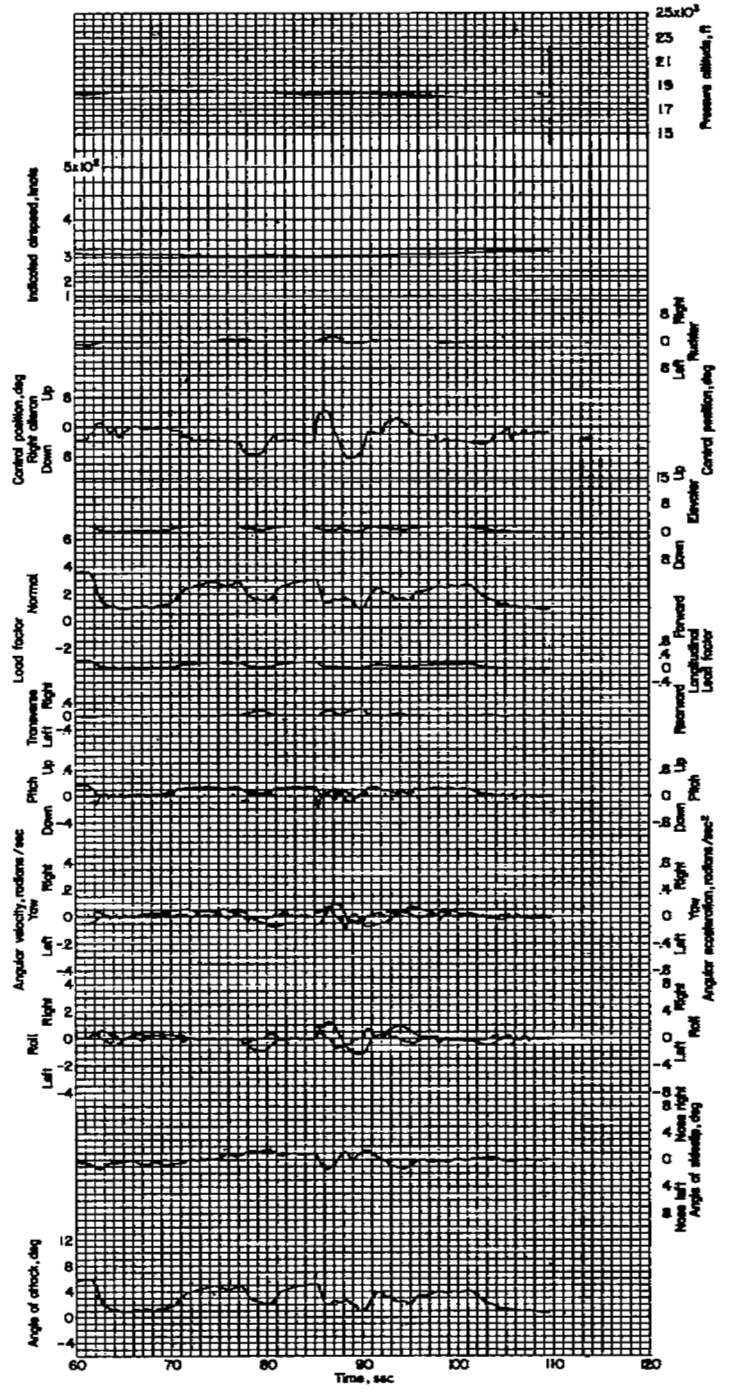
Figure 51.- Concluded.



(a)

Figure 52.- Series of banks and turns. Airplane weight, 16,370 pounds; center of gravity at 24.3 percent M.A.C.; flight 9.

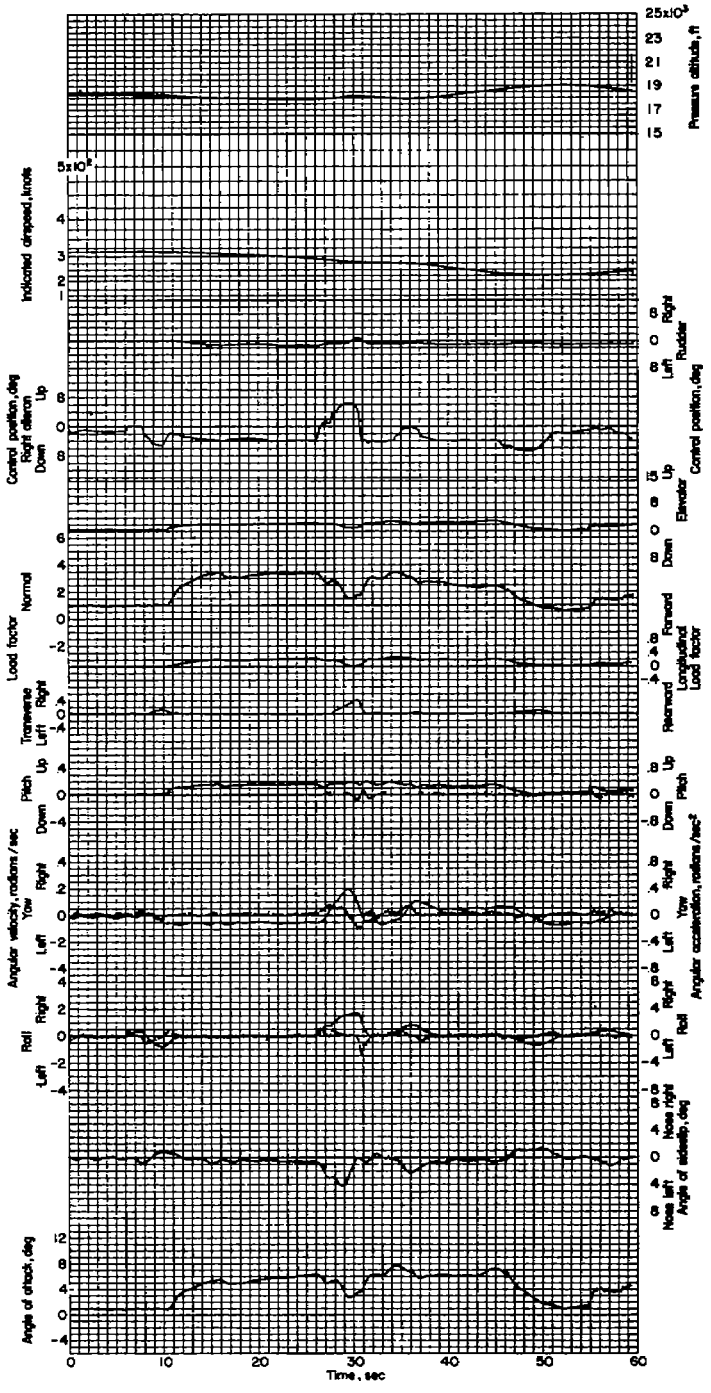
[redacted]



(b)

Figure 52.- Concluded.

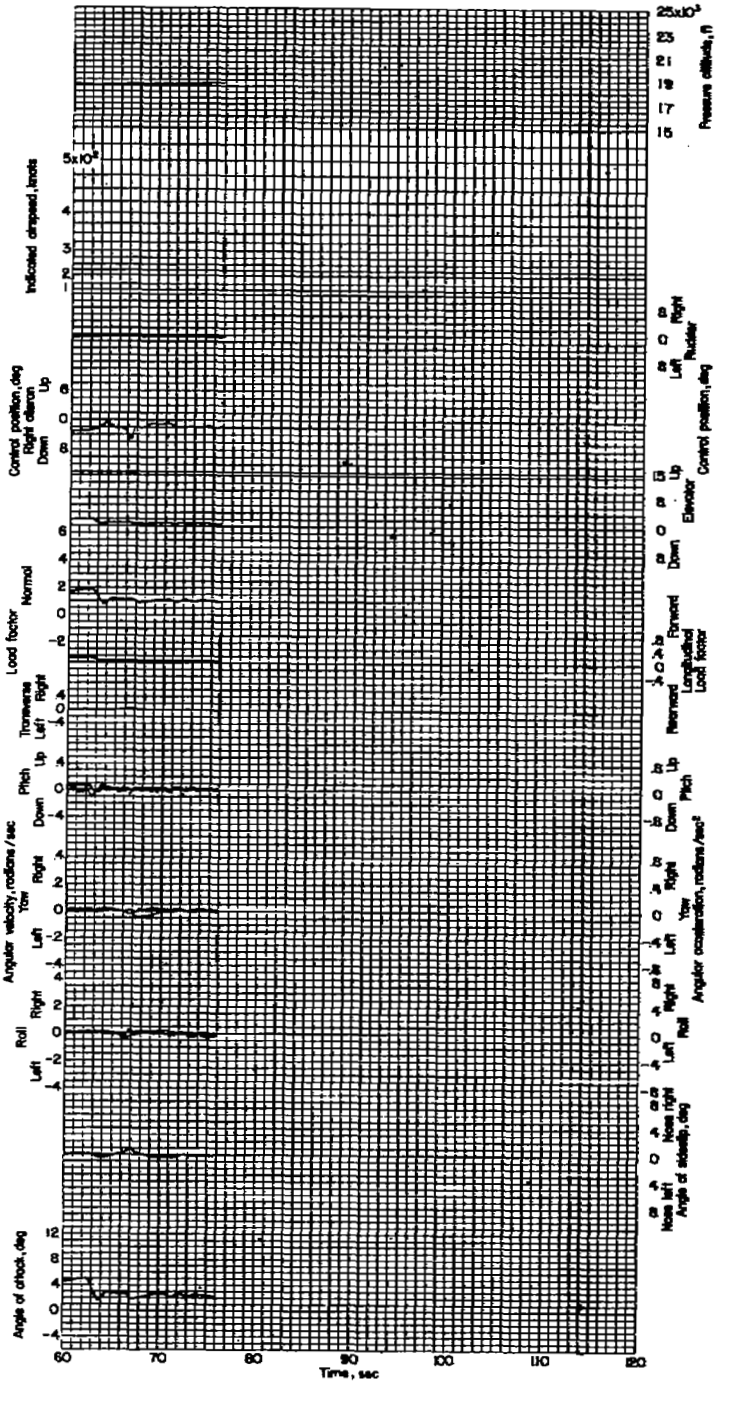
[redacted]



(a)

Figure 53.- Series of turns including right aileron roll. Airplane weight, 16,170 pounds; center of gravity at 24.3 percent M.A.C.; flight 9.

[redacted]



(b)

Figure 53.- Concluded.

[redacted]

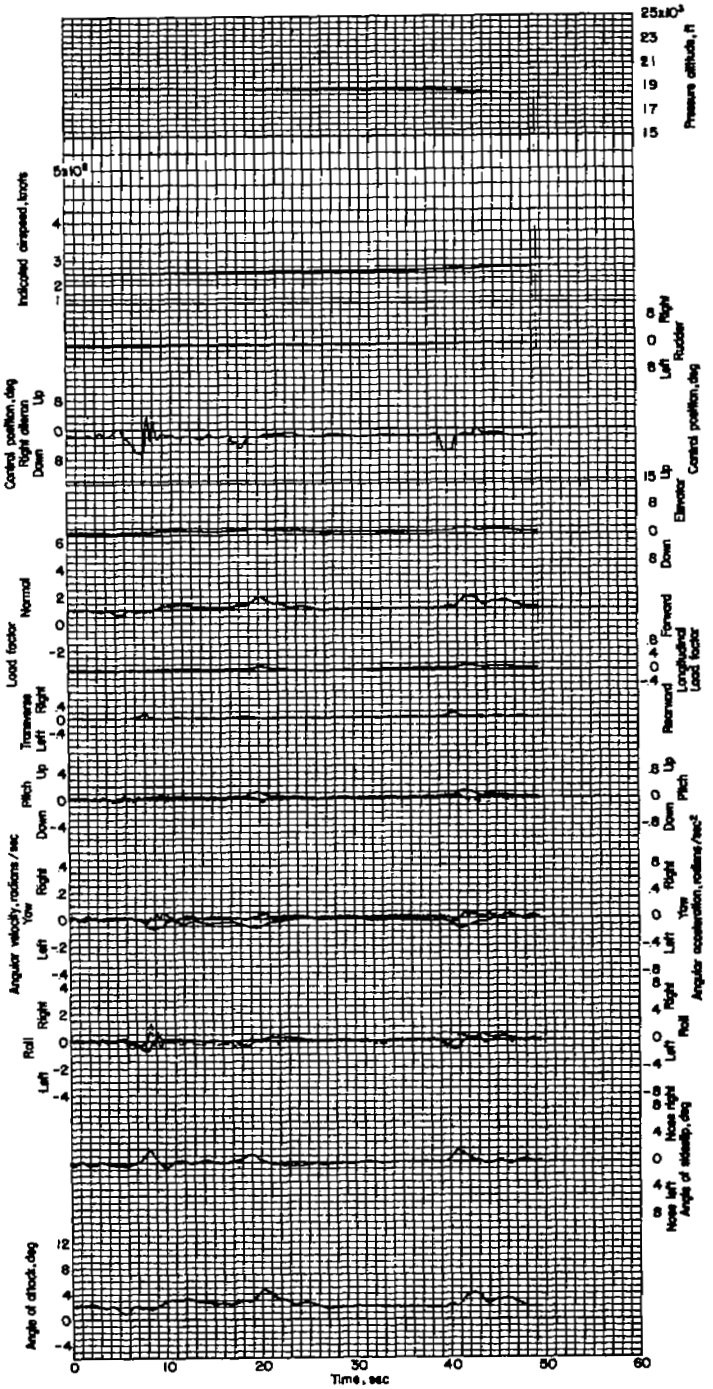


Figure 54.- Series of turns. Airplane weight, 16,120 pounds; center of gravity at 24.3 percent M.A.C.; flight 9.

[redacted]

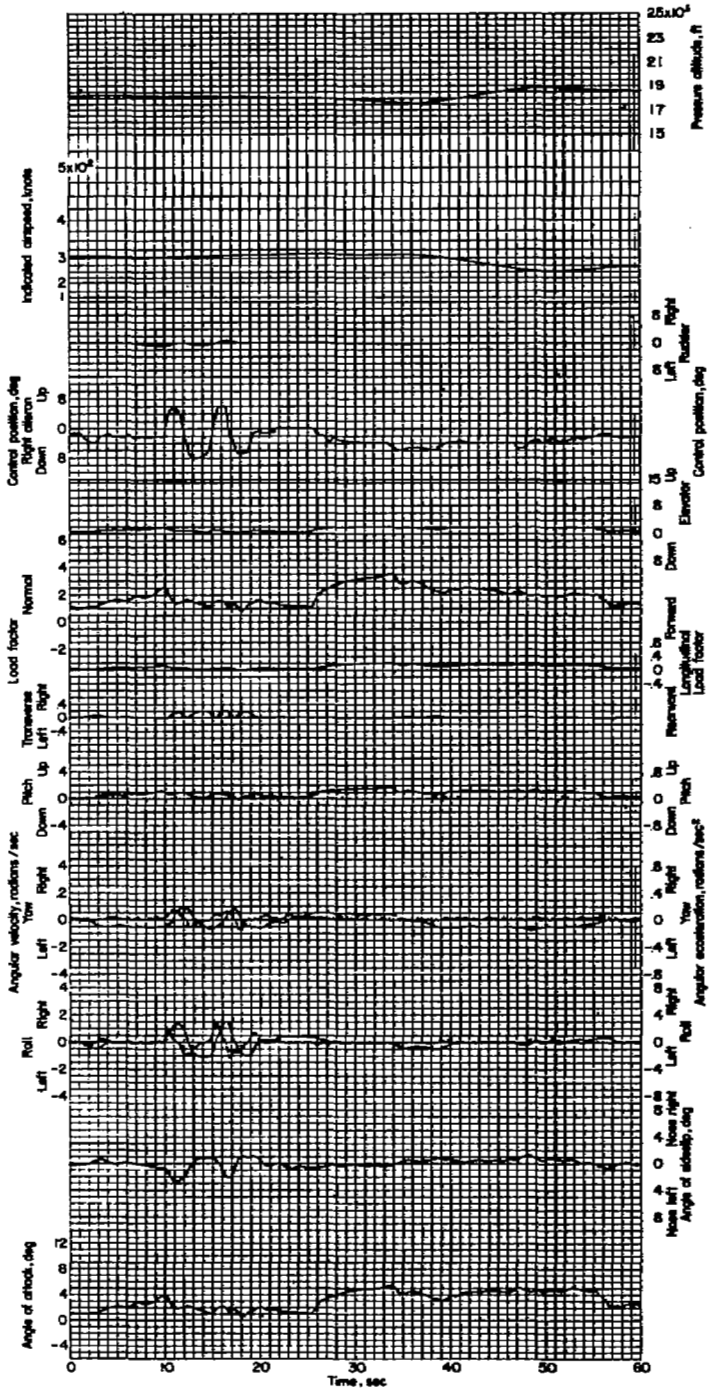


Figure 55.- Series of banks and turns. Airplane weight, 16,070 pounds; center of gravity at 24.4 percent M.A.C.; flight 9.

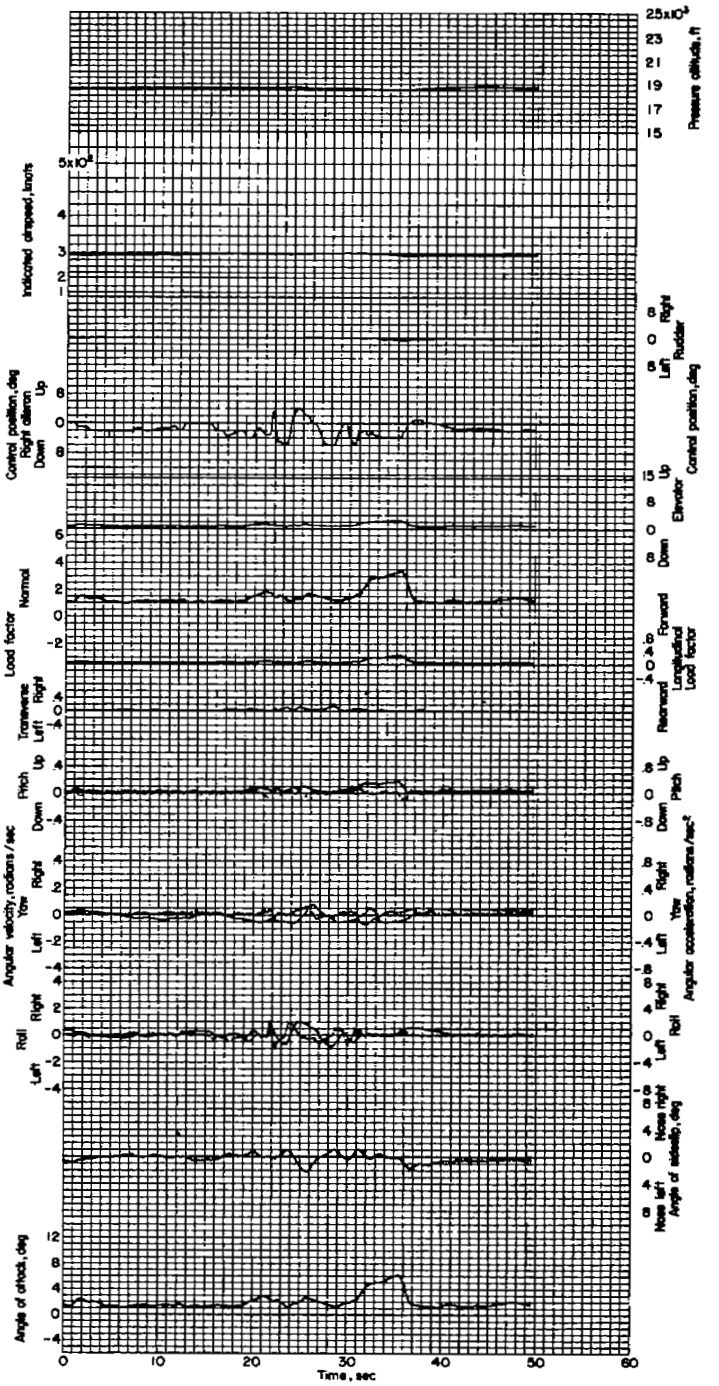


Figure 56.- Series of banks and turns. Airplane weight, 15,990 pounds; center of gravity at 24.5 percent M.A.C.; flight 9

[redacted]

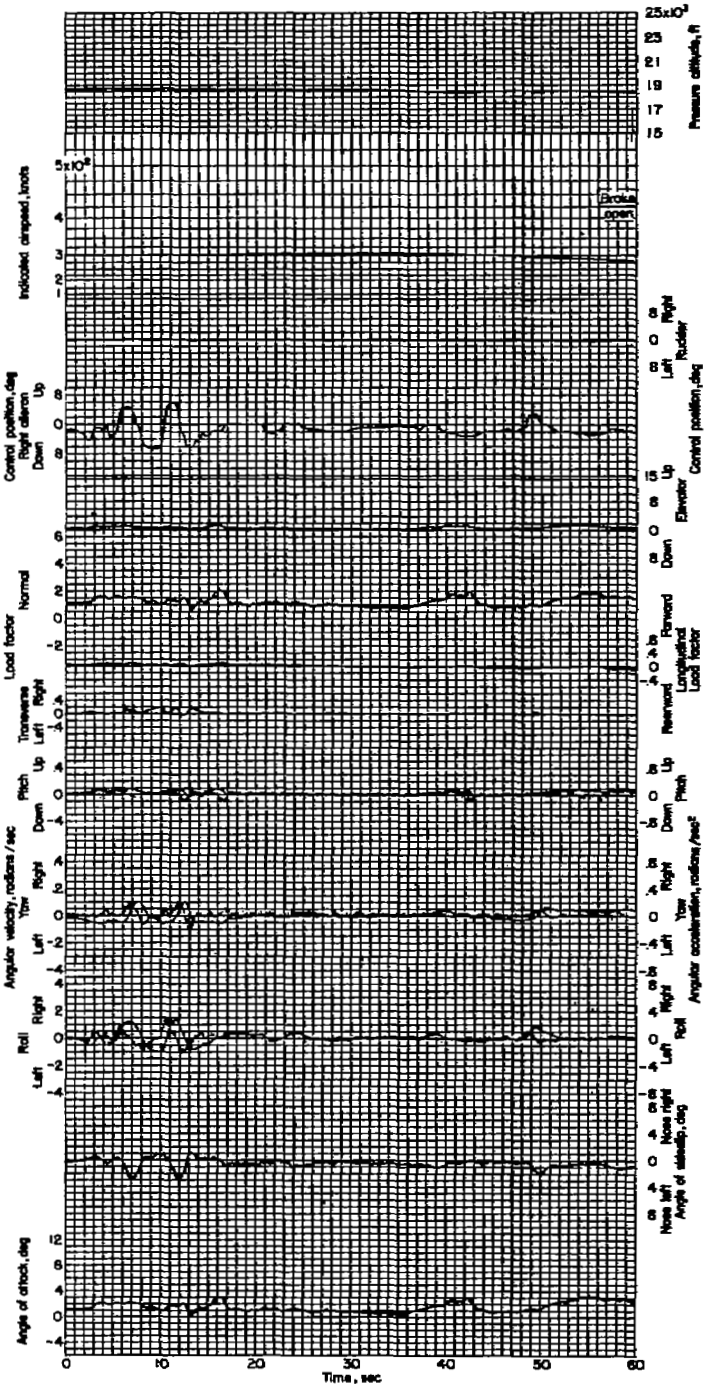


Figure 57.- Series of banks and turns. Airplane weight, 15,940 pounds; center of gravity at 24.5 percent M.A.C.; flight 9.

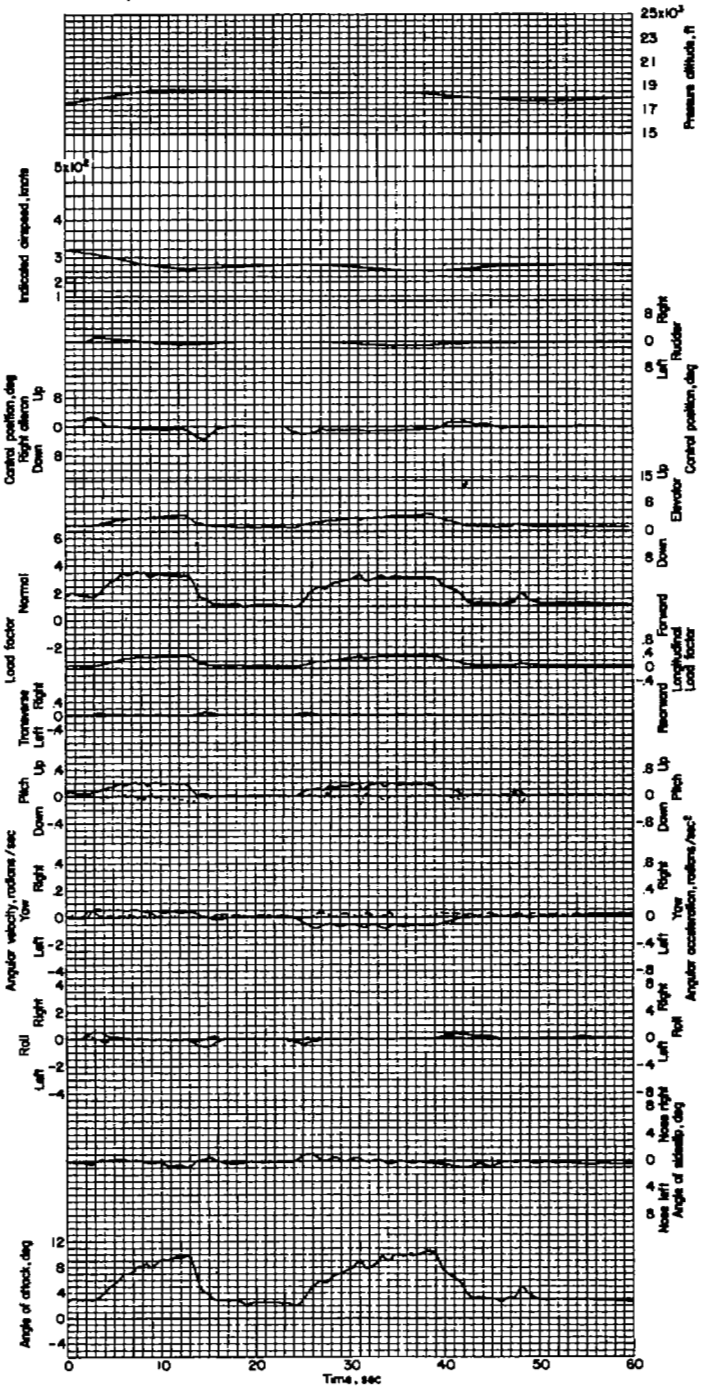


Figure 58.- Series of turns. Airplane weight, 15,990 pounds; center of gravity at 24.1 percent M.A.C.; flight 10.

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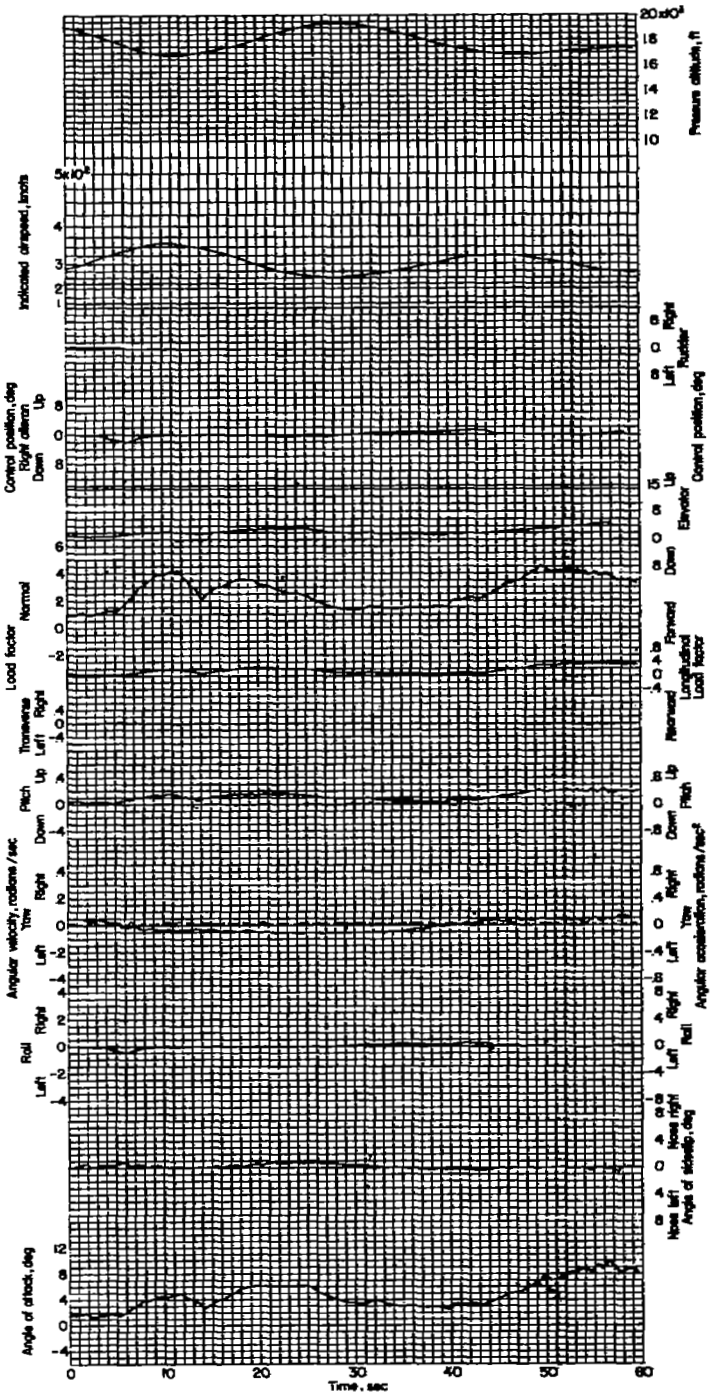
[redacted]



(a)

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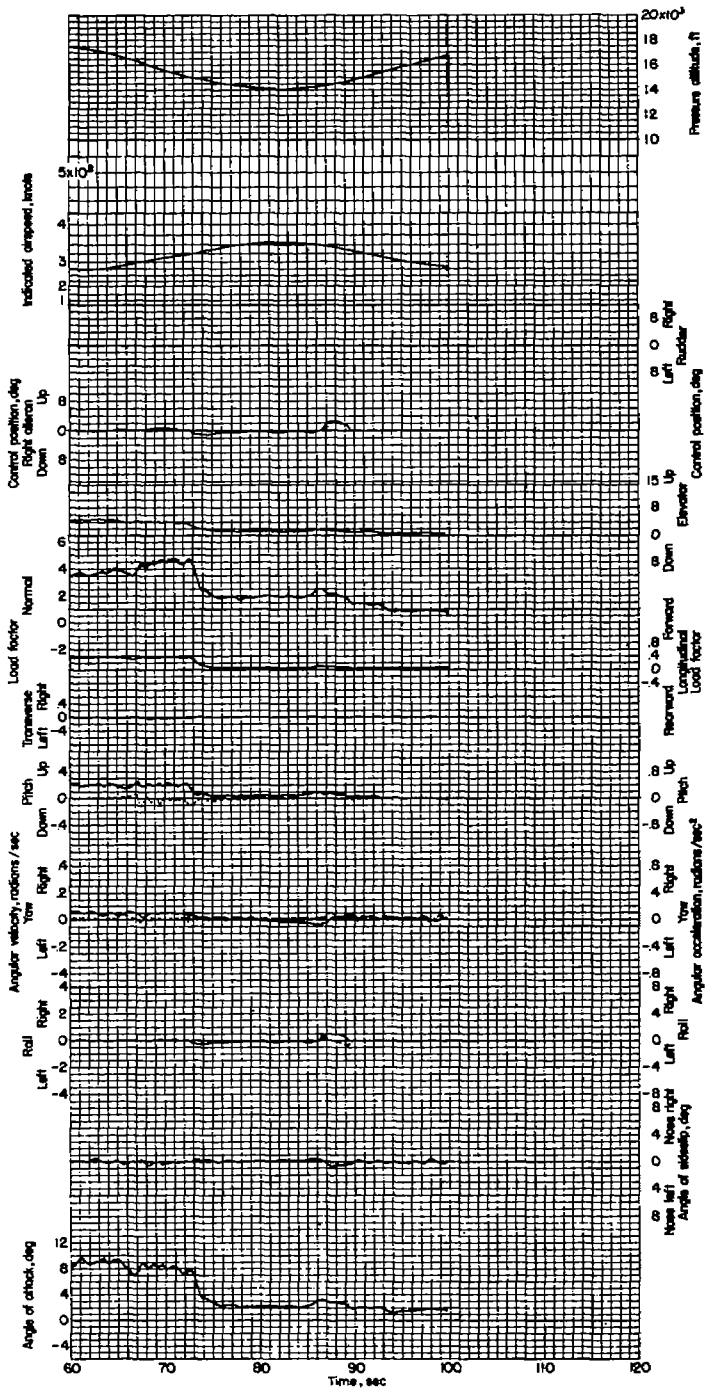
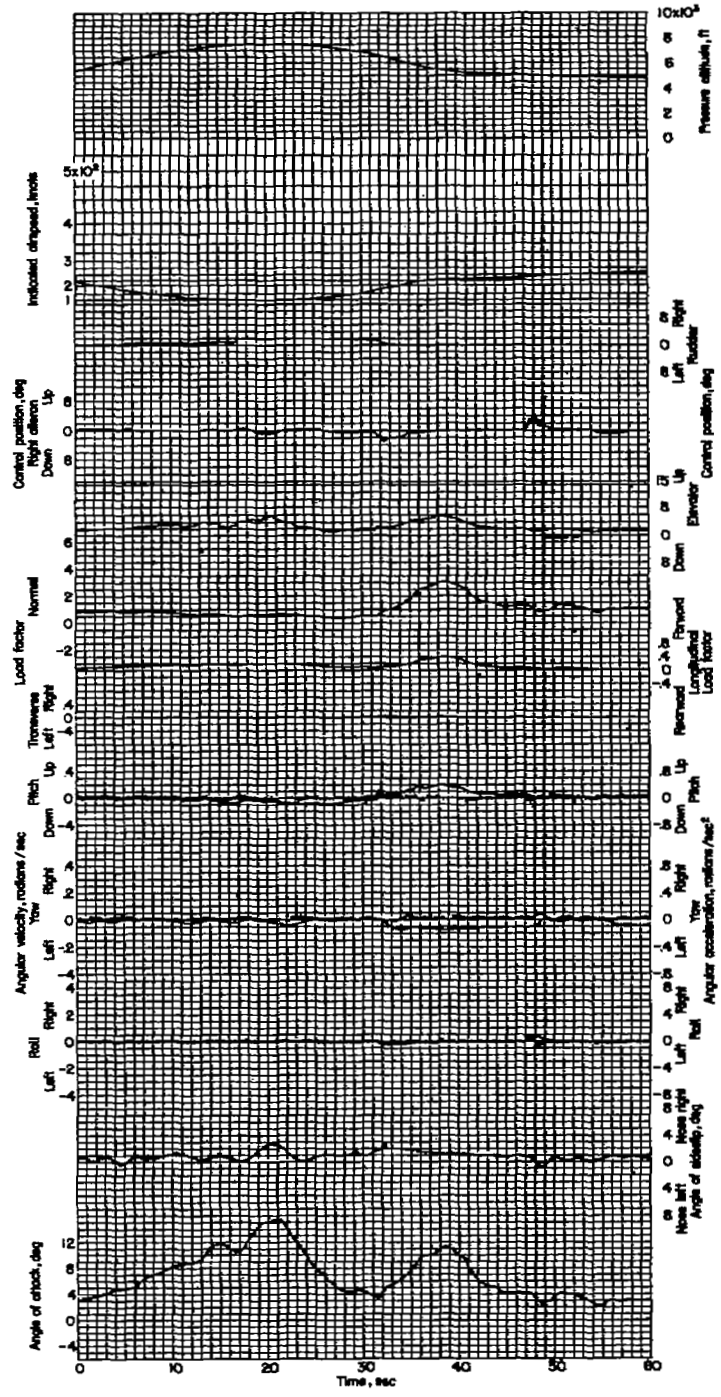
Figure 59.- Series of climbing and diving turns. Airplane weight, 15,770 pounds; center of gravity at 24.0 percent M.A.C.; flight 10.

[redacted]



(b)

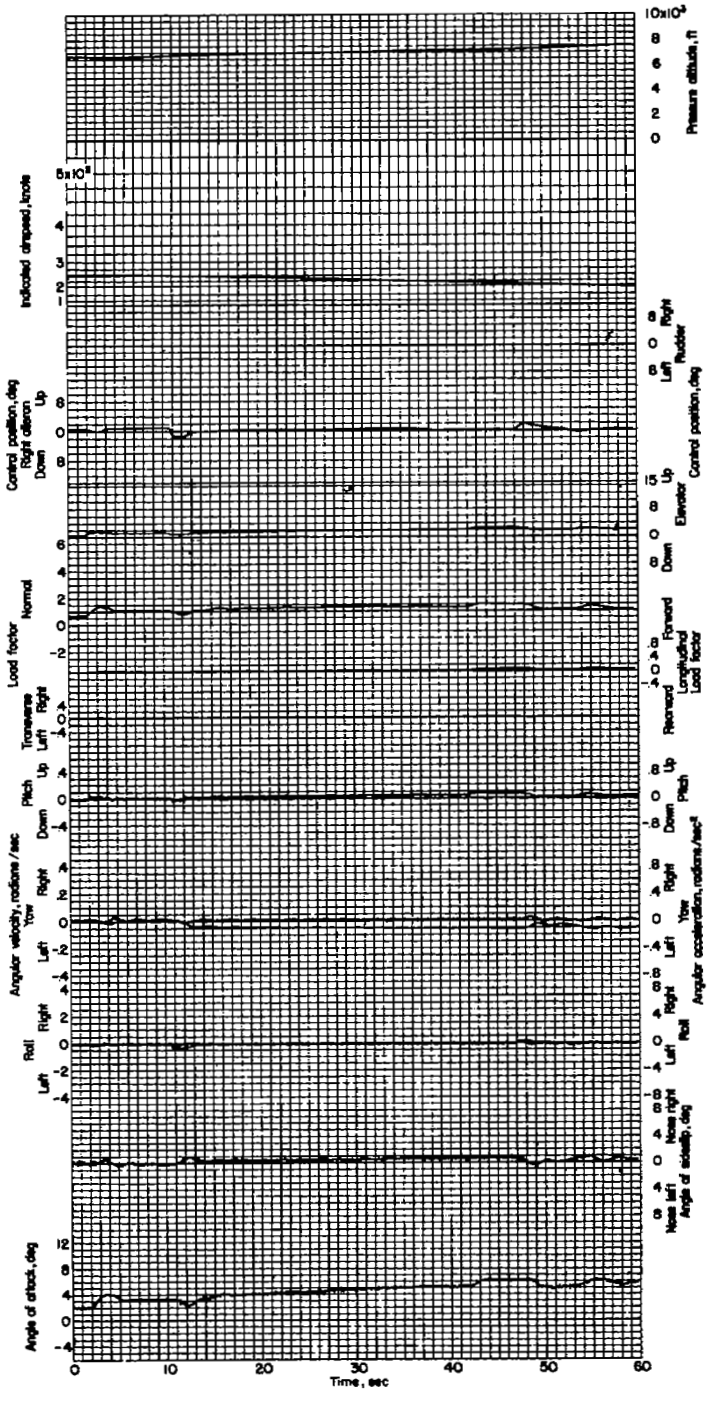
Figure 59.- Concluded.



NACA

Figure 60.- Climb to partial stall followed by left turn. Airplane weight, 15,240 pounds; center of gravity at 24.0 percent M.A.C.; flight 11.

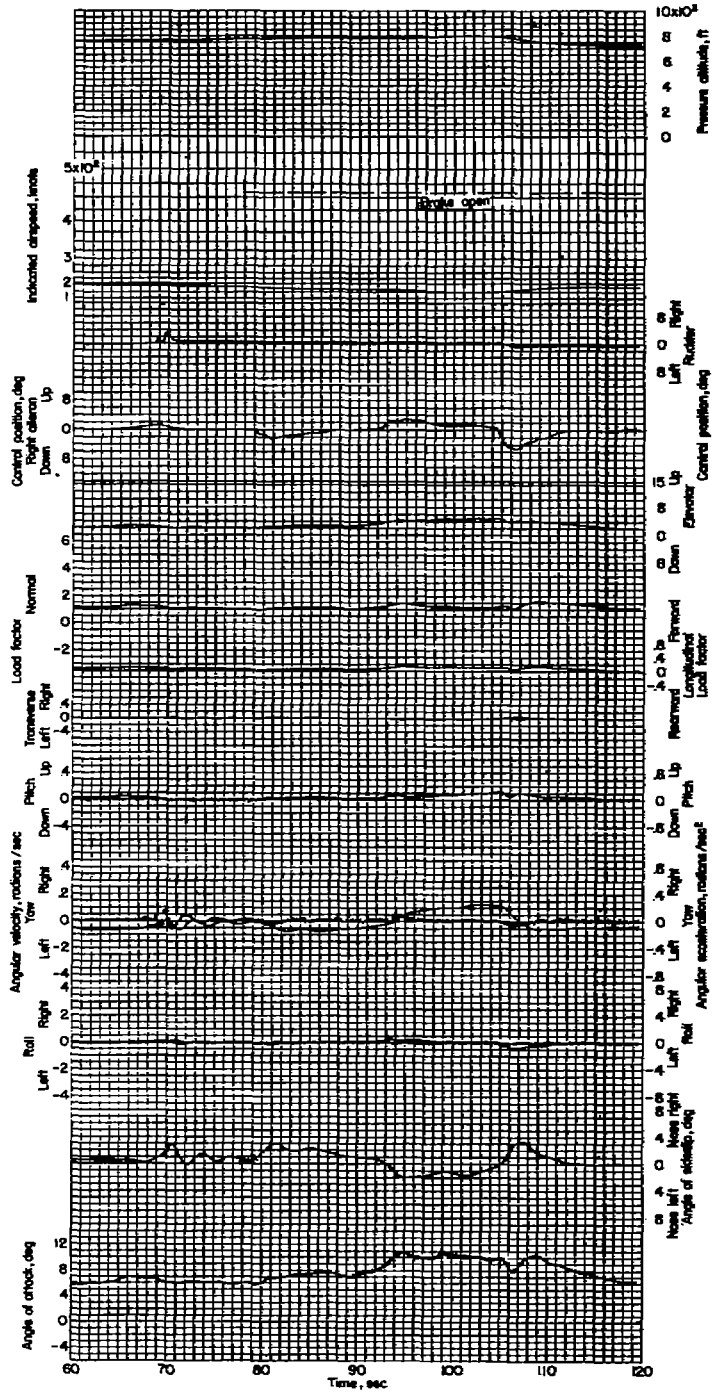
[redacted]



(a)

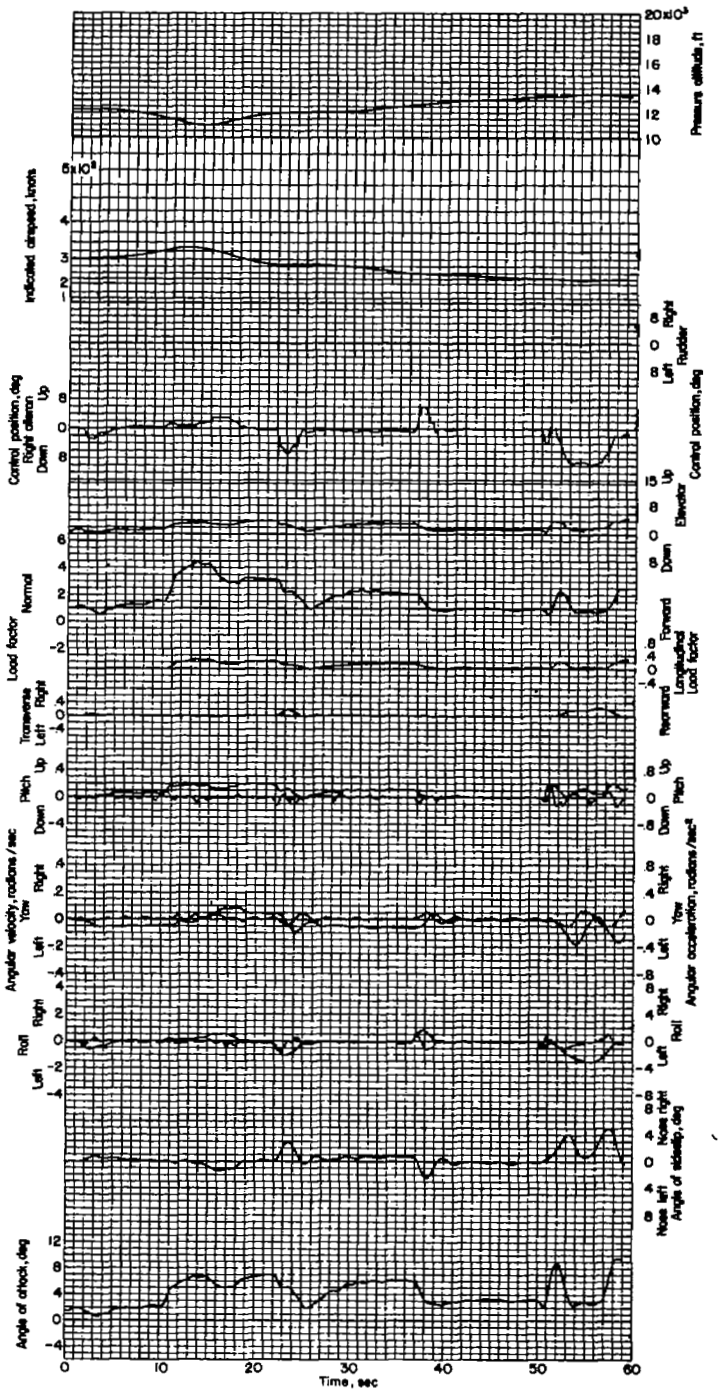
Figure 61.- Series of turns. Airplane weight, 14,770 pounds; center of gravity at 24.6 percent M.A.C.; flight 11.

[redacted]



(b)

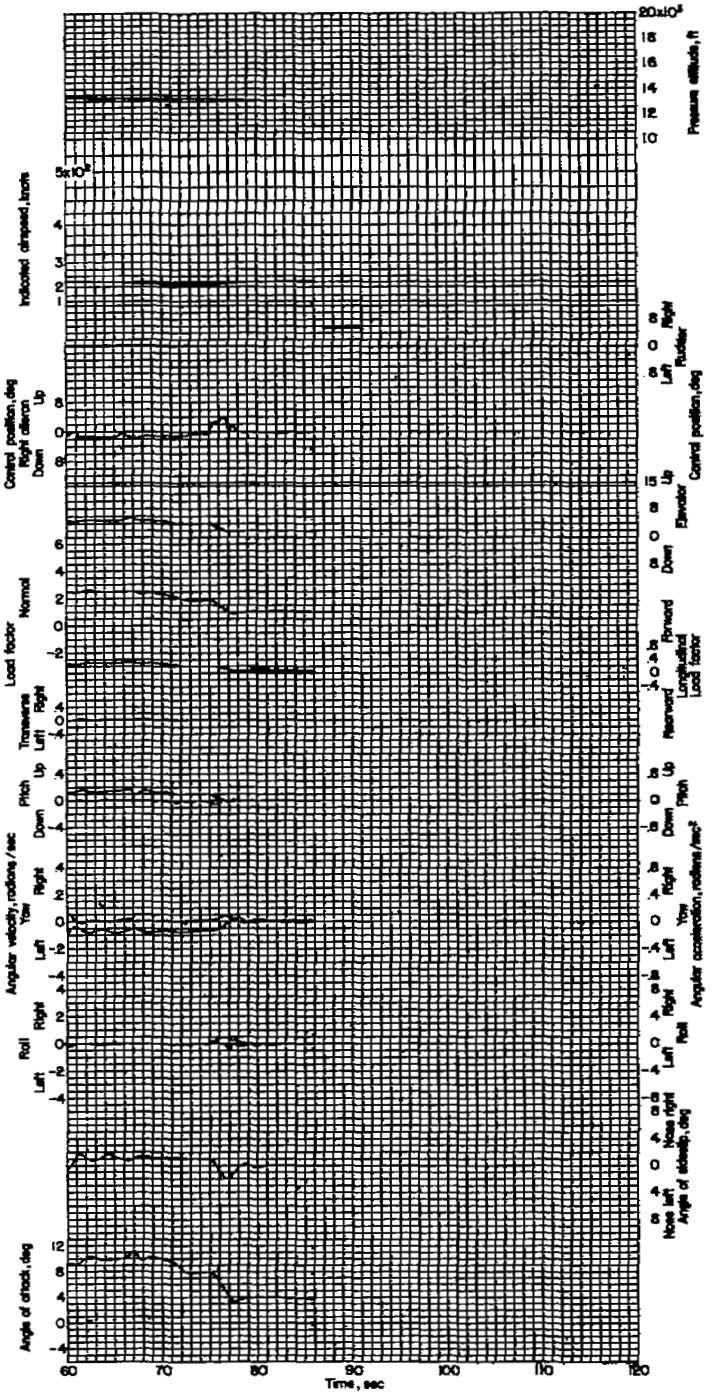
Figure 61.- Concluded.



(a)

Figure 62.- Series of turns including left aileron roll. Airplane weight, 16,820 pounds; center of gravity at 24.6 percent M.A.C.; flight 12.

[redacted]



(b)

Figure 62.- Concluded.

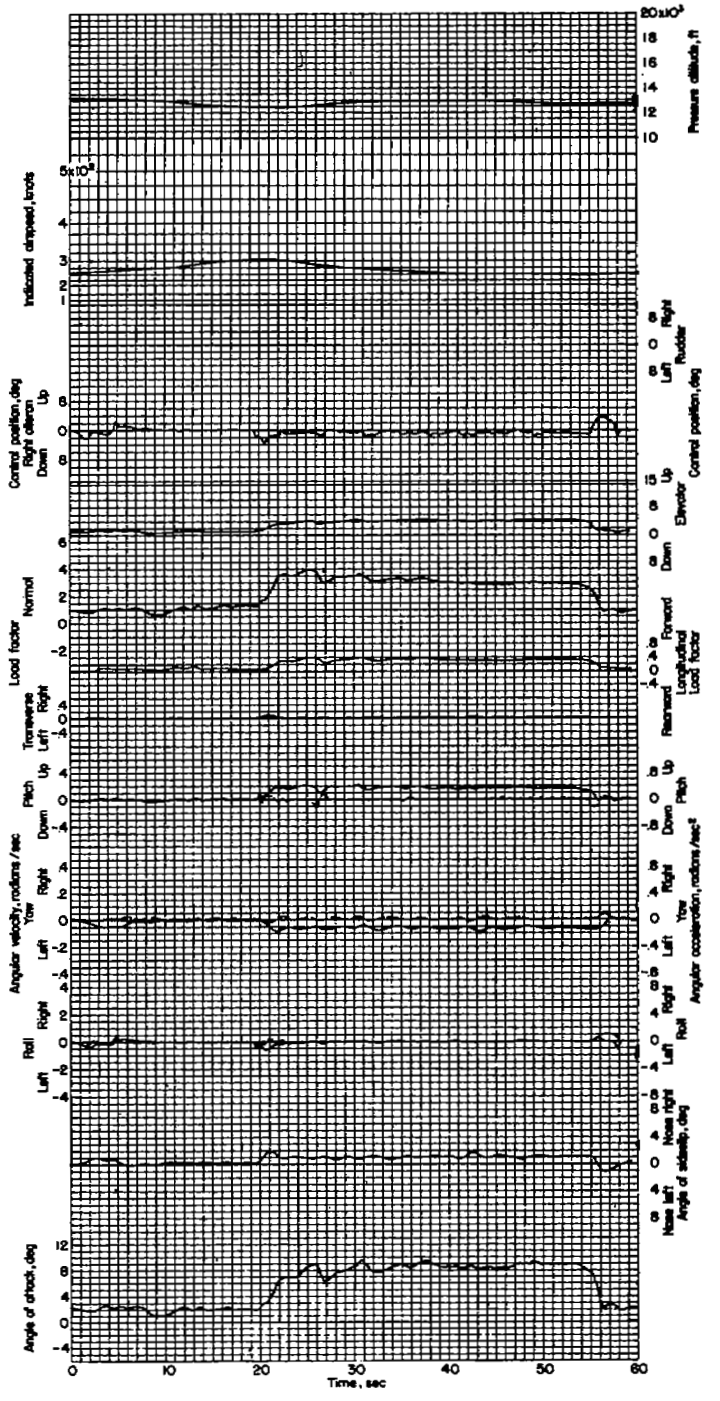
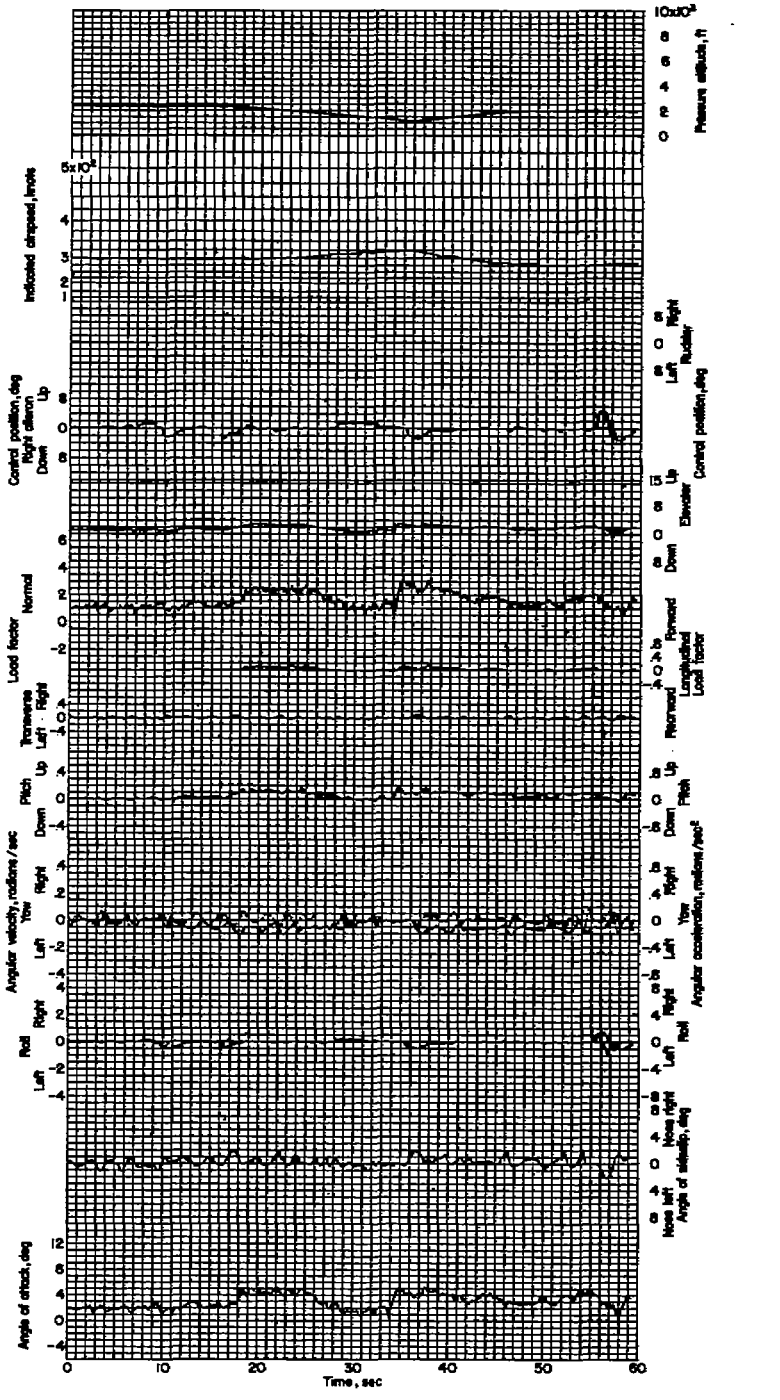


Figure 63.- Left turn. Airplane weight, 15,960 pounds; center of gravity at 24.1 percent M.A.C.; flight 12.

[redacted]



(a)

NACA

Figure 64.- Series of turns. Airplane weight, 15,730 pounds; center of gravity at 23.8 percent M.A.C.; flight 12.

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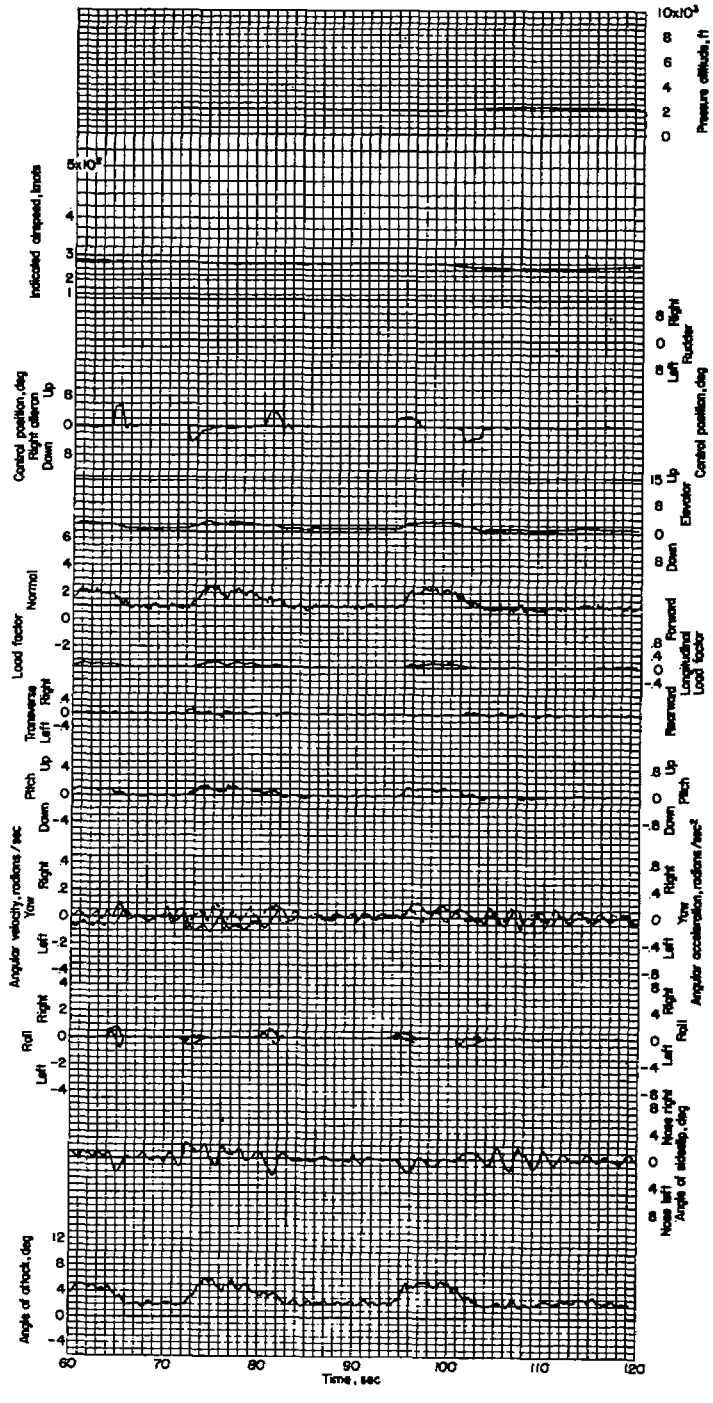
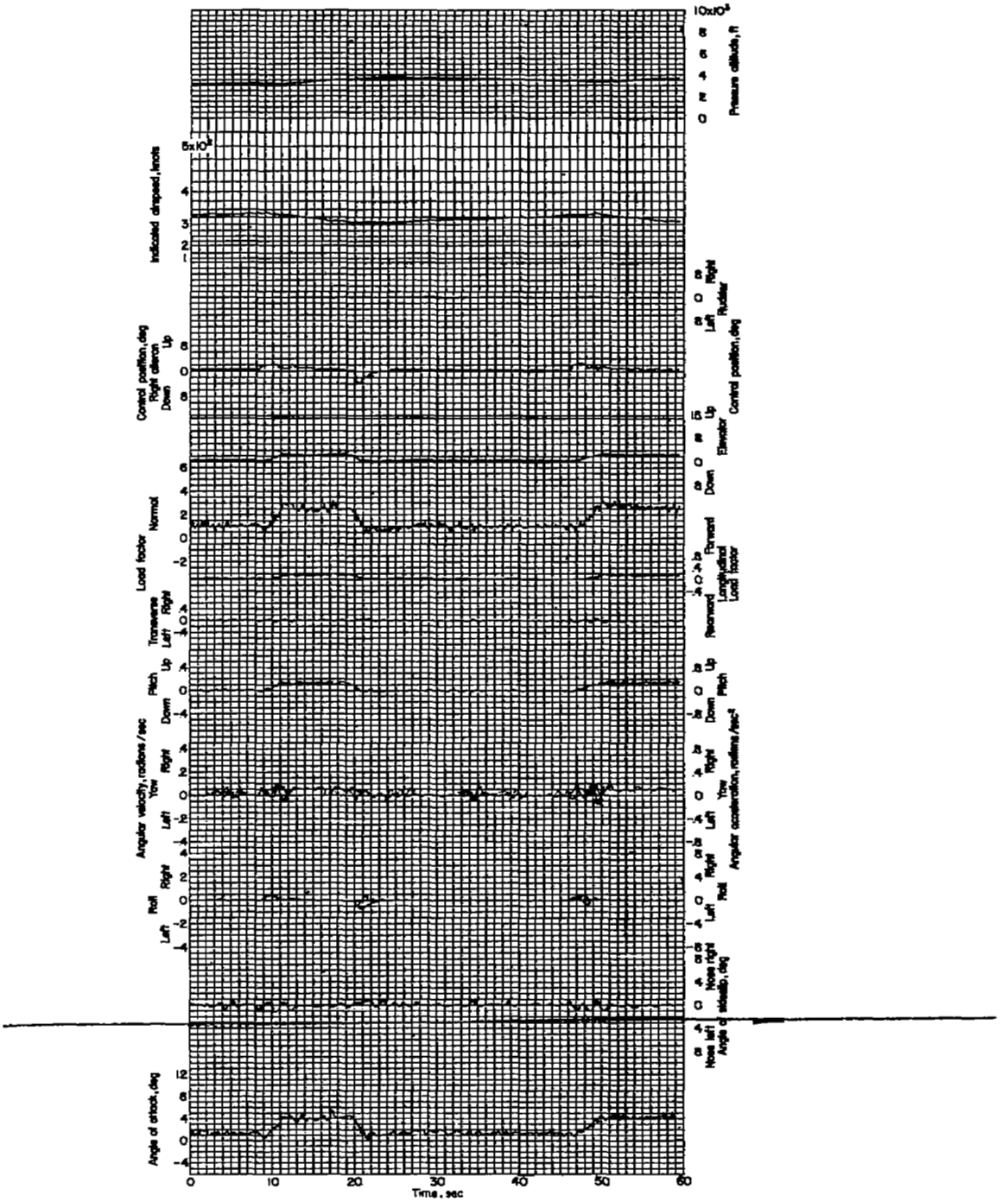


(b)

Figure 64.- Concluded.

[redacted]



(a)

Figure 65.- Series of turns. Airplane weight, 15,570 pounds; center of gravity at 23.9 percent M.A.C.; flight 12.

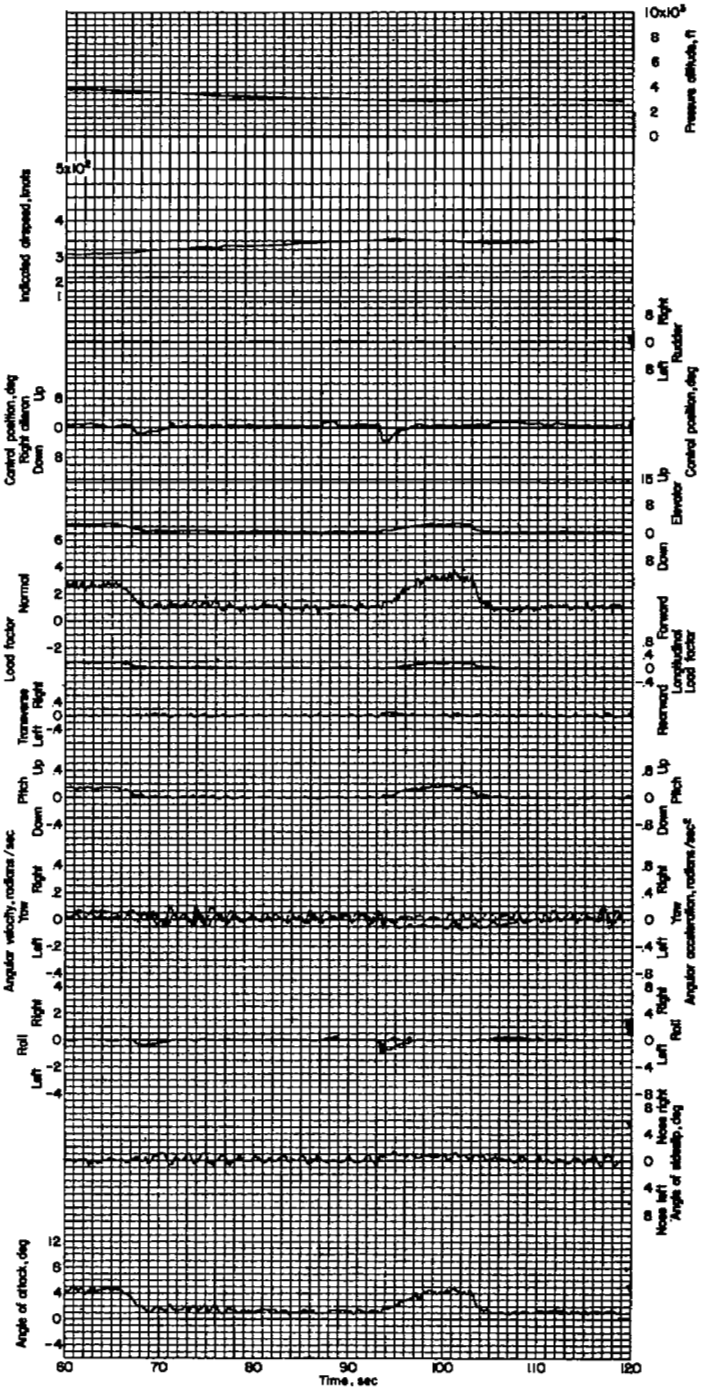


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Figure 65.- Concluded.

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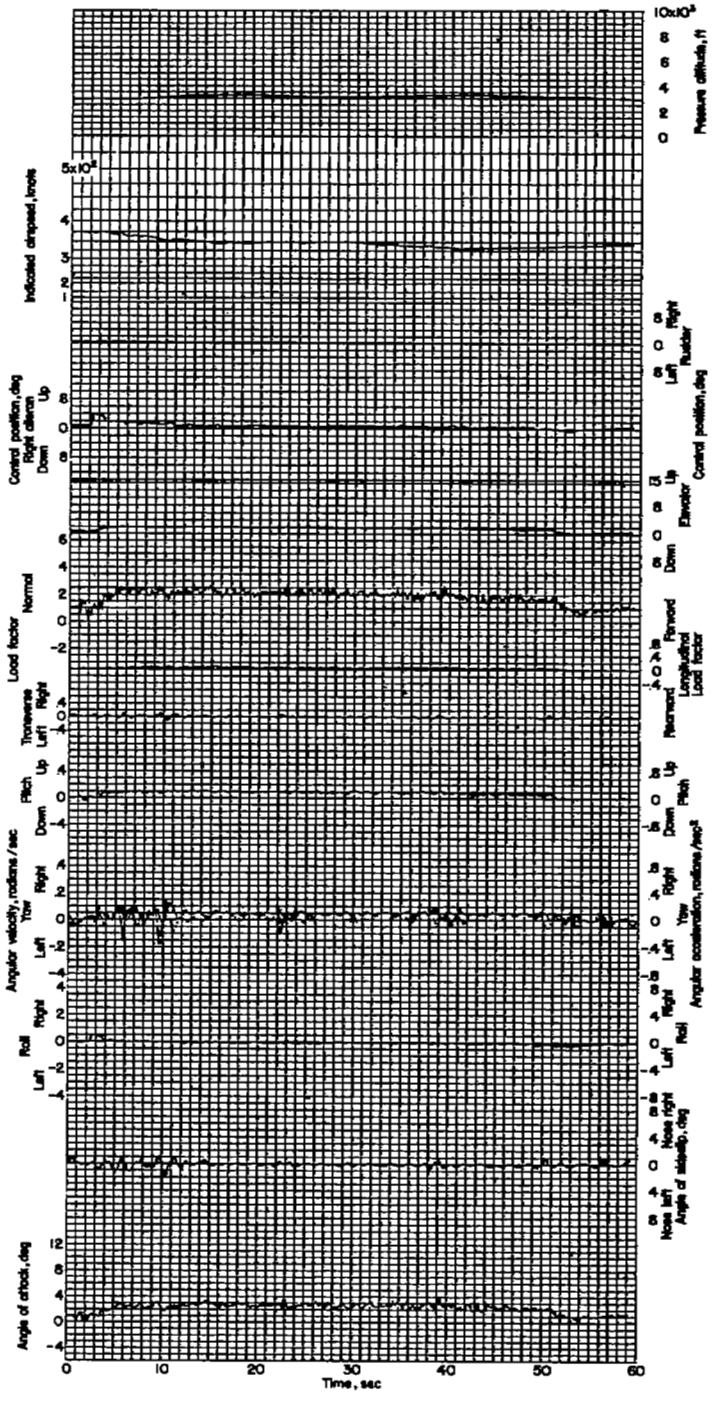

Figure 66.- Right turn. Airplane weight, 15,450 pounds; center of gravity at 23.8 percent M.A.C.; flight 12.

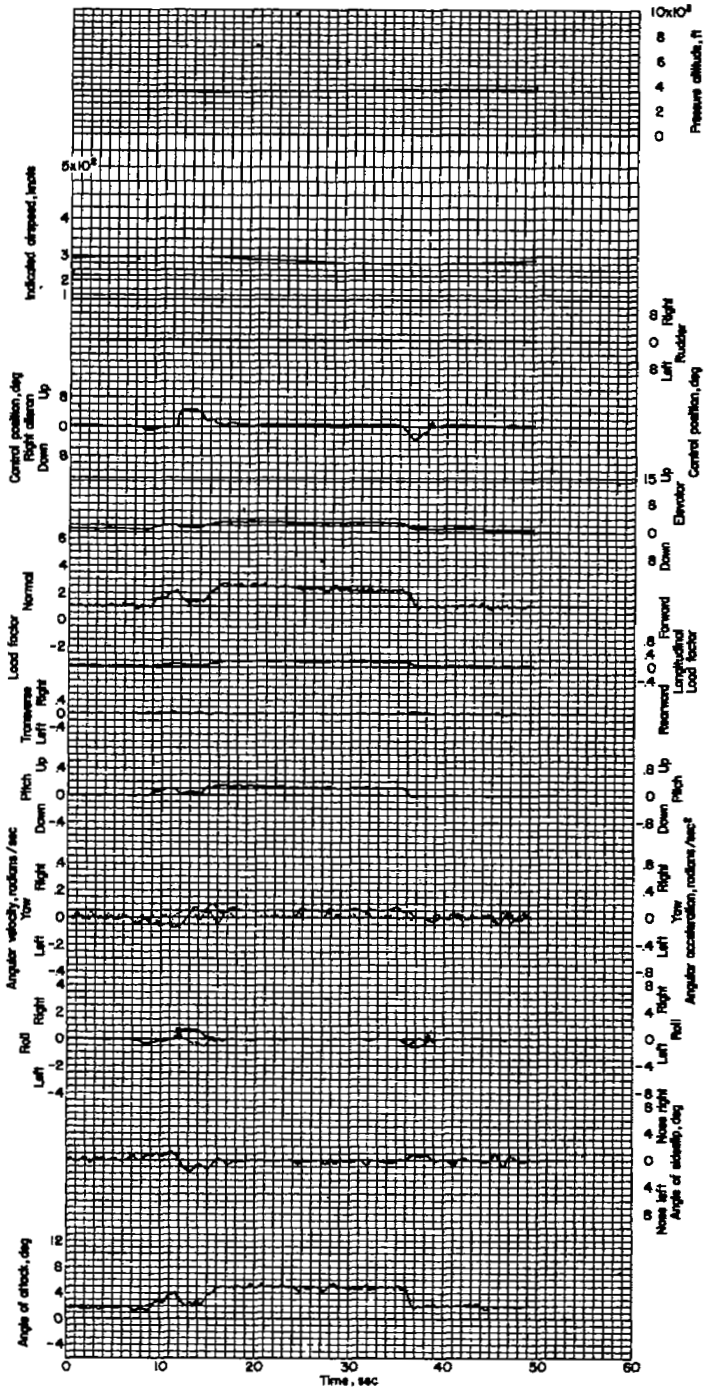

Figure 67.- Right turn. Airplane weight, 15,200 pounds; center of gravity at 24.1 percent M.A.C.; flight 12.

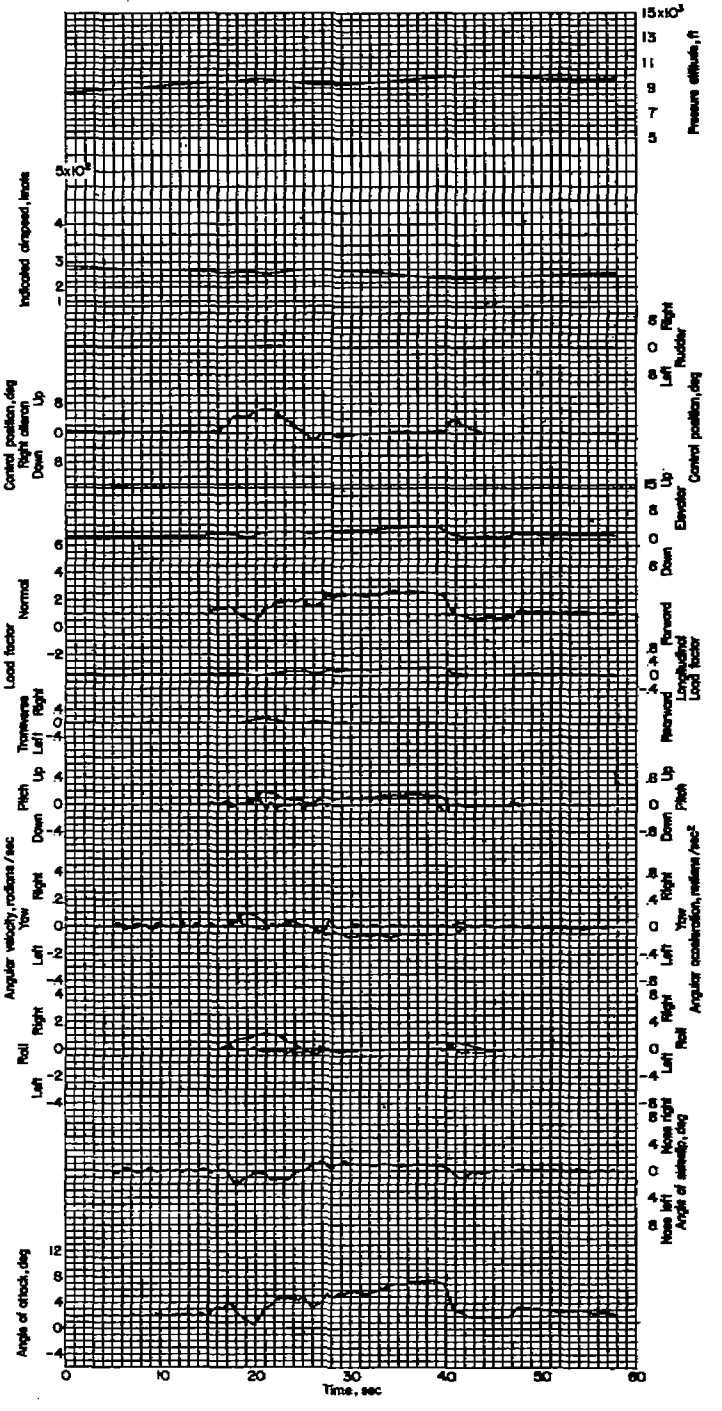

Figure 68.- Right aileron roll and left turn. Airplane weight, 15,070 pounds; center of gravity at 24.2 percent M.A.C.; flight 12. (Note: In this fig. only, time scale should be multiplied by 1.04.)

[redacted]

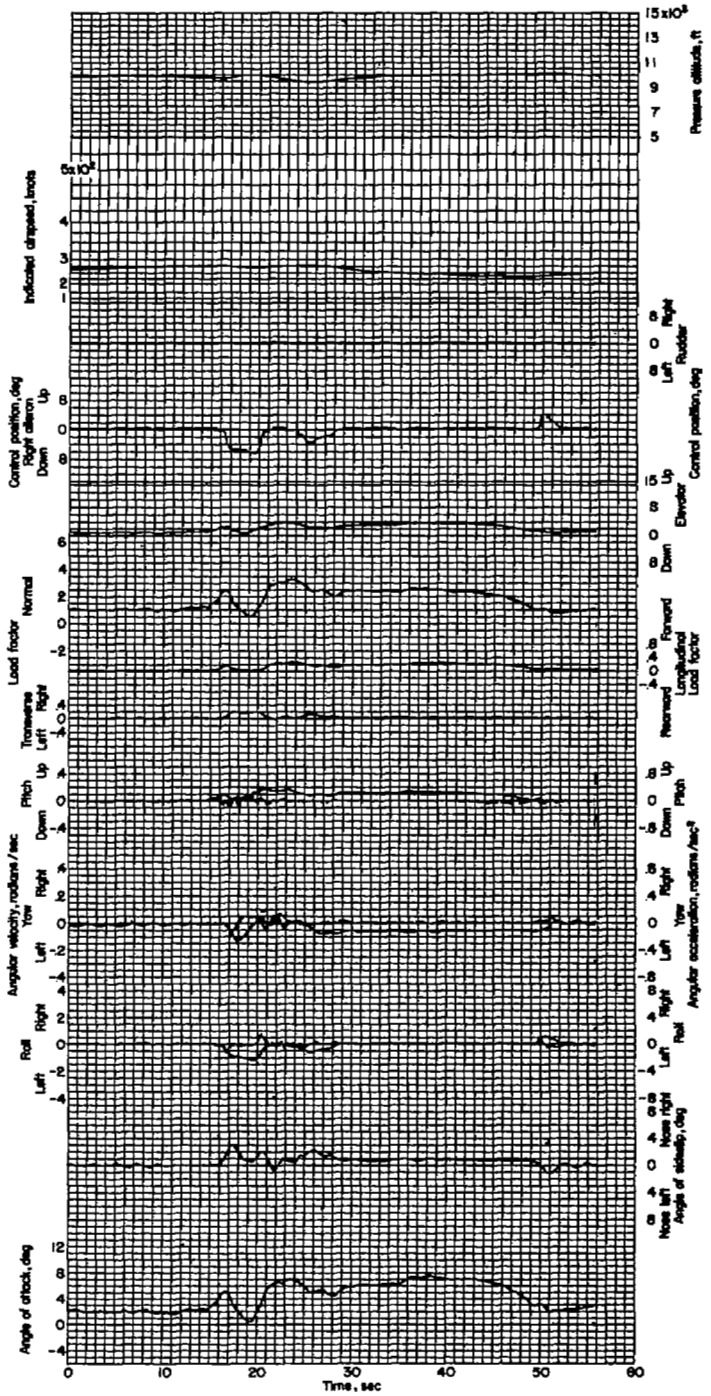

Figure 69.- Left aileron roll and left turn. Airplane weight, 15,030 pounds; center of gravity at 24.3 percent M.A.C.; flight 12. (Note: In this fig. only, time scale should be multiplied by 1.075.)

[redacted]

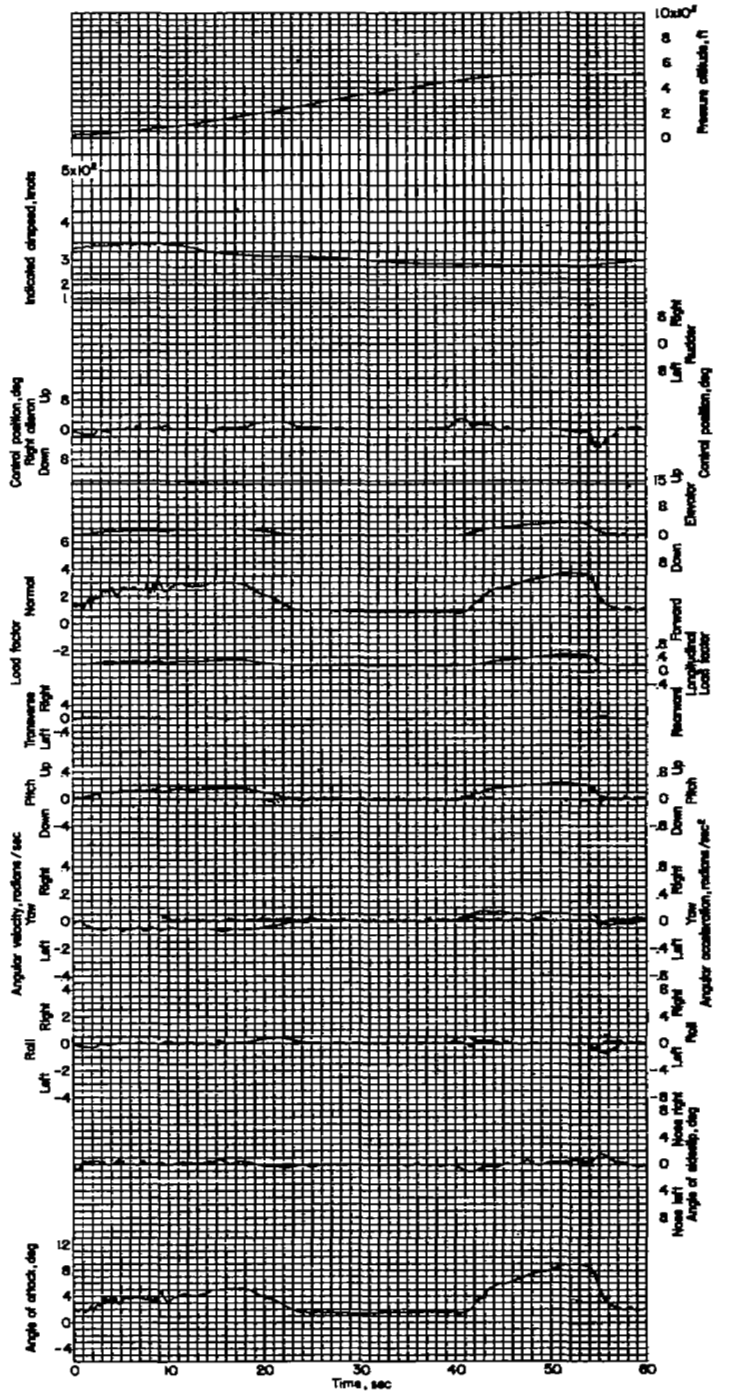

Figure 70.- Climbing left and right turn. Airplane weight, 16,760 pounds; center of gravity at 24.5 percent M.A.C.; flight 13.

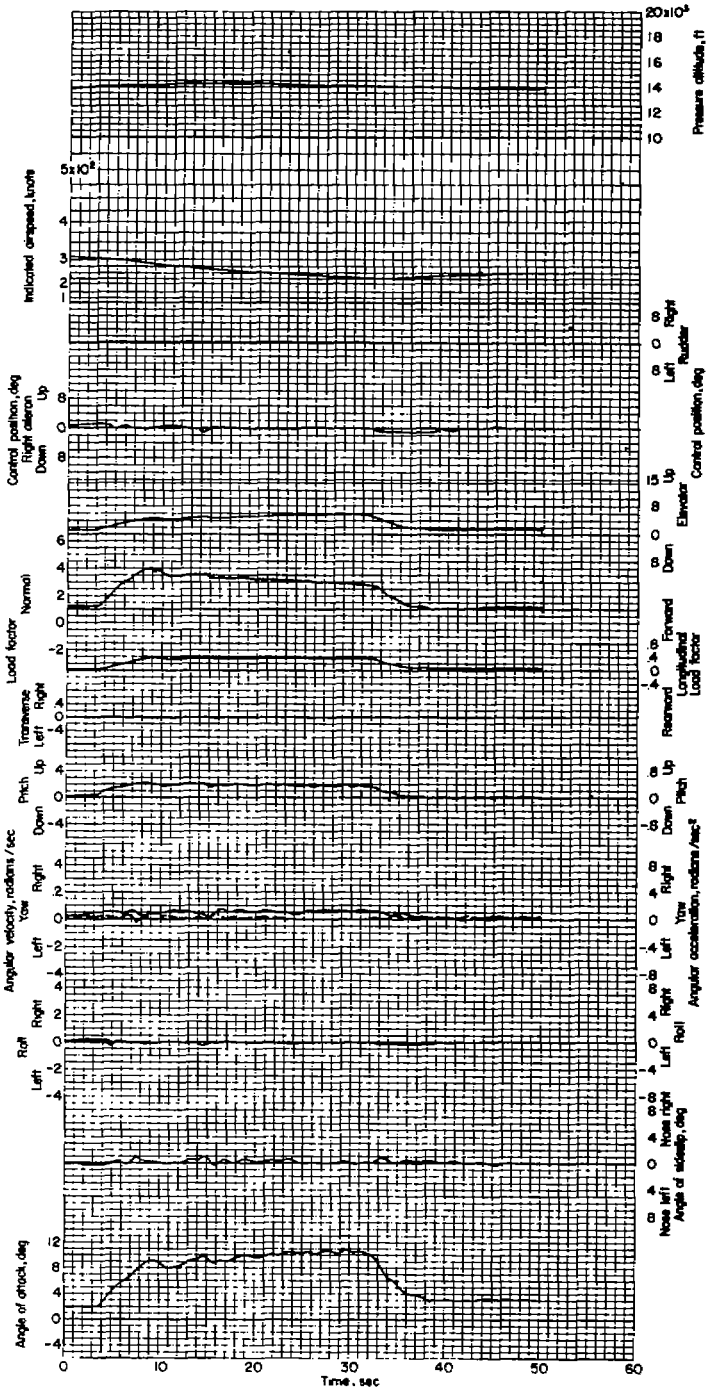

Figure 71.- Right turn. Airplane weight, 15,760 pounds; center of gravity at 24.0 percent M.A.C.; flight 13.

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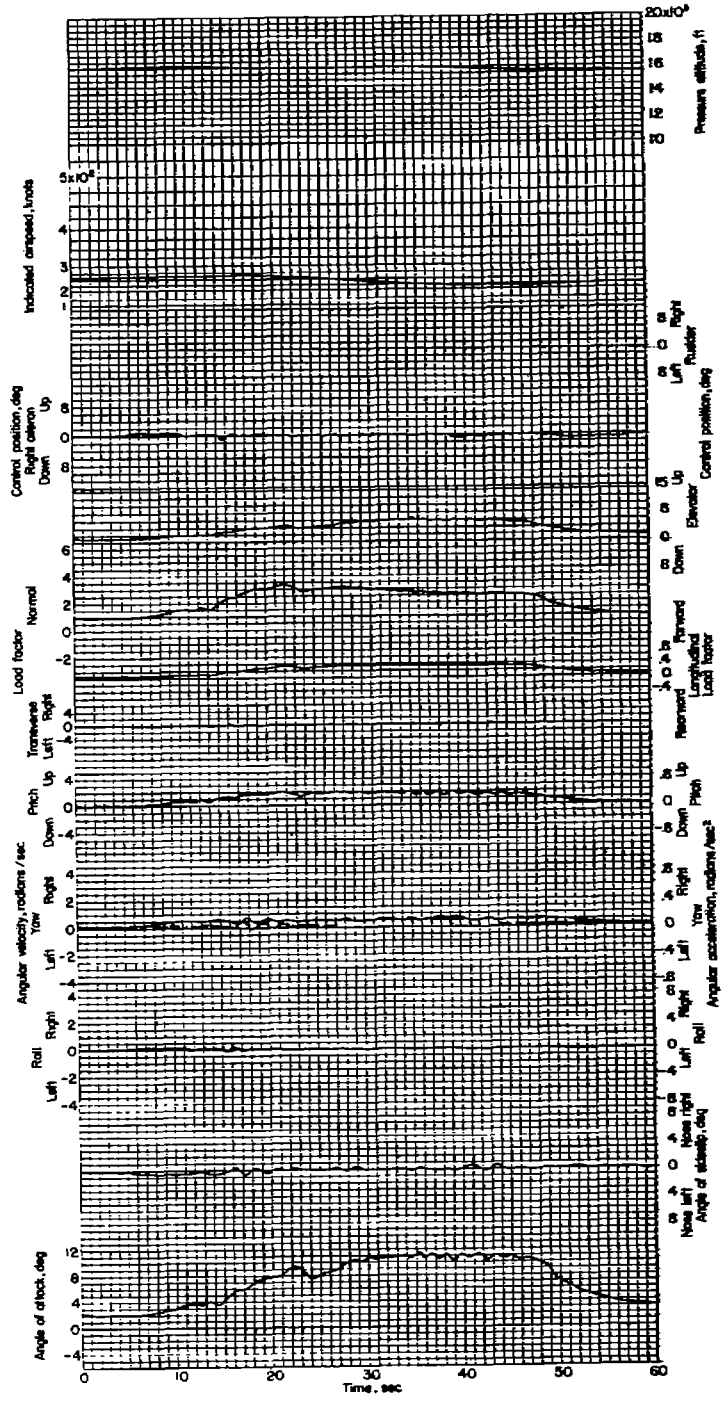

Figure 72.- Right turn. Airplane weight, 15,520 pounds; center of gravity at 23.8 percent M.A.C.; flight 13.

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[redacted]

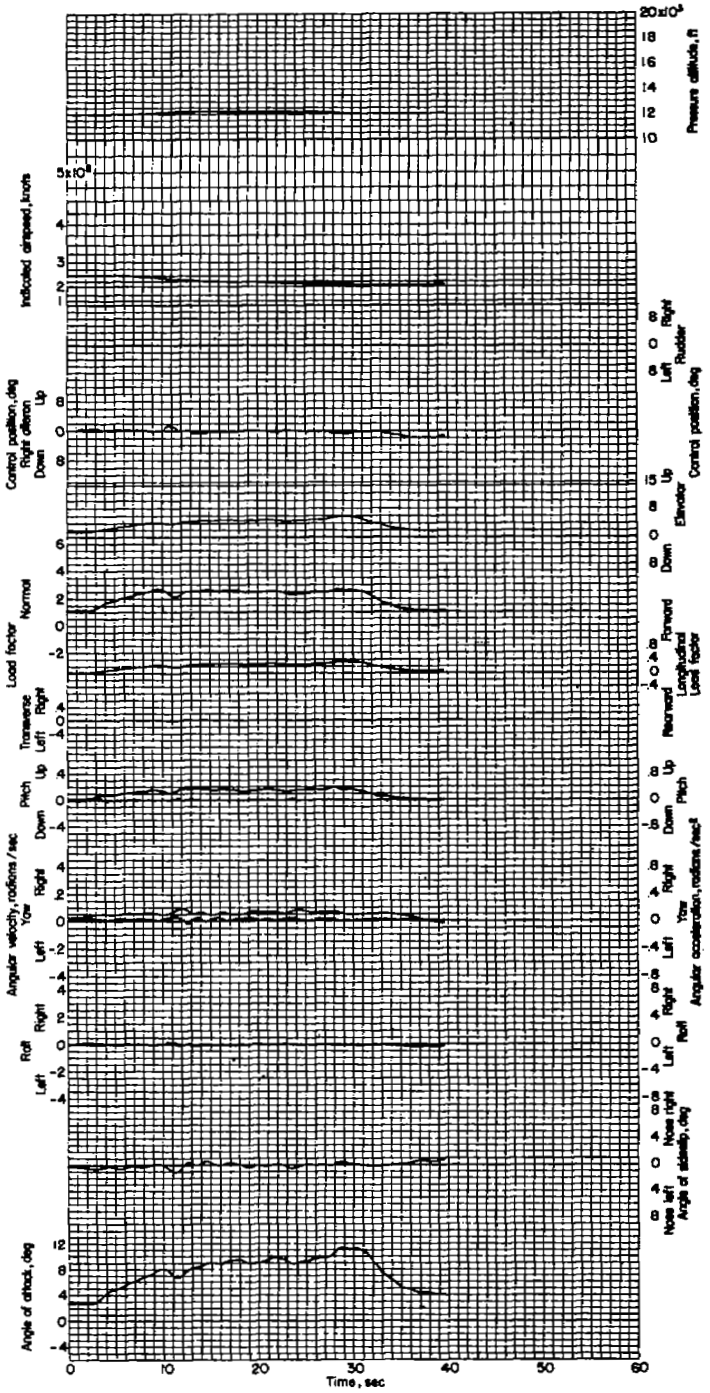
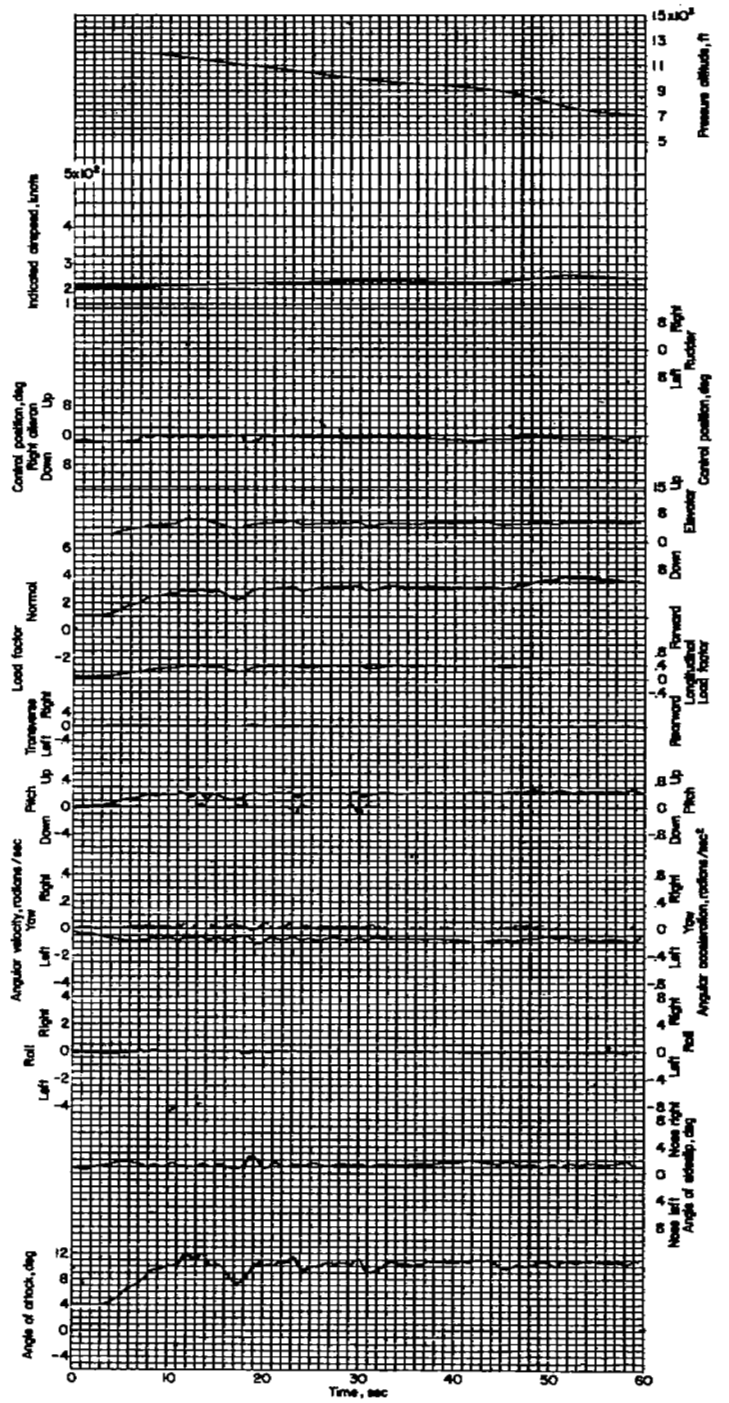


Figure 73.- Right turn. Airplane weight, 15,130 pounds; center of gravity at 24.2 percent M.A.C.; flight 13.

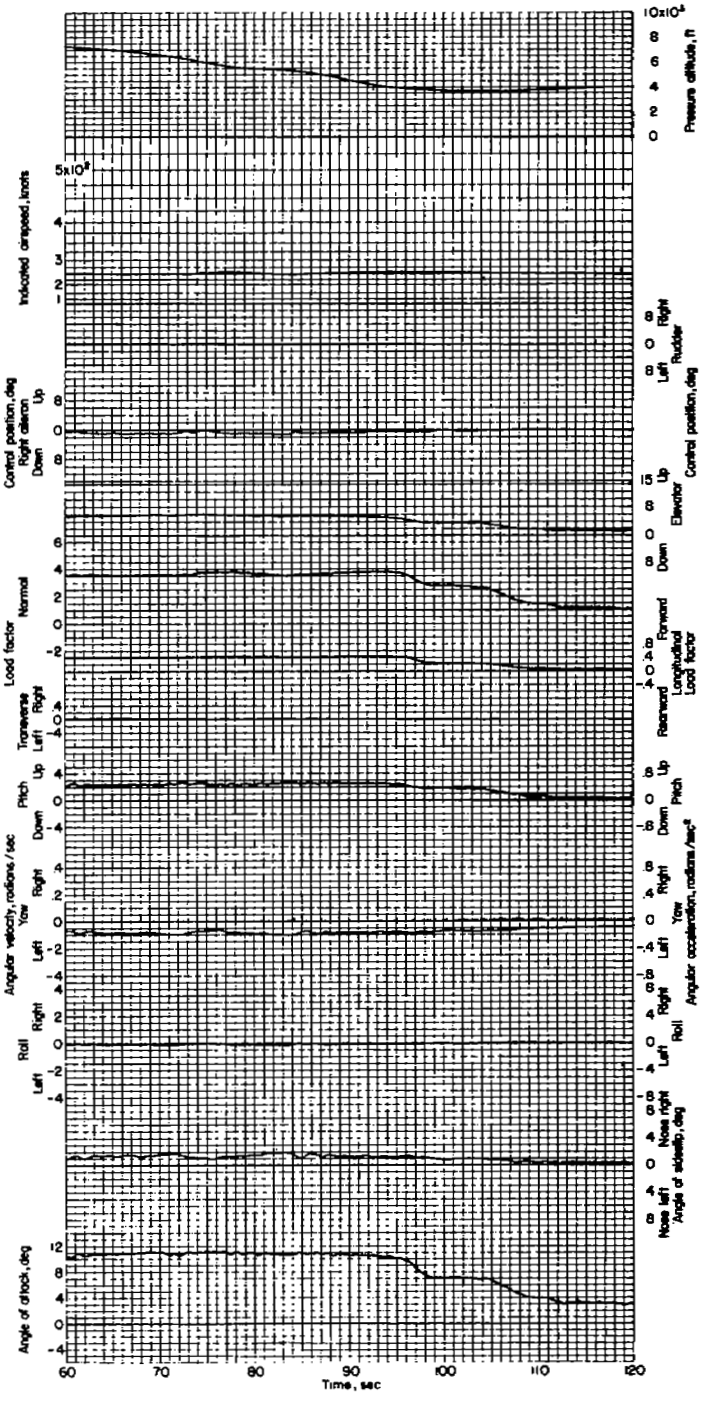


(a)

NACA

Figure 74.- Diving left turn. Airplane weight, 15,070 pounds; center of gravity at 24.2 percent M.A.C.; flight 13.

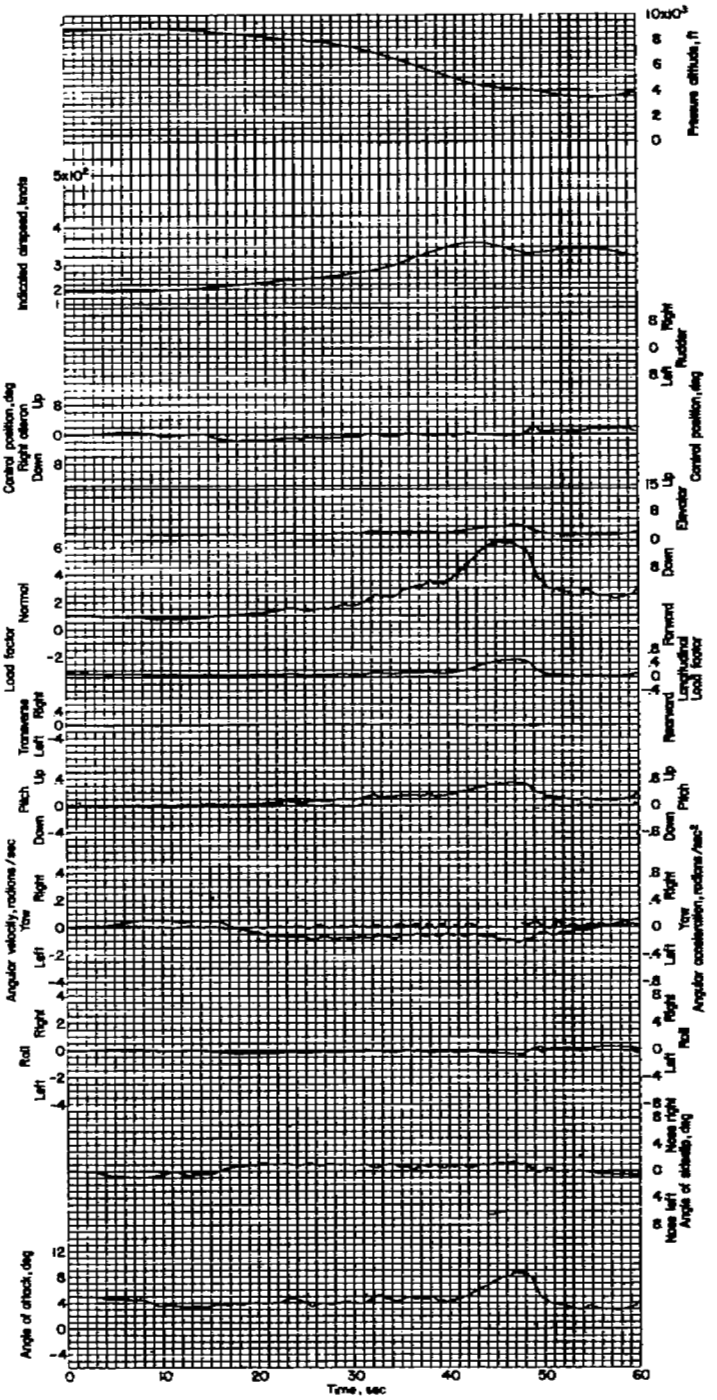
[redacted]



(b)

Figure 74.- Concluded.

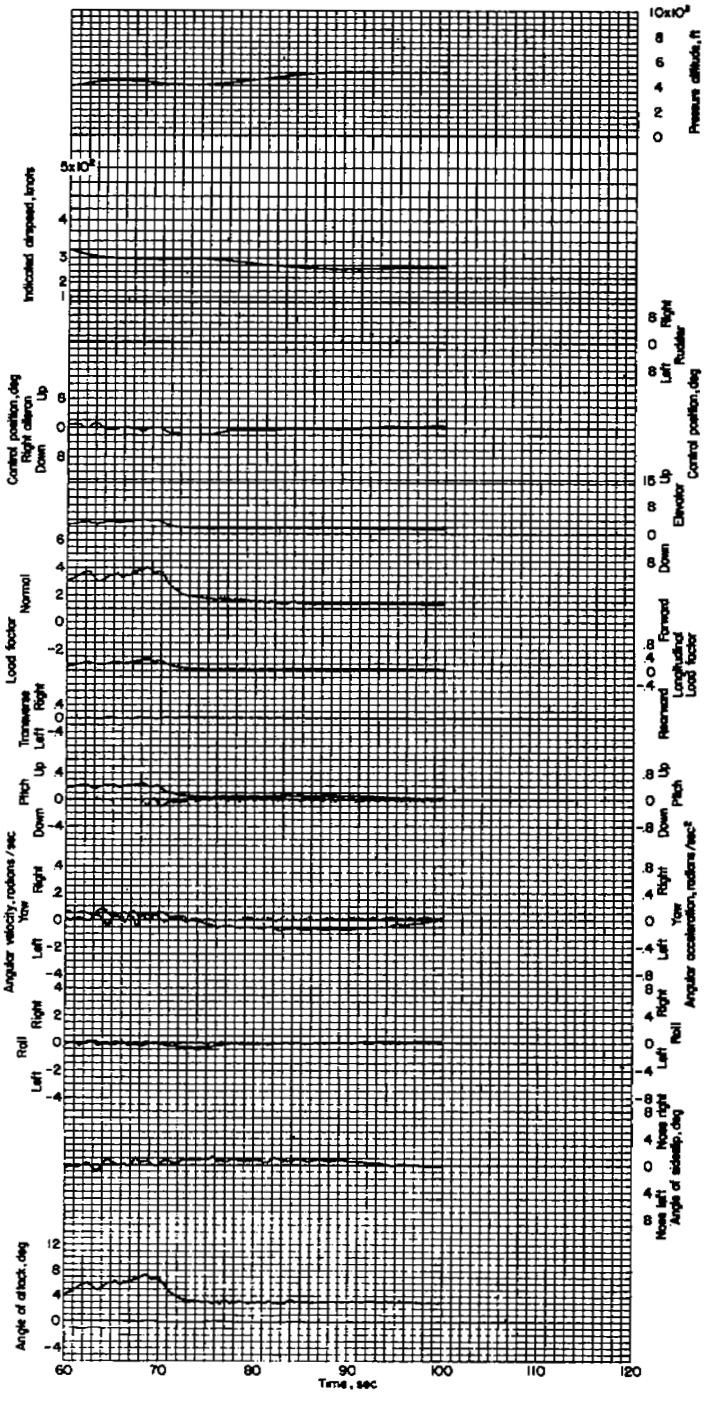
[redacted]



(a)

Figure 75.- Series of turns. Airplane weight, 14,850 pounds; center of gravity at 24.5 percent M.A.C.; flight 13.

[redacted]



(b)

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Figure 75.- Concluded.

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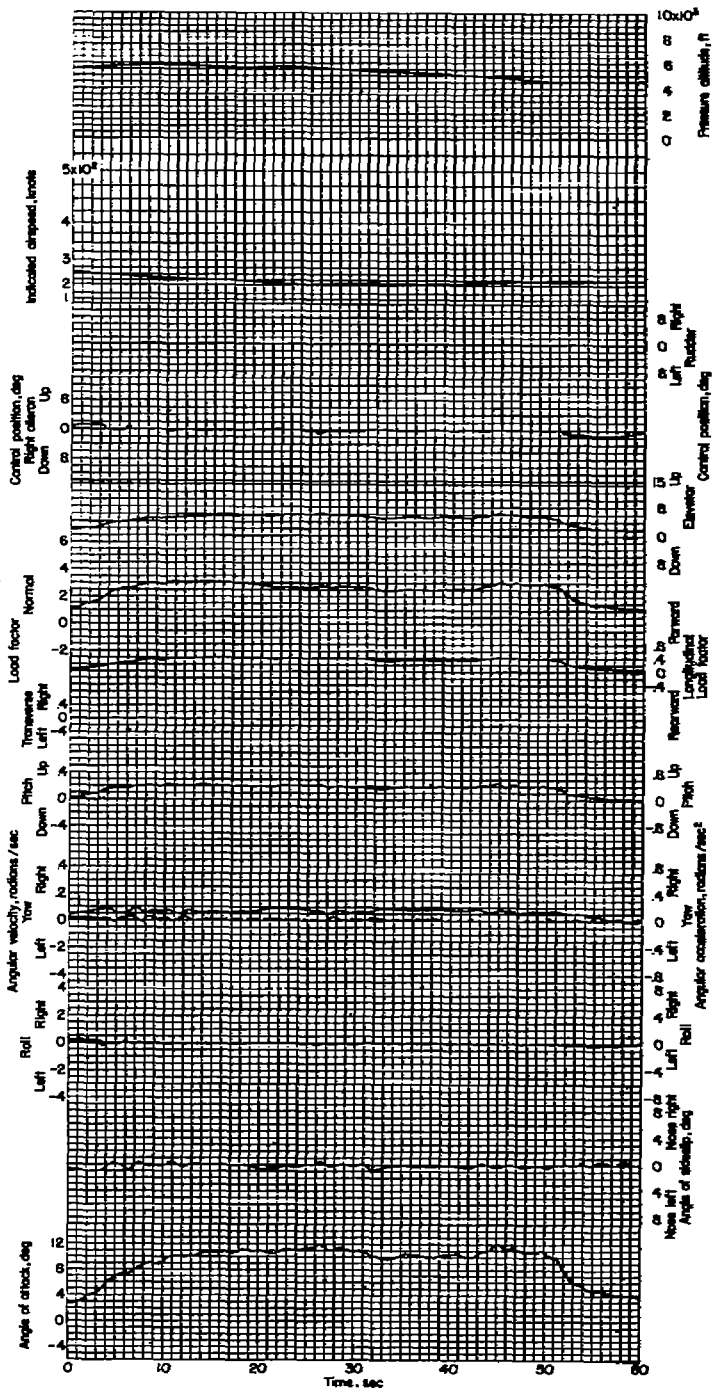


Figure 76.- Right turn. Airplane weight, 14,790 pounds; center of gravity at 24.6 percent M.A.C.; flight 13.

[redacted]

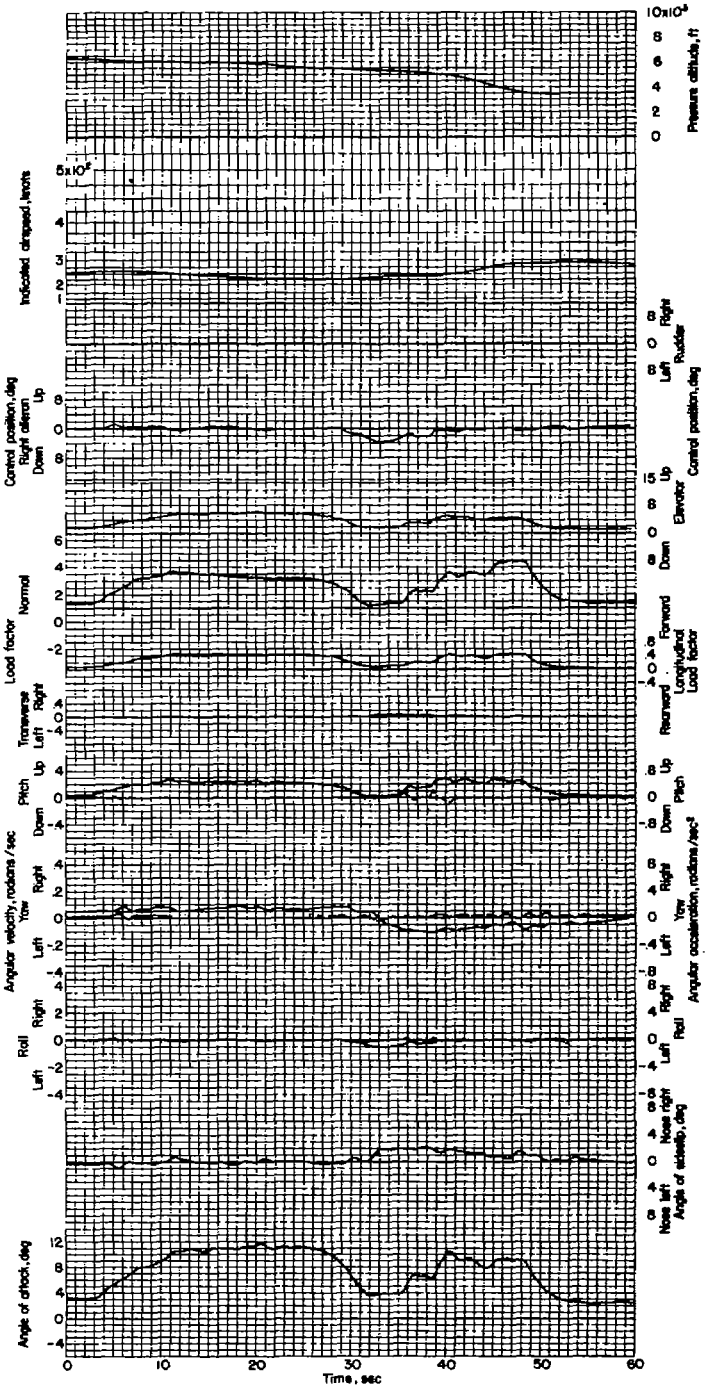


Figure 77.- Right and left turn. Airplane weight, 14,670 pounds; center of gravity at 24.8 percent M.A.C.; flight 13.

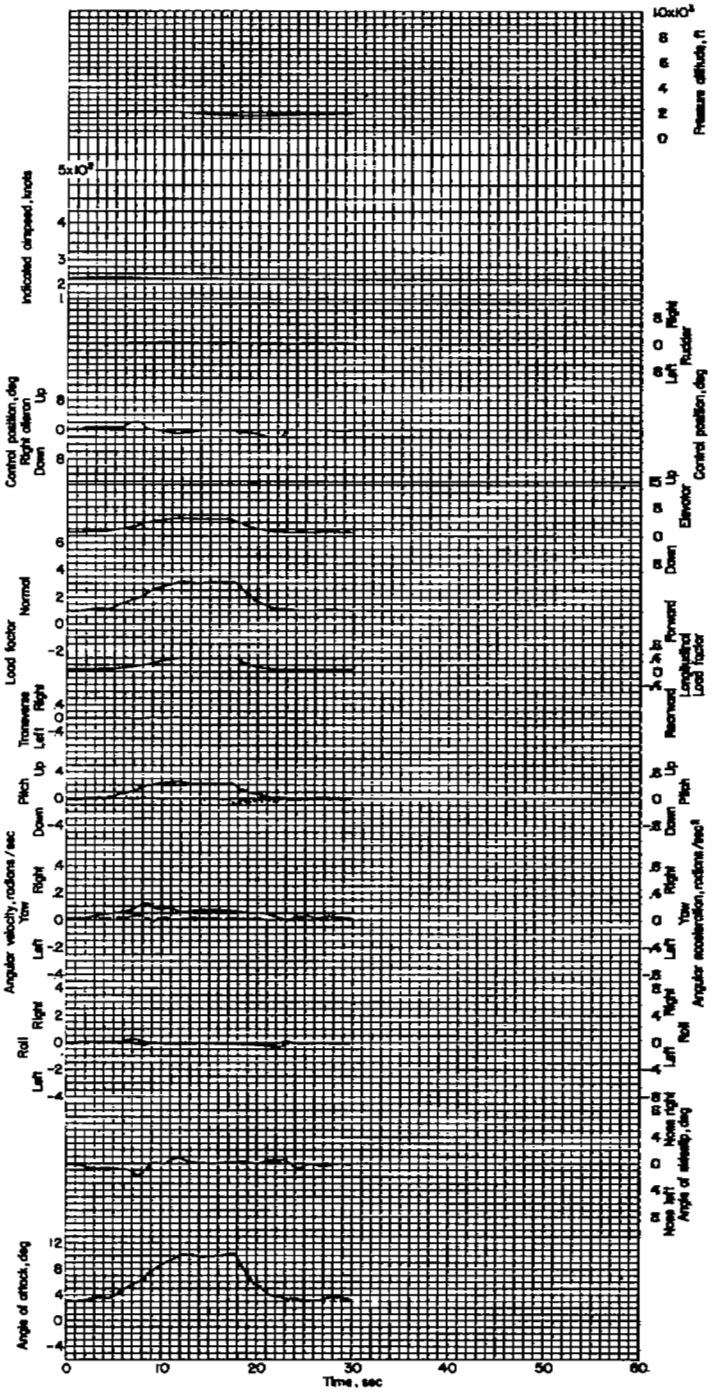


Figure 78.- Right turn. Airplane weight, 14,260 pounds; center of gravity at 25.4 percent M.A.C.; flight 13.

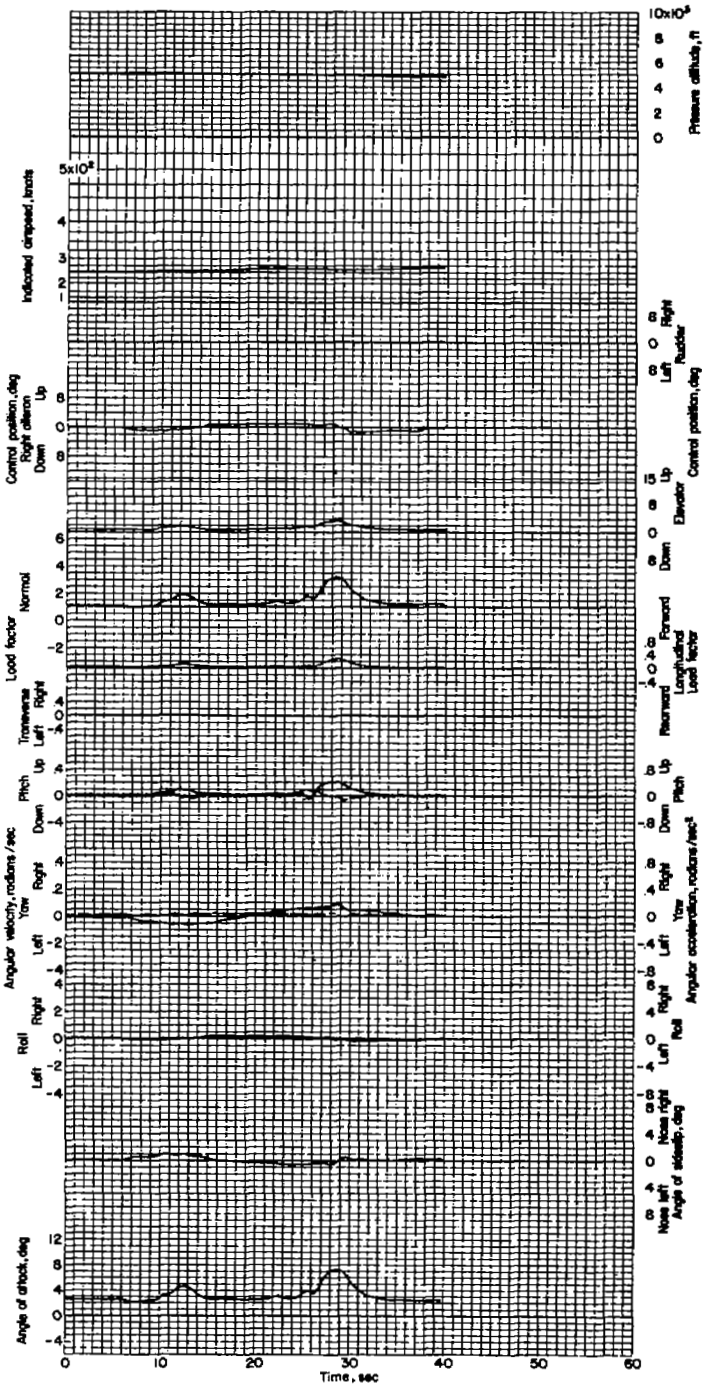
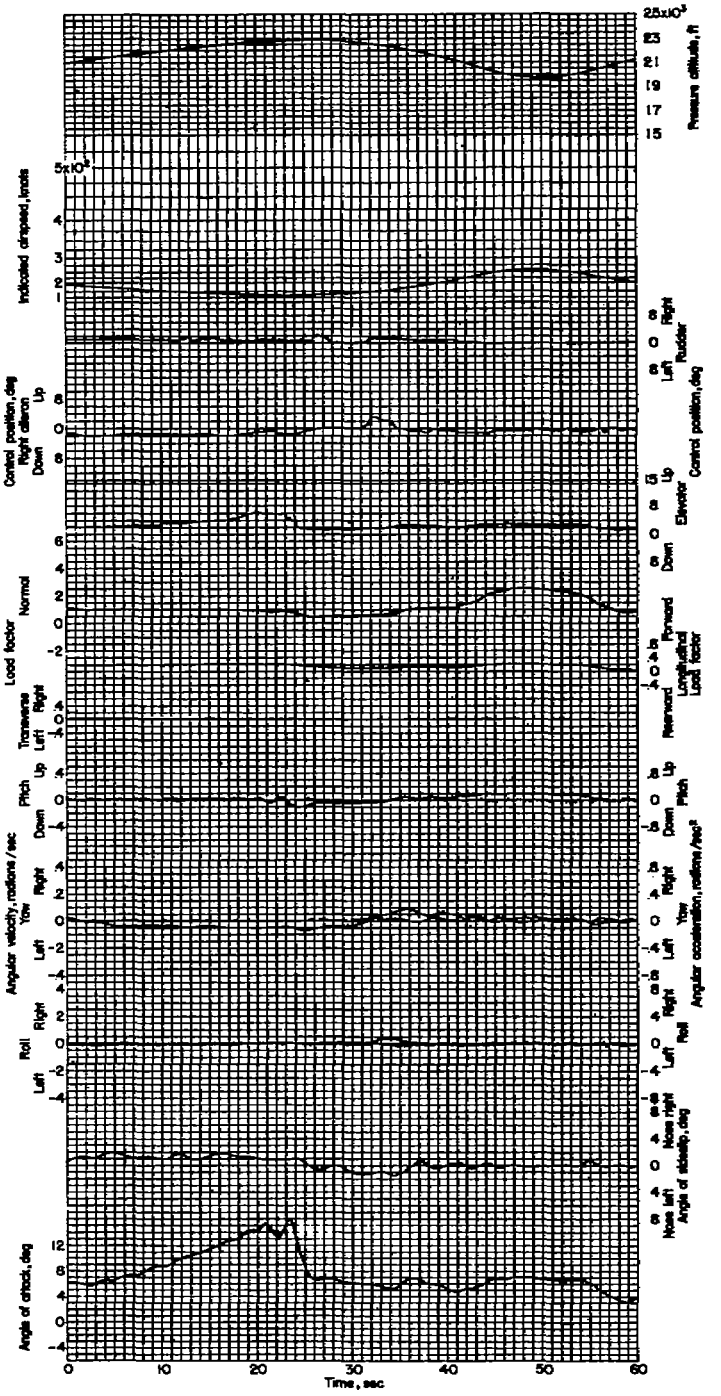


Figure 79.- Left and right turn. Airplane weight, 14,070 pounds; center of gravity at 25.6 percent M.A.C.; flight 13.

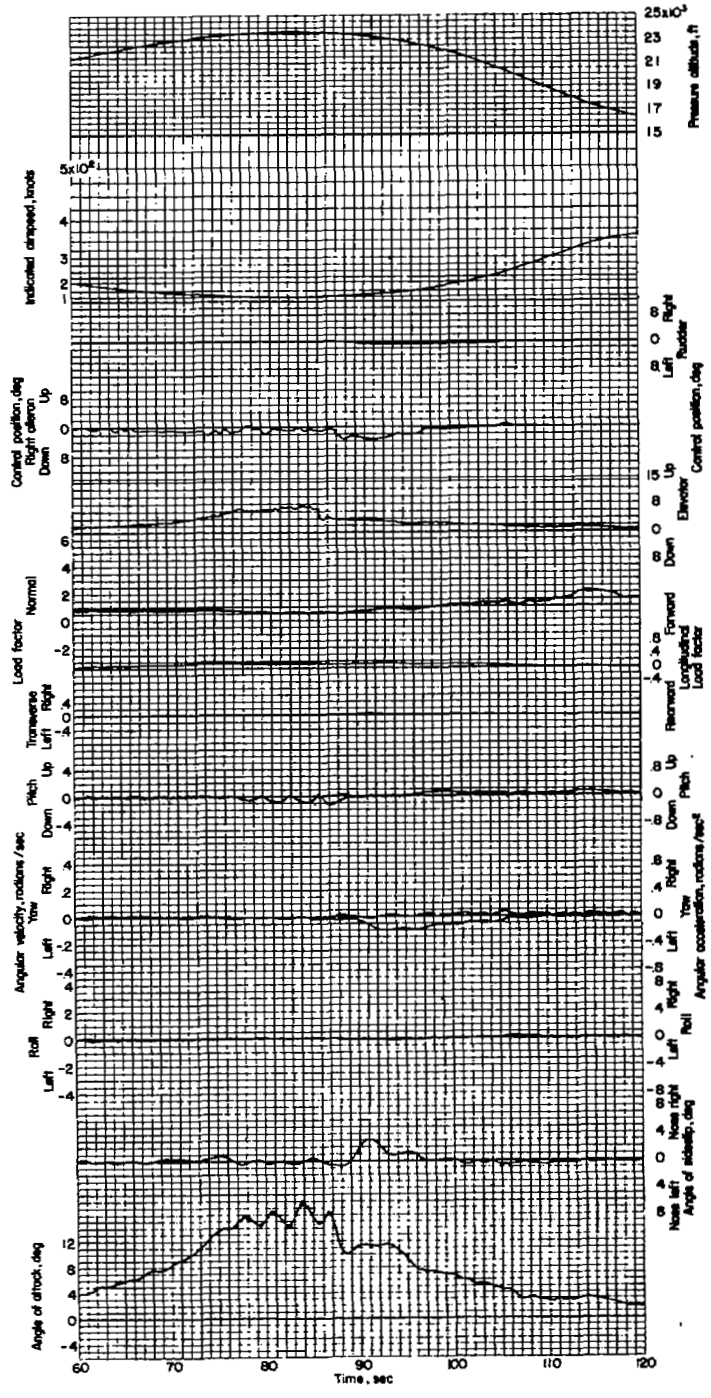
[redacted]



(a)

Figure 80.- Climbing and diving turns. Airplane weight, 16,400 pounds; center of gravity at 24.4 percent M.A.C.; flight 14.

[redacted]



(b)

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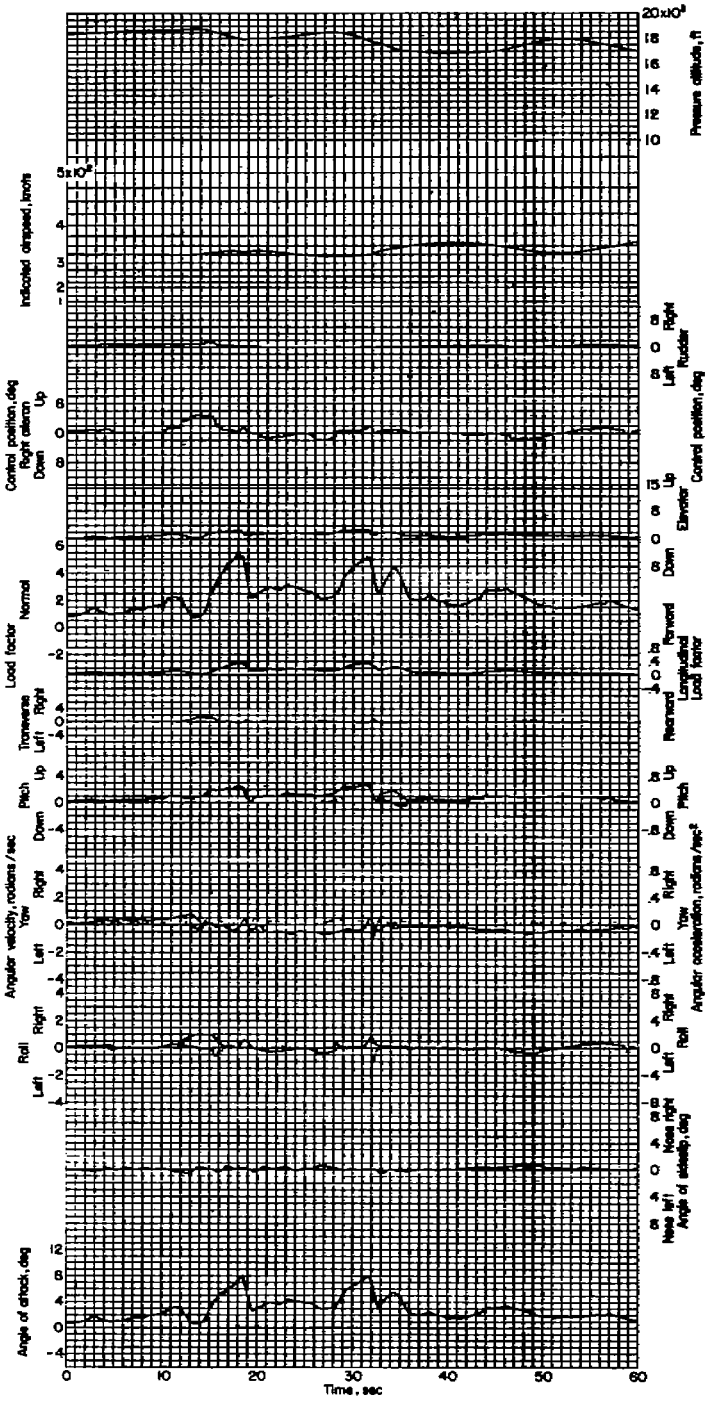

Figure 81.- Three-quarter right roll followed by left turns. Airplane weight, 15,670 pounds; center of gravity at 23.9 percent M.A.C.; flight 14.

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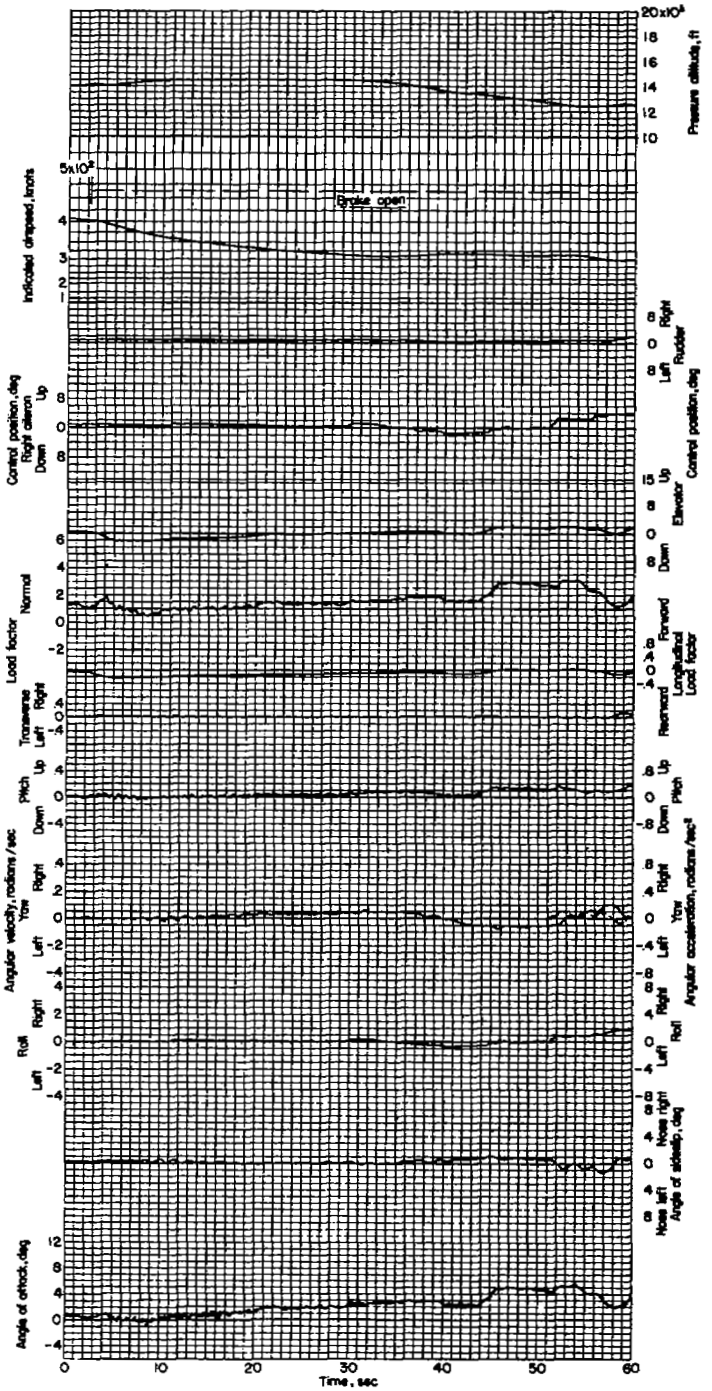
[redacted]

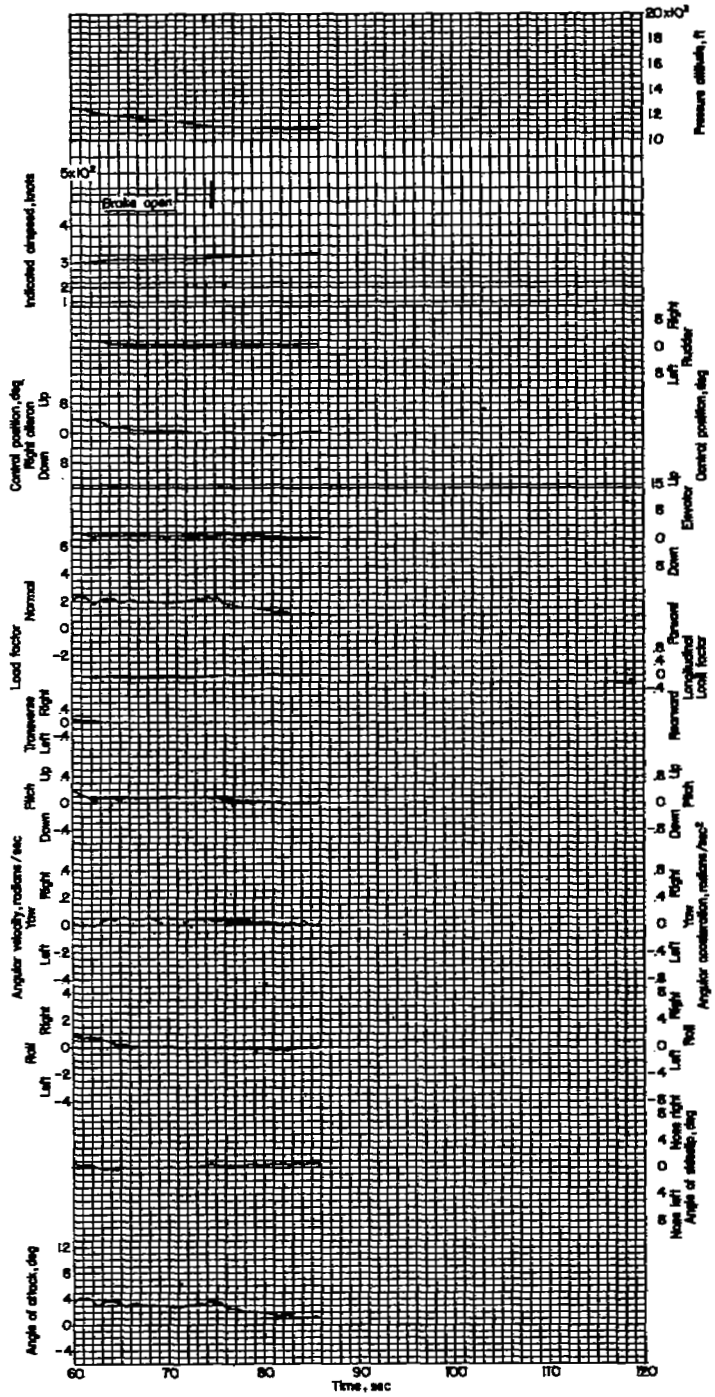


(a)

NACA

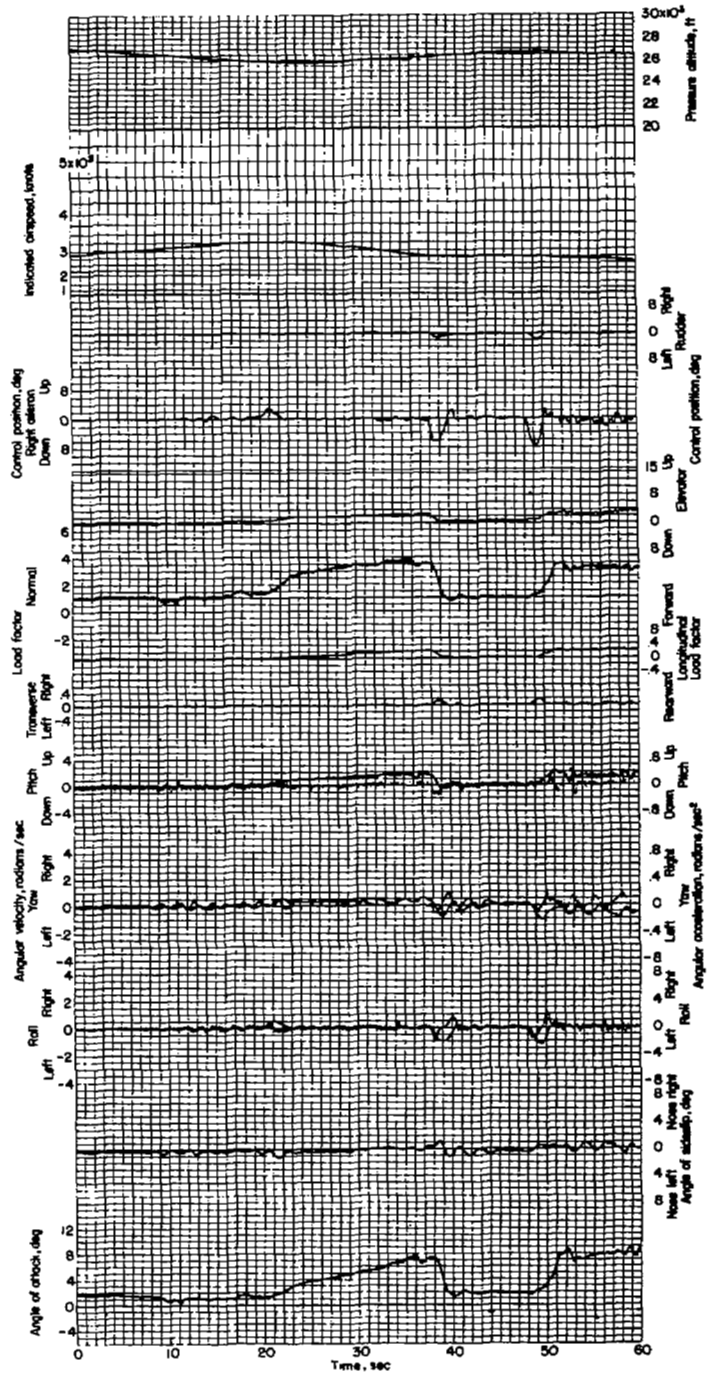
Figure 82.- Right and left turn followed by right barrel roll and right turn. Airplane weight, 15,510 pounds; center of gravity at 23.8 percent M.A.C.; flight 14.

C[redacted]



(b)

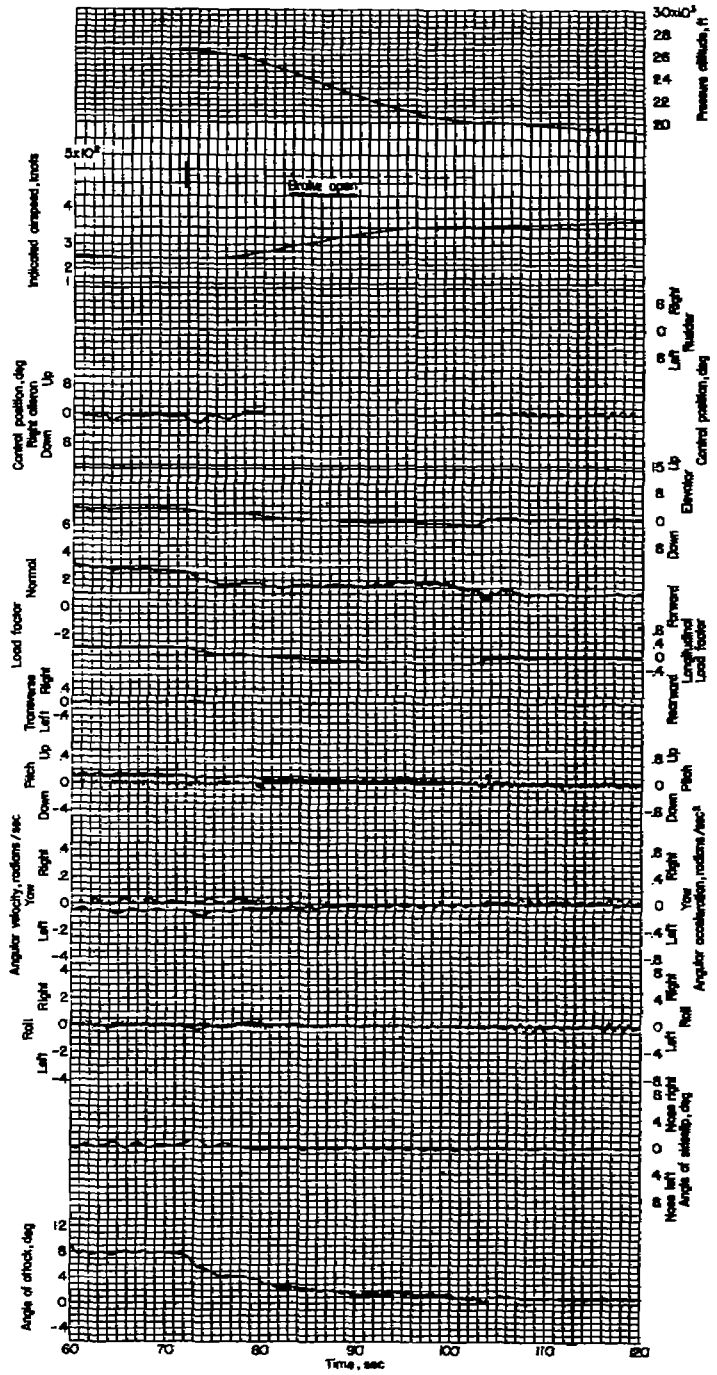
Figure 82.- Concluded.



(a)

Figure 83.- Right and left turn followed by dive. Airplane weight, 15,920 pounds; center of gravity at 24.1 percent M.A.C.; flight 15.

[redacted]



(b)

Figure 83.- Concluded.

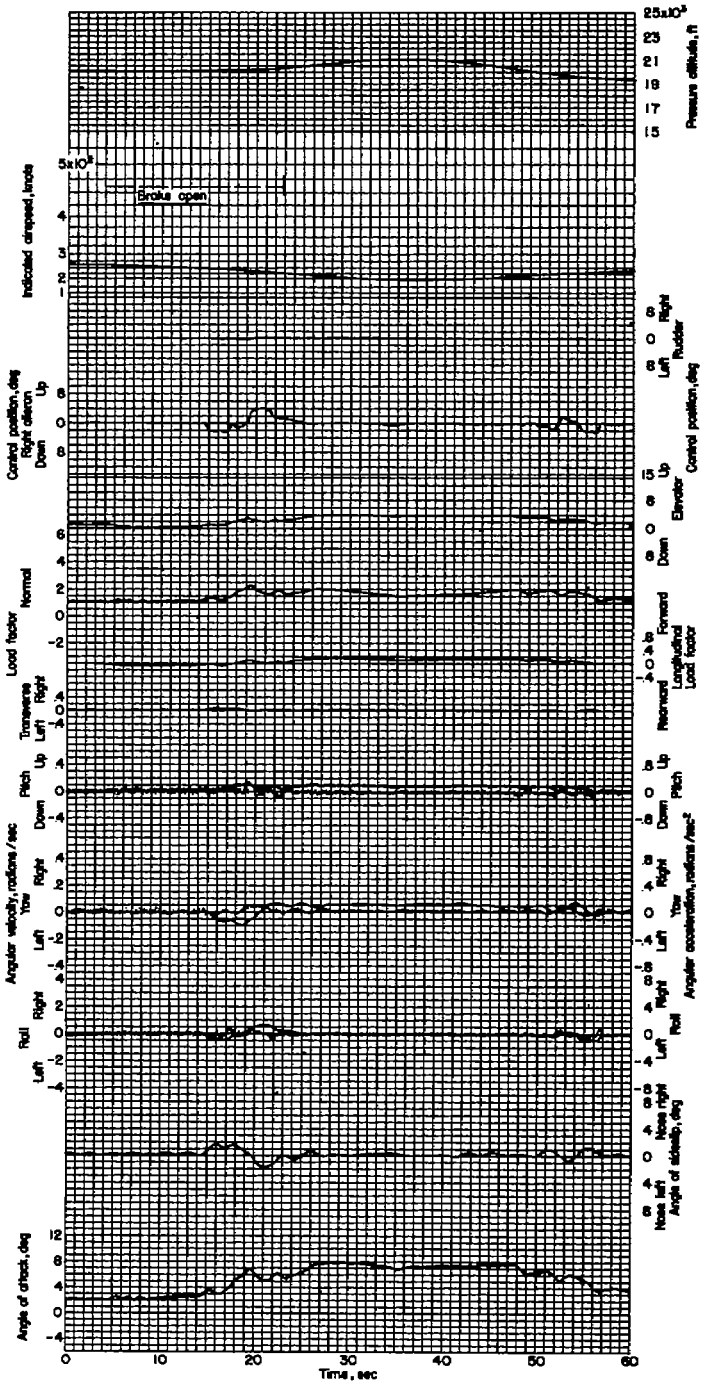
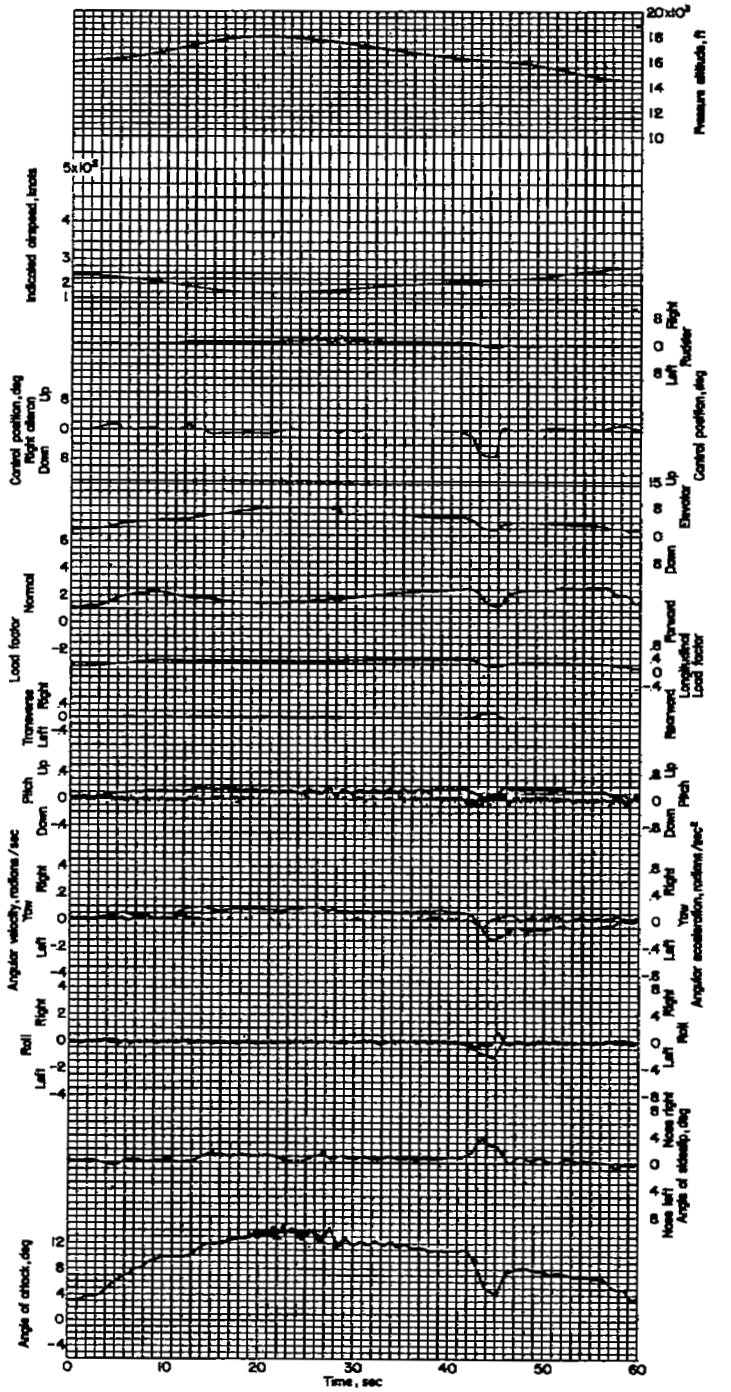


Figure 84.- Right turn. Airplane weight, 15,430 pounds; center of gravity at 23.8 percent M.A.C.; flight 15.

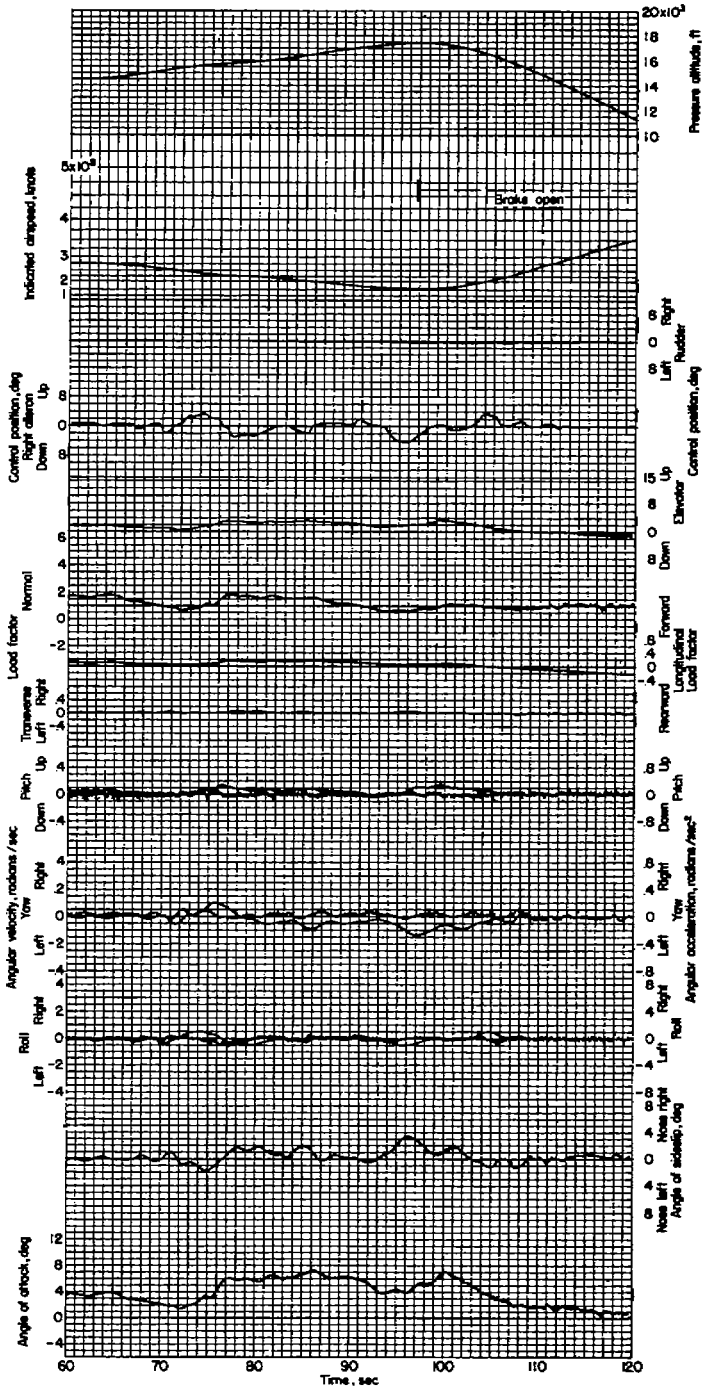


(a)

NACA

Figure 85.- Series of turns into dive. Airplane weight, 15,170 pounds; center of gravity at 24.1 percent M.A.C.; flight 15.

[redacted]



(b)

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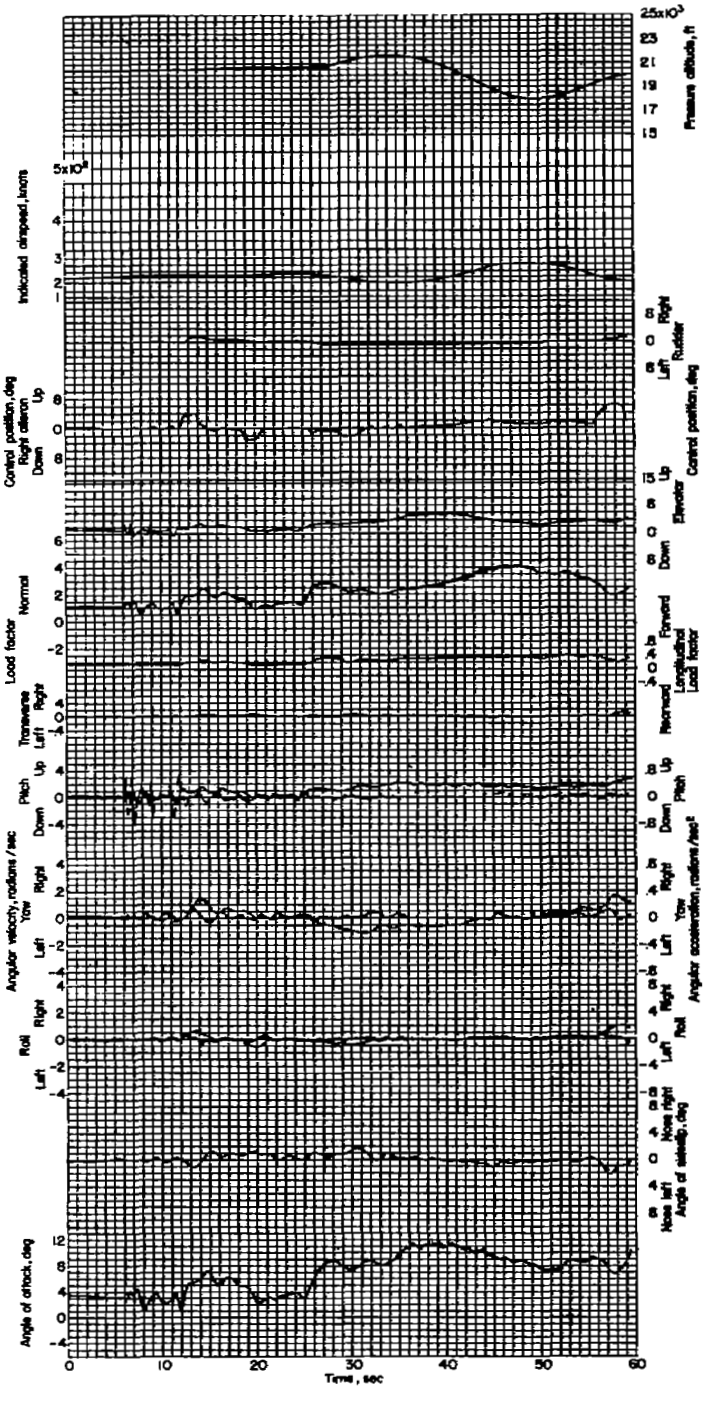
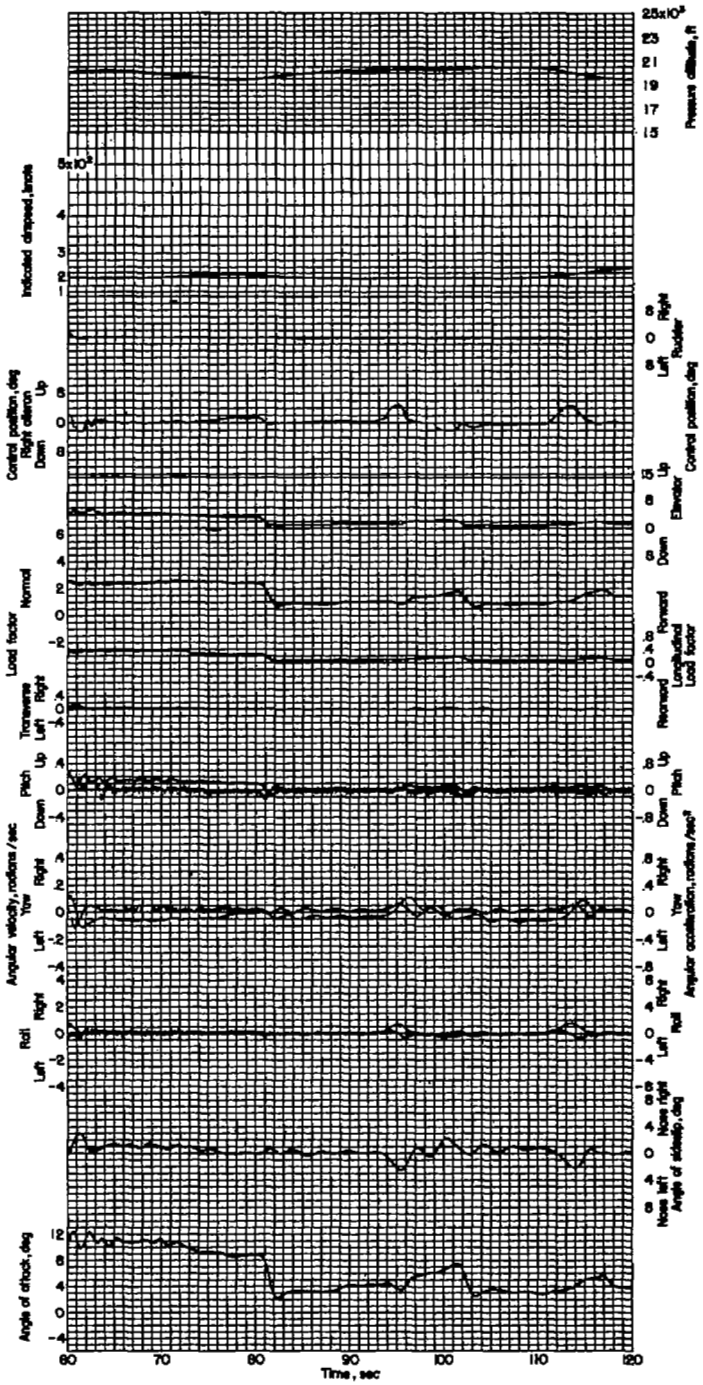


(a)

Figure 86.- Right and left turn followed by three-quarter right roll into left turns. Airplane weight, 14,580 pounds; center of gravity at 24.9 percent M.A.C.; flight 15.

[redacted]



(b)

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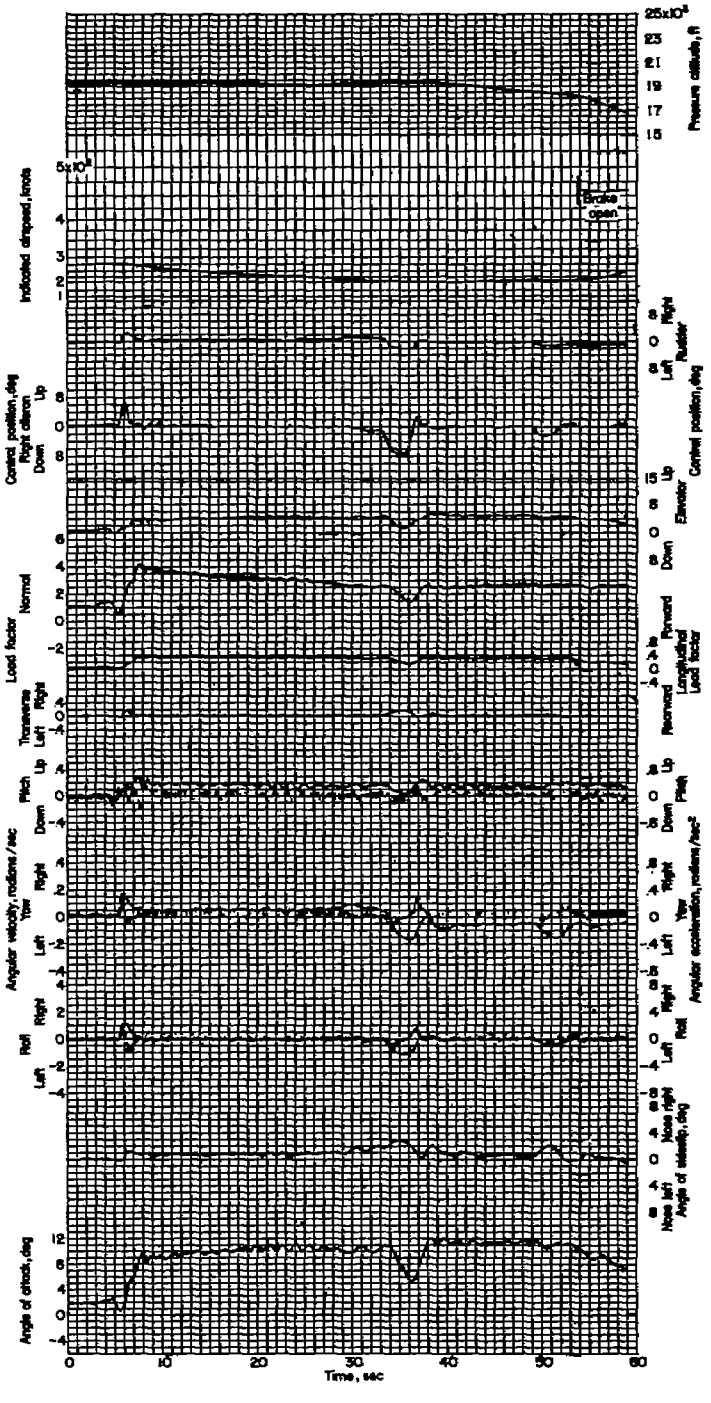
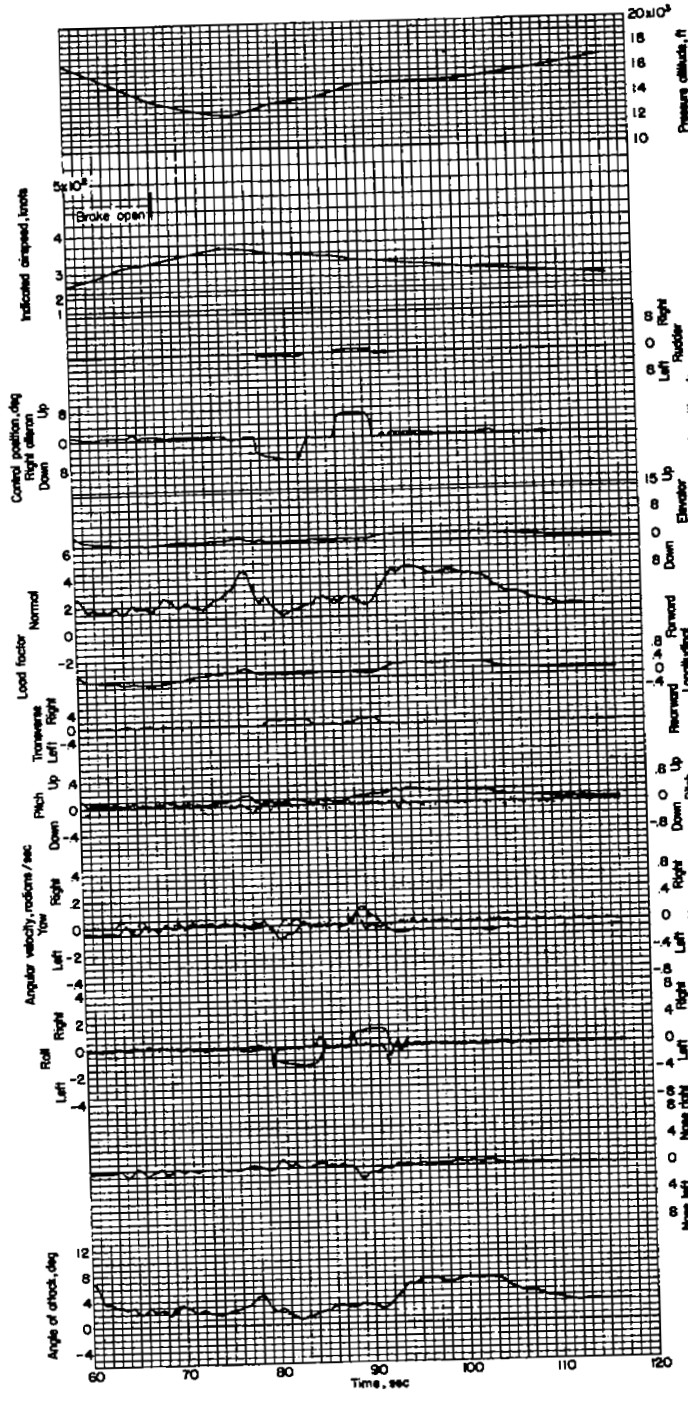


(a)

Figure 87.- Right and left stall turn into dive and pull-up followed by left and right barrel roll and left turn. Airplane weight, 14,460 pounds; center of gravity at 25.1 percent M.A.C.; flight 15.

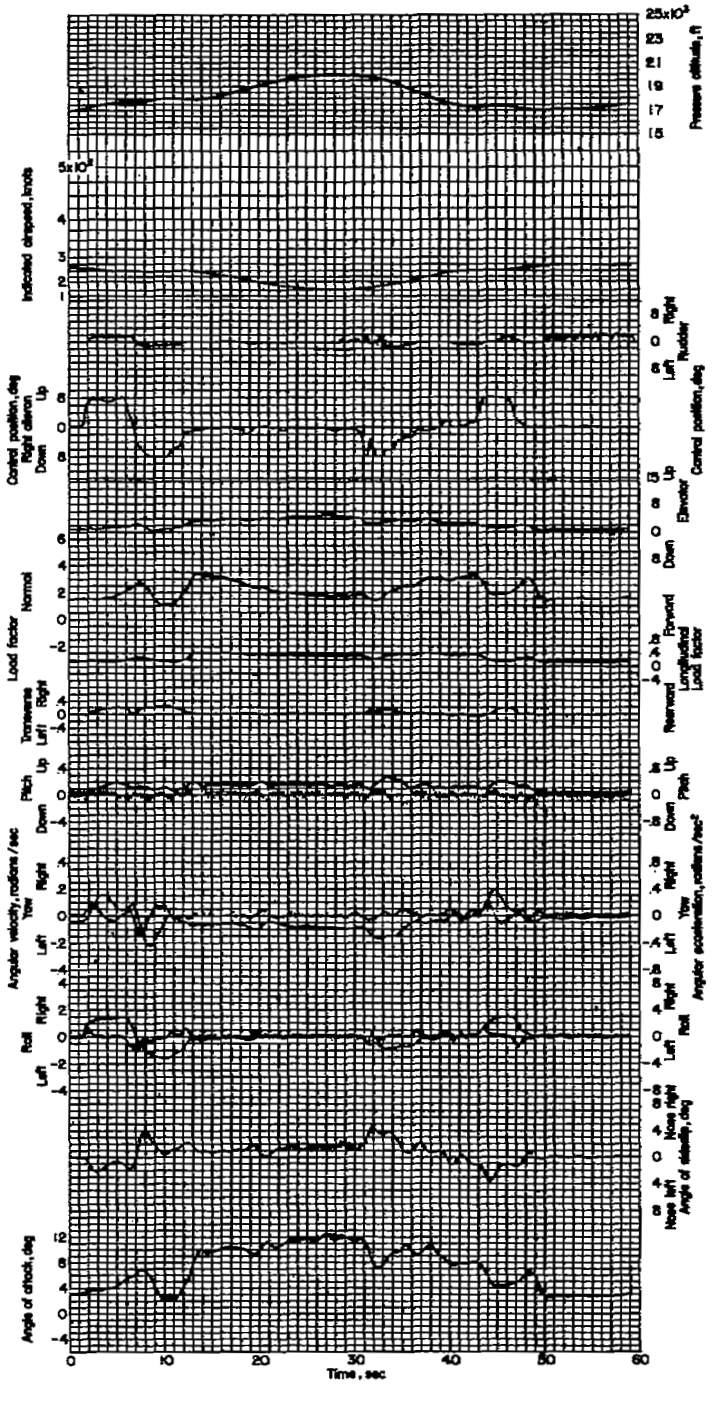
[redacted]



(b)

Figure 87.- Concluded.

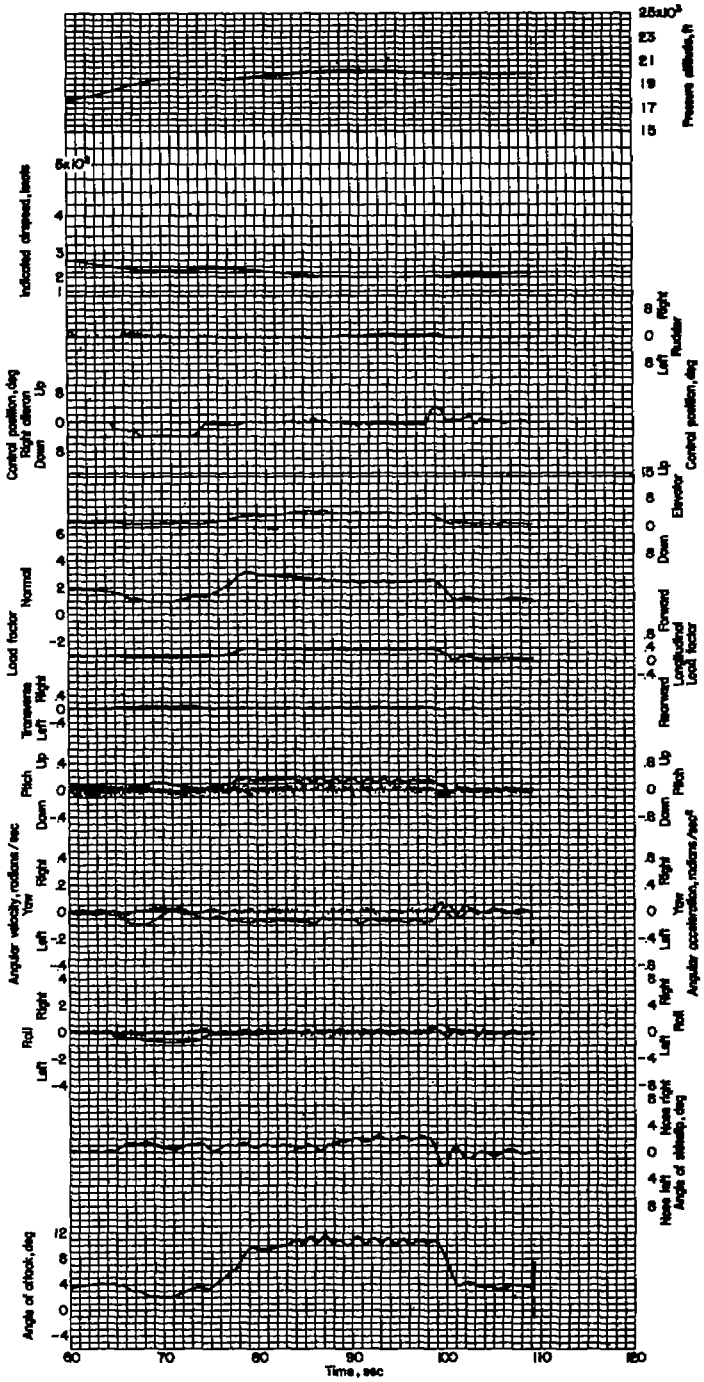
[redacted]



(a)

Figure 88.- Right and left barrel roll into stall left turn with three-quarter left-roll recovery followed by right barrel roll and left aileron roll into stall left turn. Airplane weight, 14,370 pounds; center of gravity at 25.2 percent M.A.C.; flight 15.

[redacted]

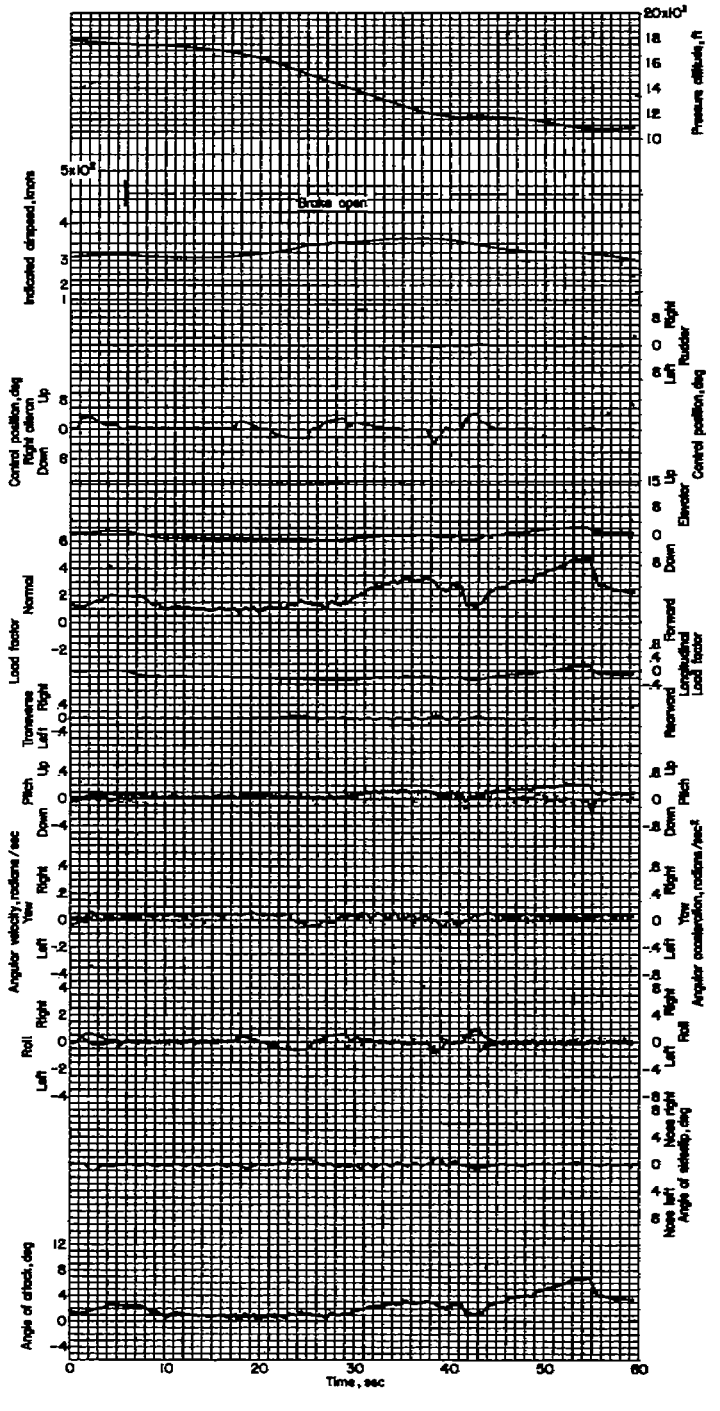


(b)

NACA

Figure 88.- Concluded.

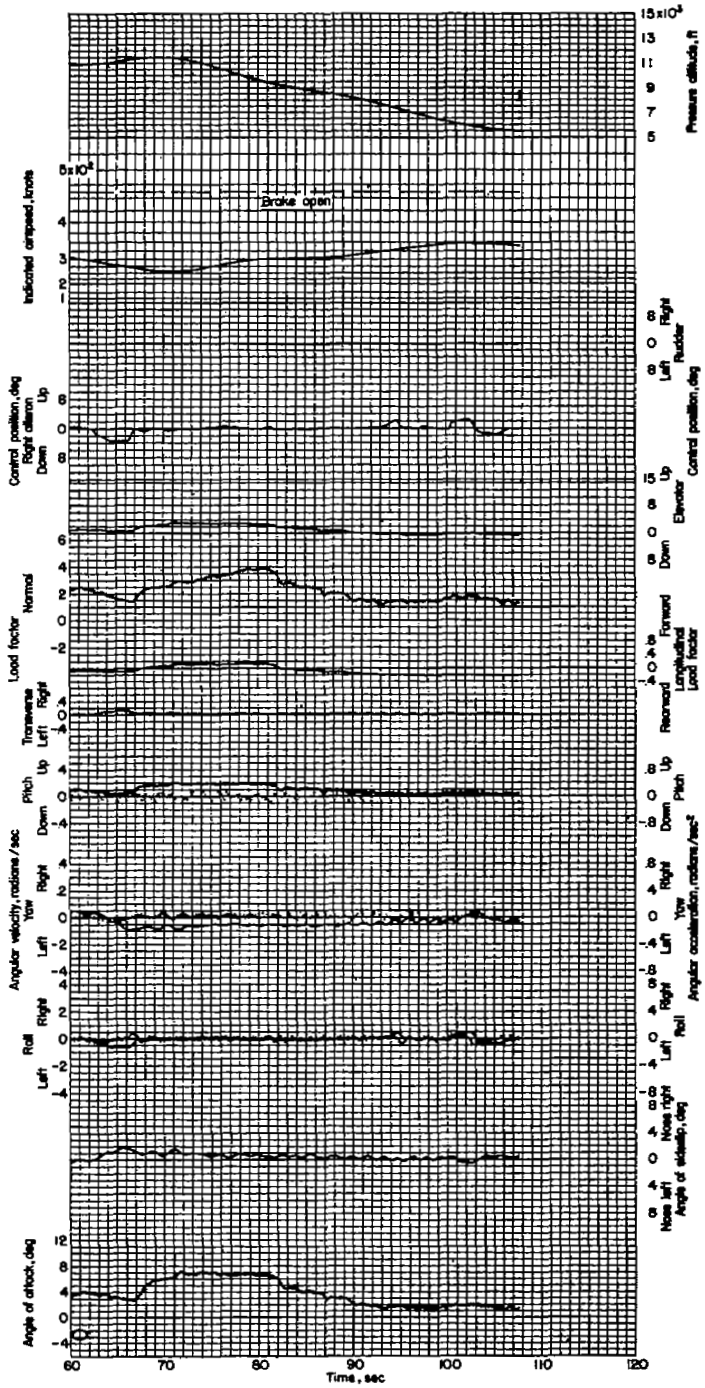
[redacted]



(a)

Figure 89.- Series of diving turns. Airplane weight, 14,230 pounds; center of gravity at 25.4 percent M.A.C.; flight 15.

[redacted]



(b)

Figure 89.- Concluded.

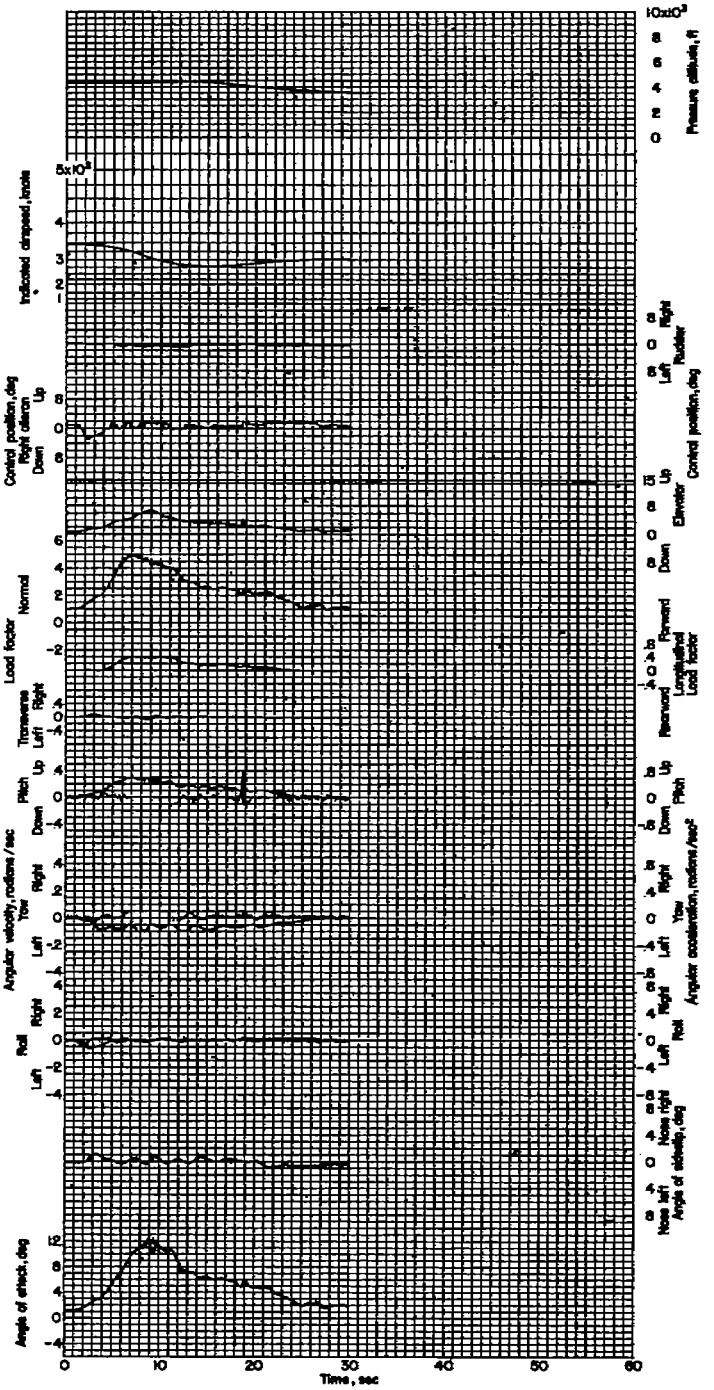
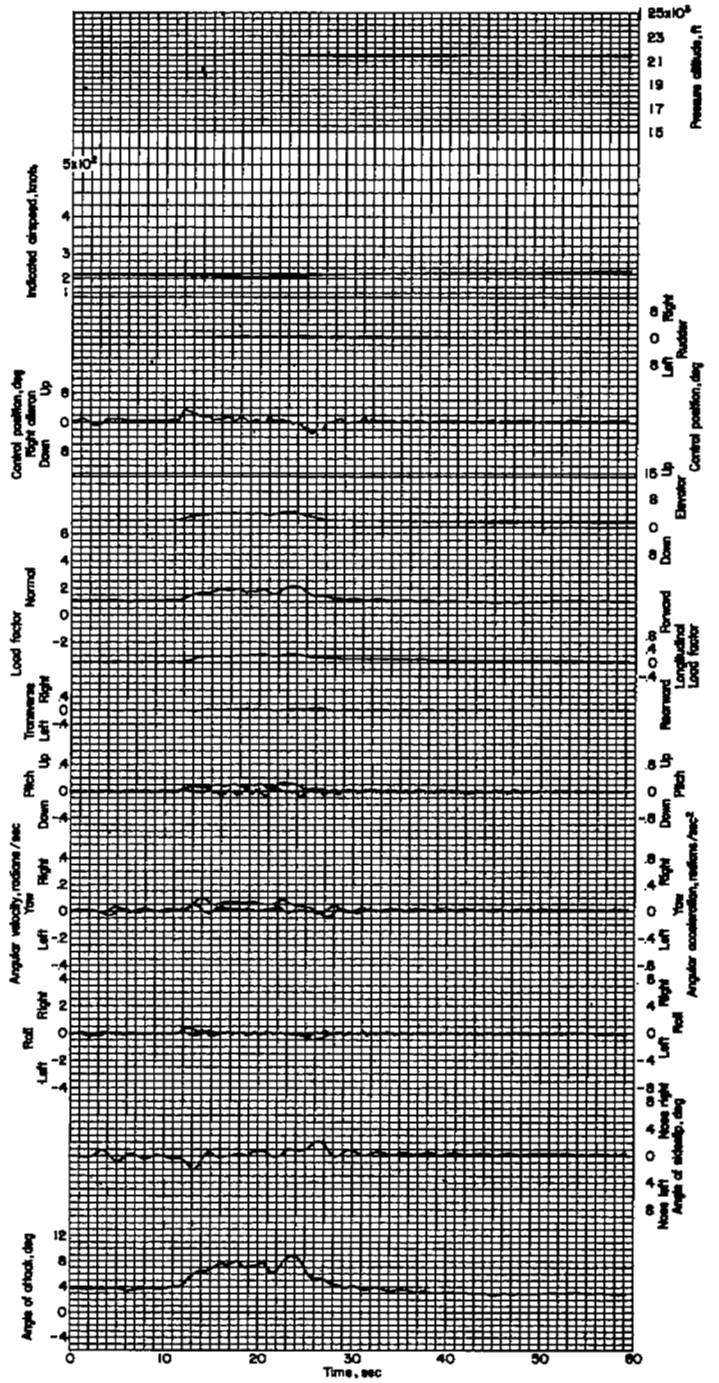


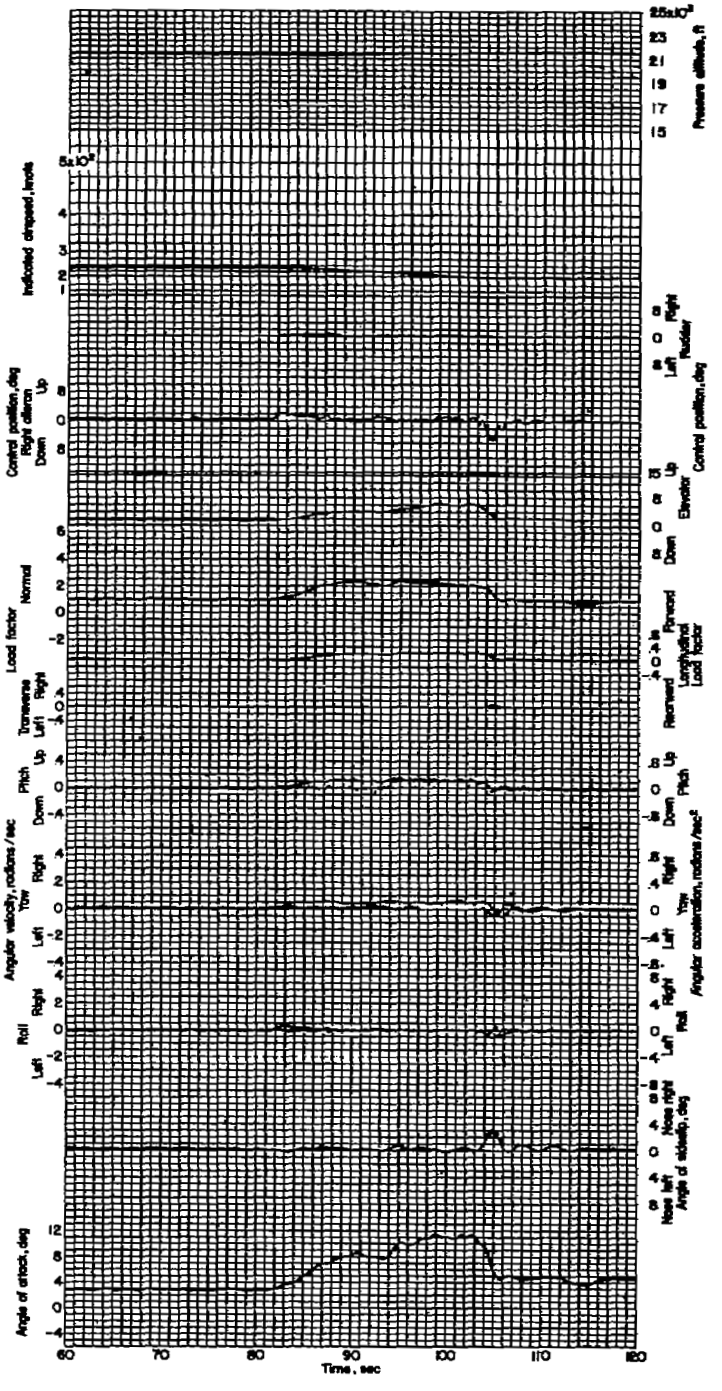
Figure 90.- Left turn. Airplane weight, 16,590 pounds; center of gravity at 24.5 percent M.A.C.; flight 16.

[redacted]



(a)

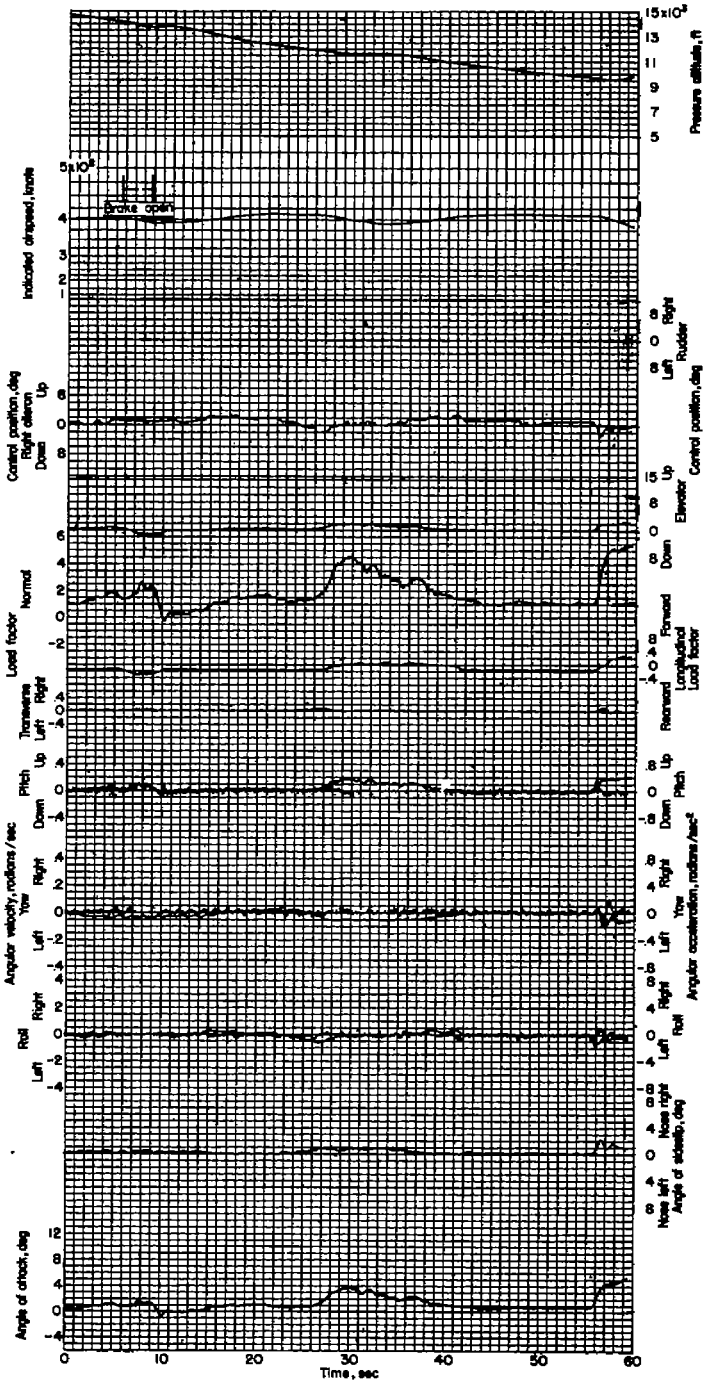
Figure 91.- Two right turns. Airplane weight, 15,360 pounds; center of gravity at 23.9 percent M.A.C.; flight 16.



(b)

Figure 91.- Concluded.

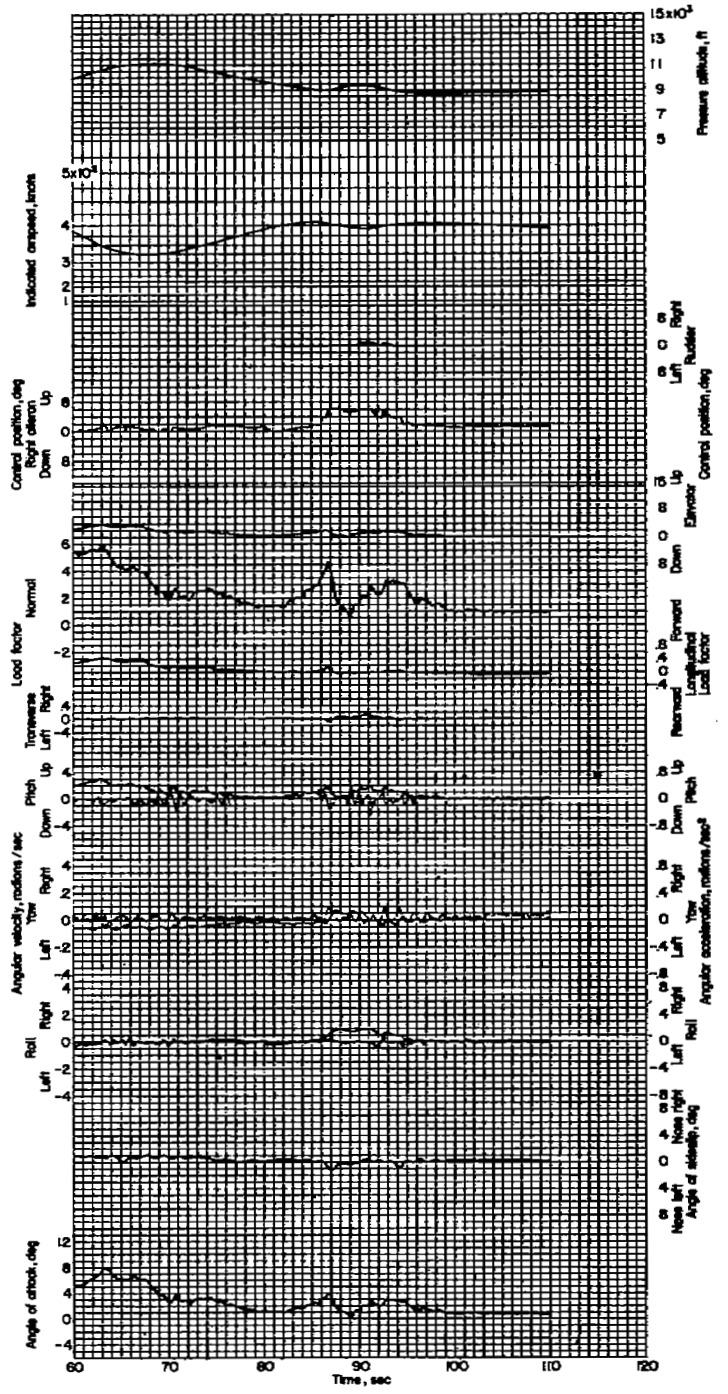
[redacted]



(a)

Figure 92.- Series of turns in shallow dive followed by pull-up into left turn and right barrel roll. Airplane weight, 15,130 pounds; center of gravity at 24.2 percent M.A.C.; flight 16.

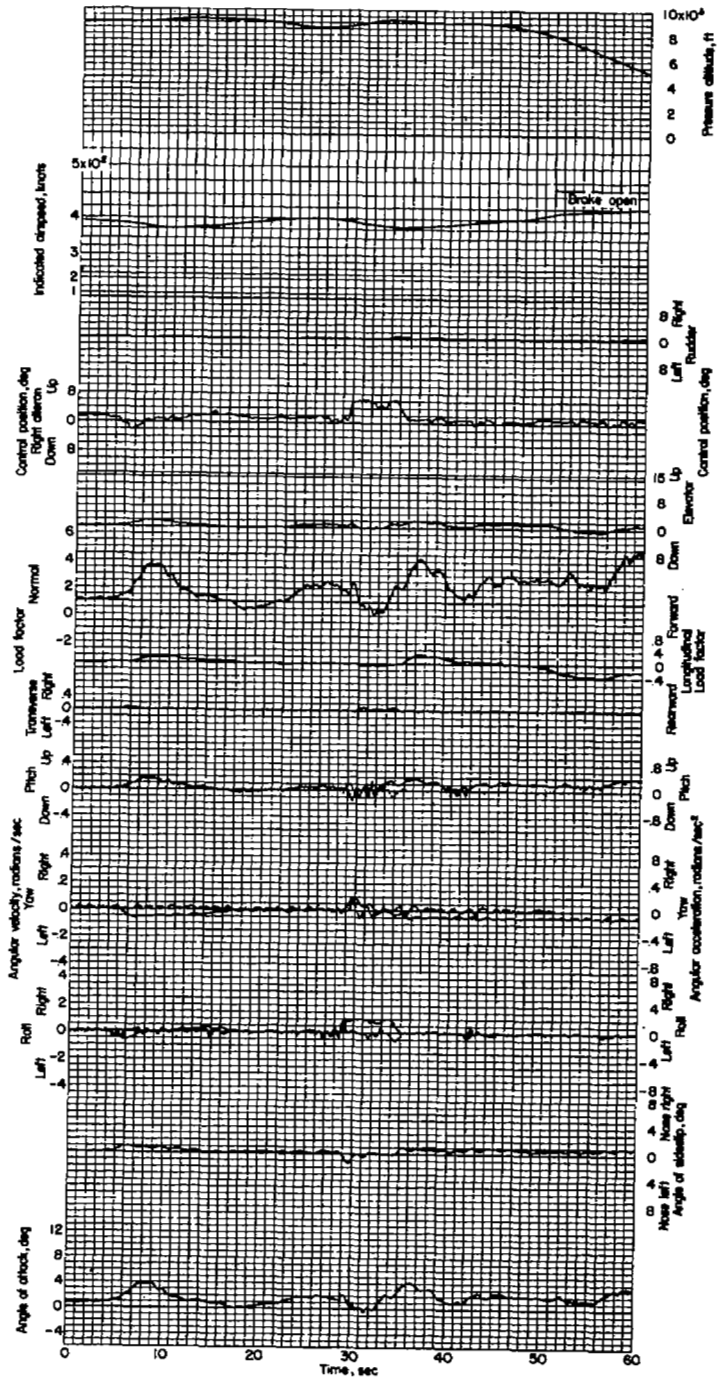
[redacted]



(b)

Figure 92.- Concluded.

[redacted]



(a)

Figure 93.- Left turn followed by three-quarter right roll into diving left turn. Airplane weight, 15,040 pounds; center of gravity at 24.3 percent M.A.C.; flight 16.

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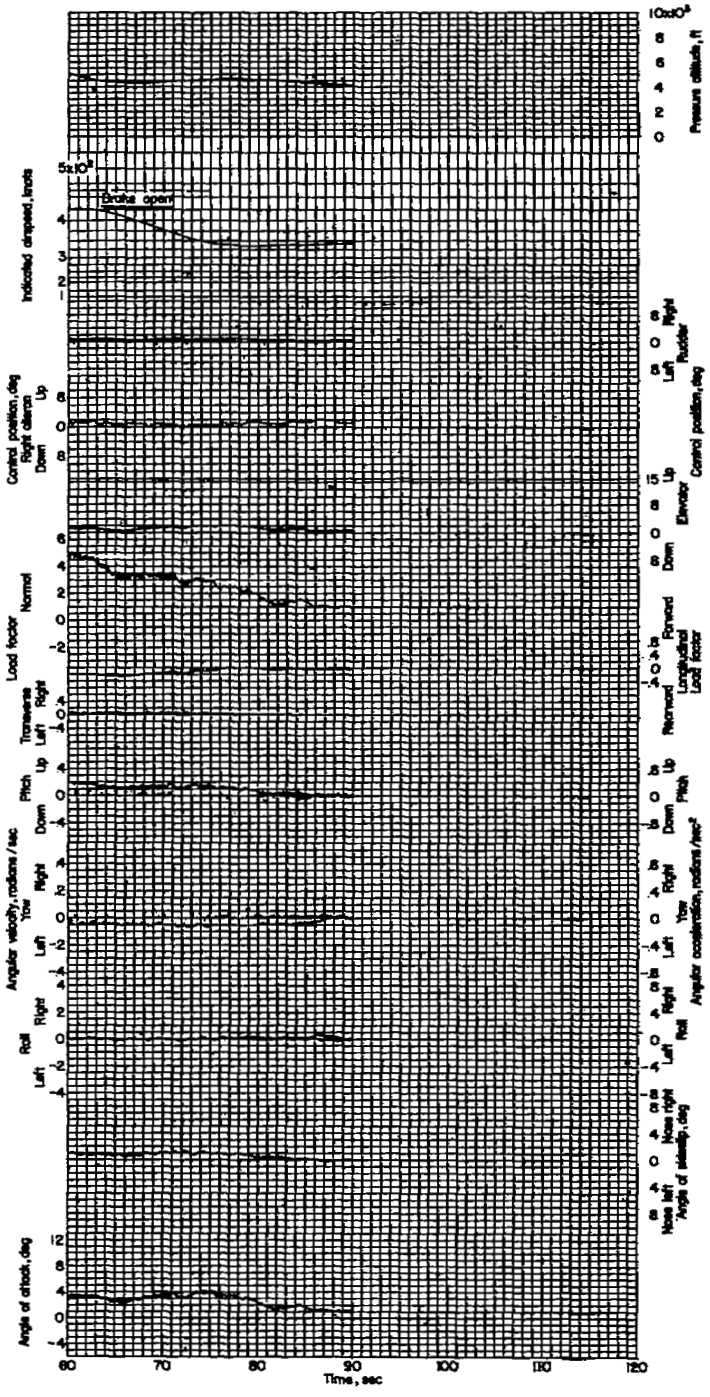

(b)

Figure 93.- Concluded.

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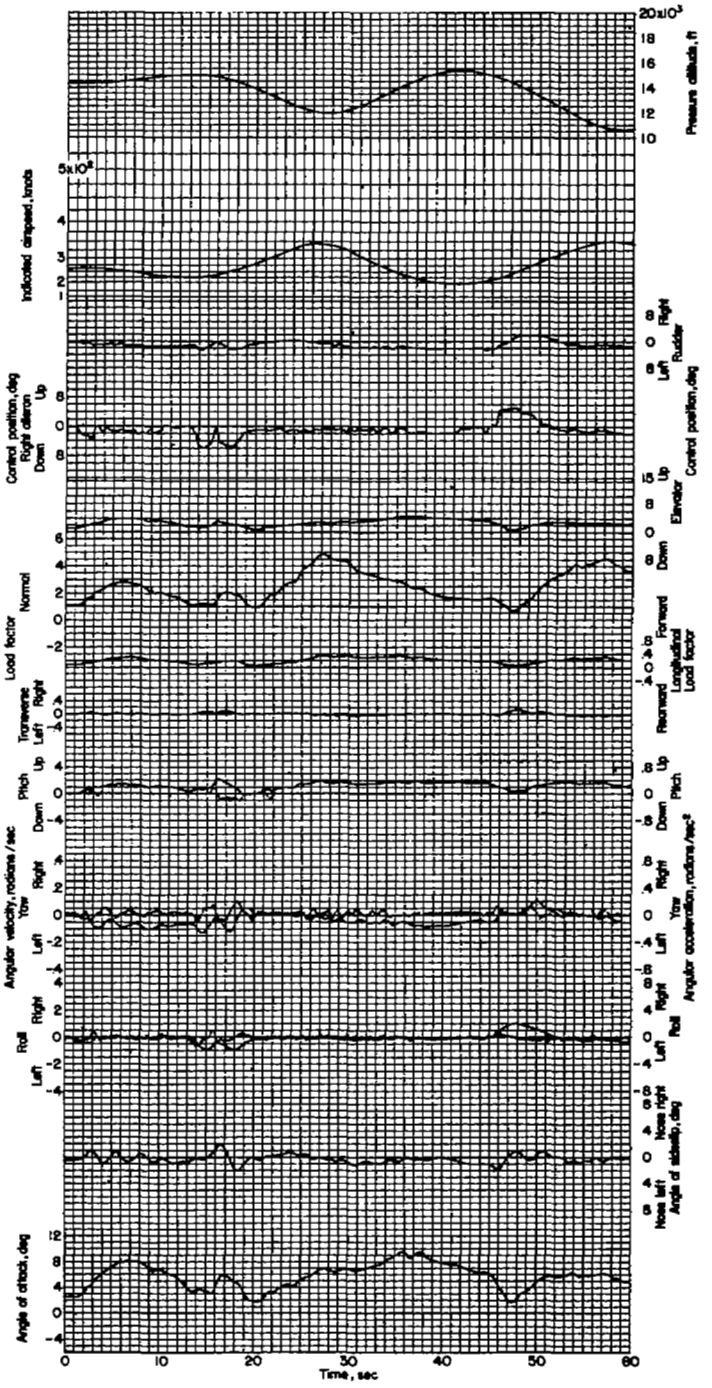
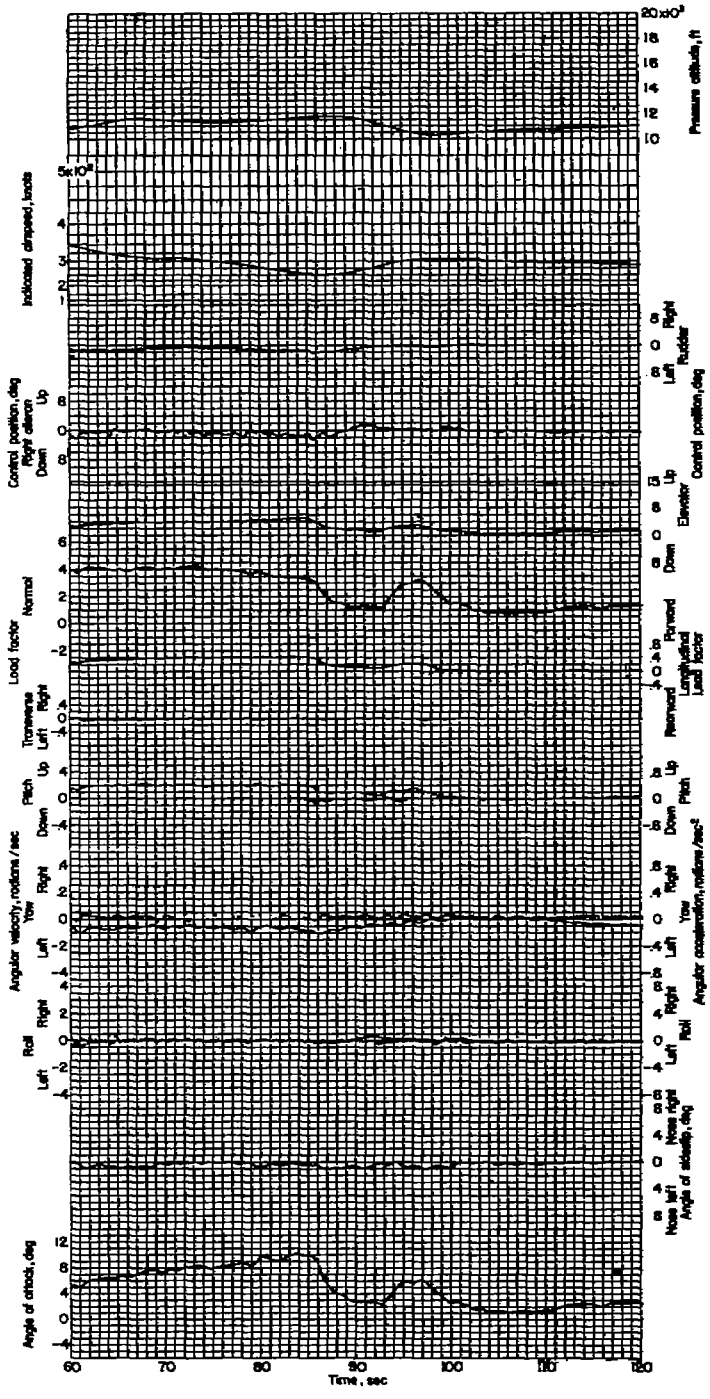


(a)

Figure 94.- Left turn into diving left aileron roll followed by chandelle with three-quarter right-roll recovery into left turn. Airplane weight, 16,010 pounds; center of gravity at 24.1 percent M.A.C.; flight 17.

[redacted]



(b)

Figure 94.- Concluded.

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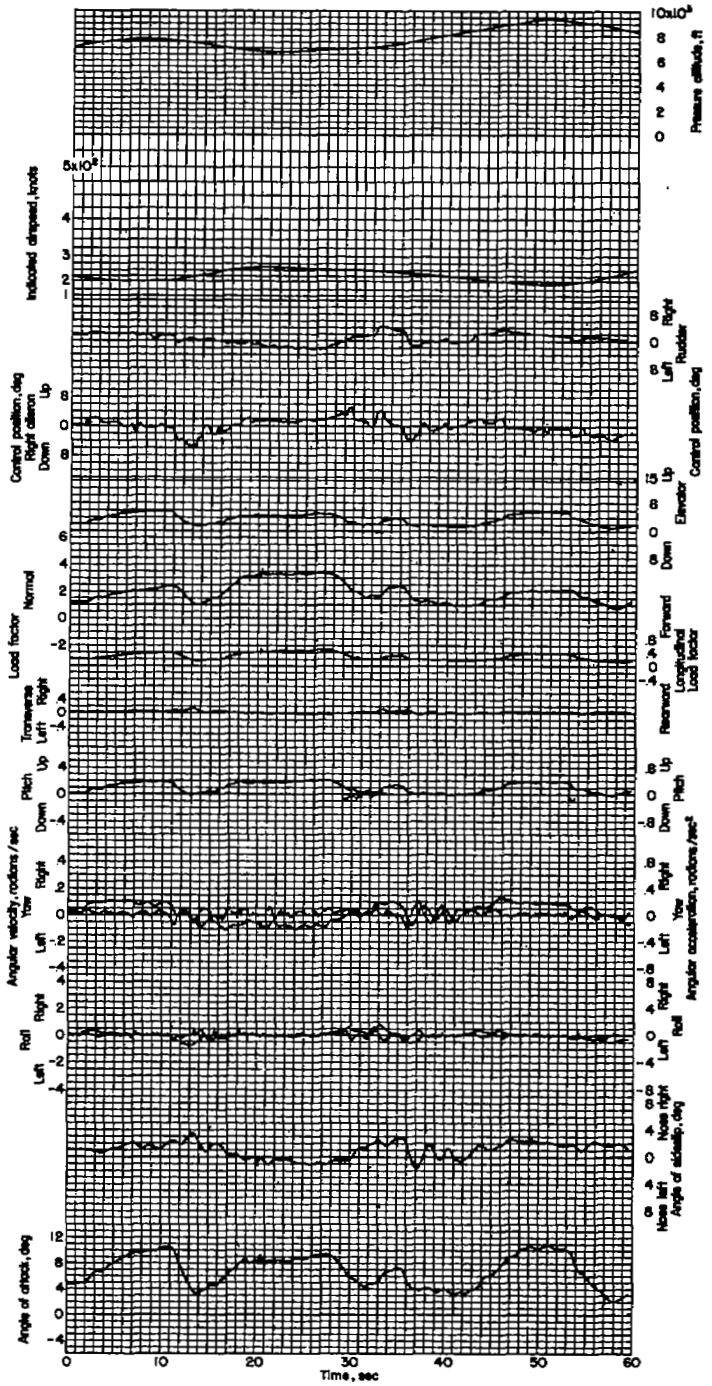
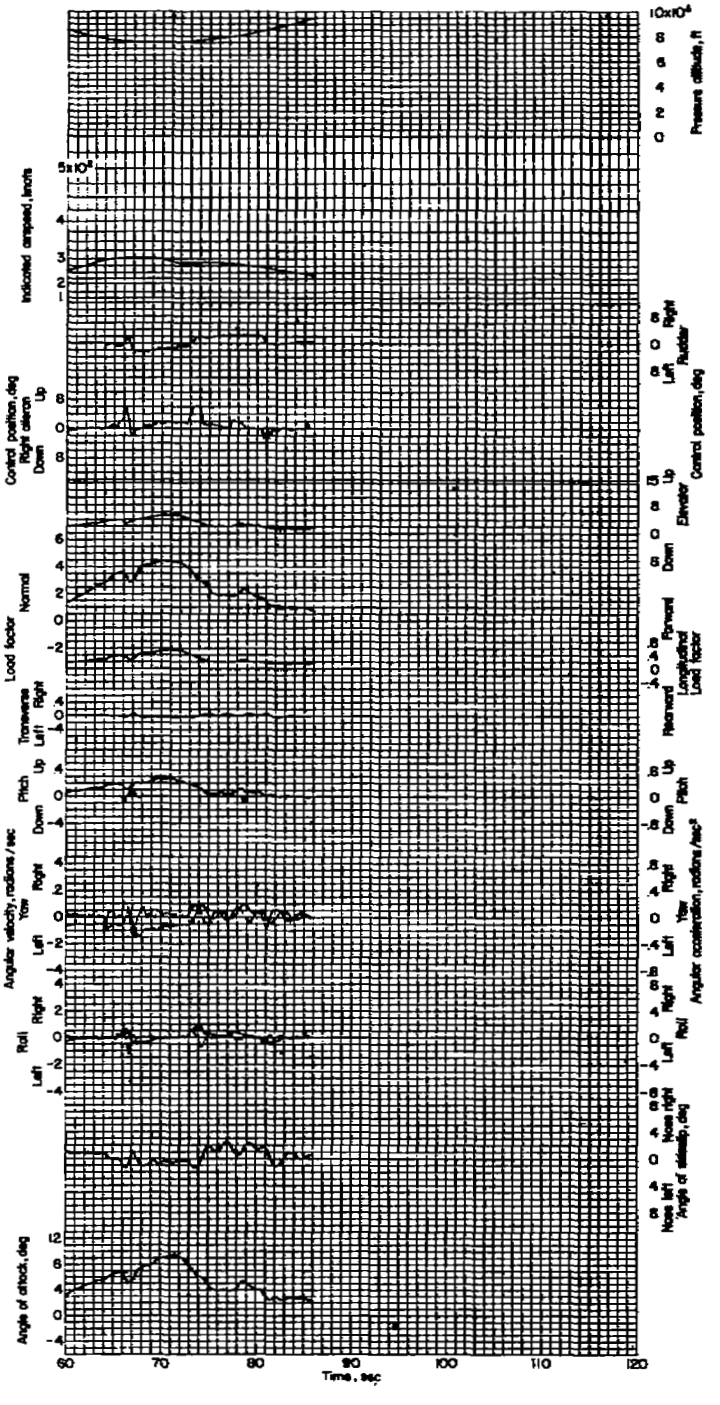


(a)

Figure 95.- Series of turns. Airplane weight, 15,140 pounds; center of gravity at 24.1 percent M.A.C.; flight 17.

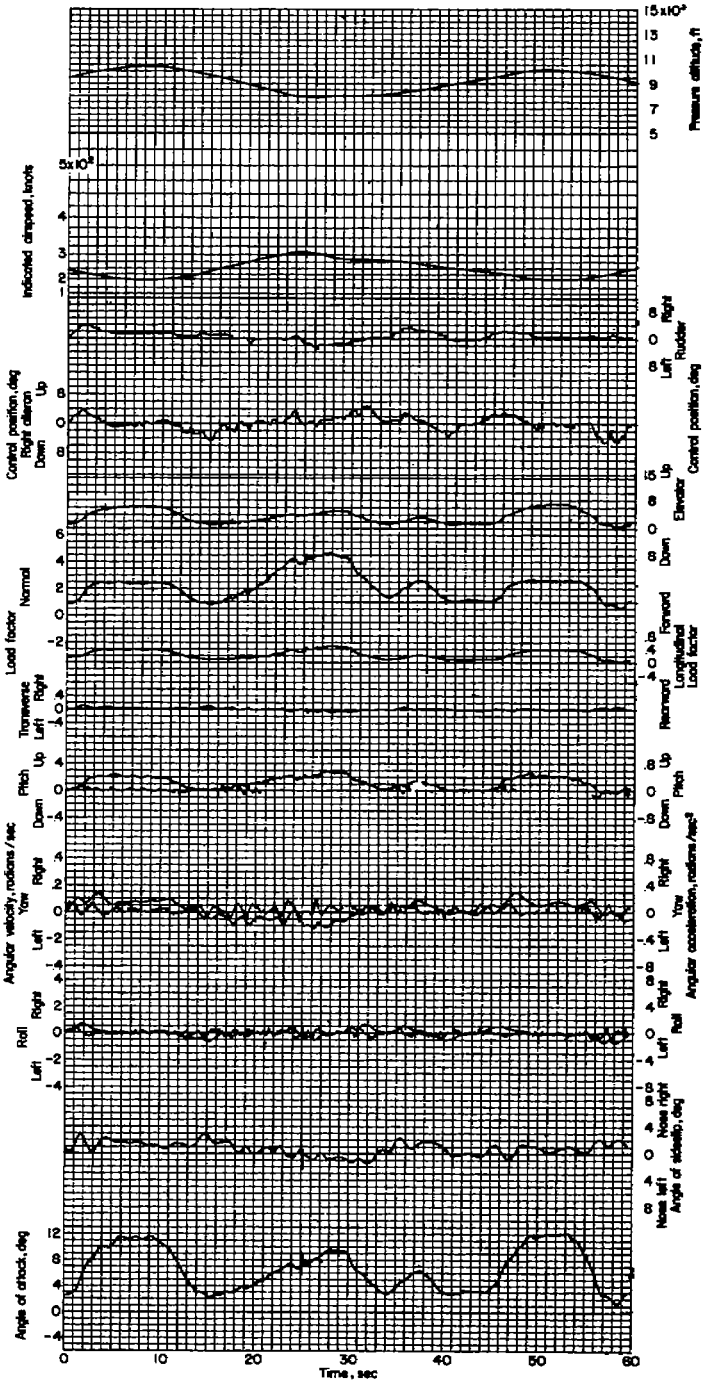
[redacted]



(b)

Figure 95.- Concluded.

[redacted]

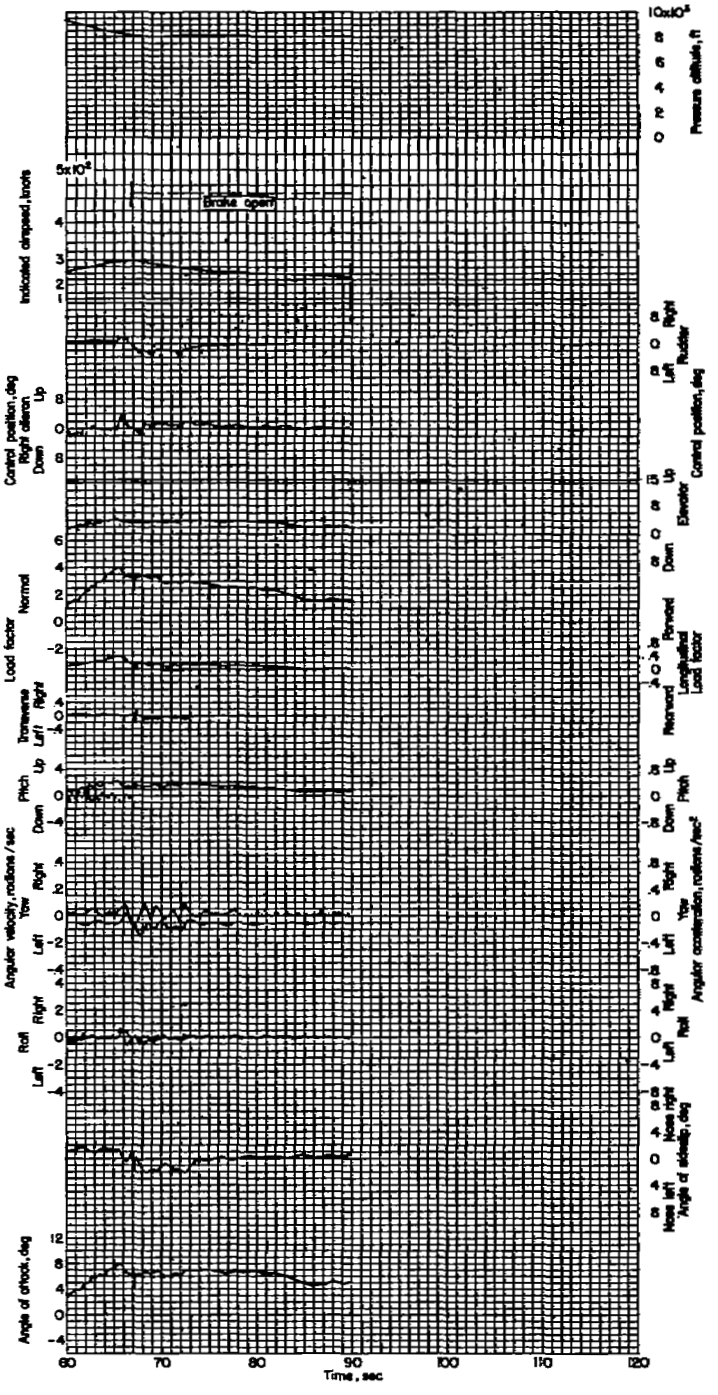


(a)

NACA

Figure 96.- Series of turns. Airplane weight, 15,070 pounds; center of gravity at 24.2 percent M.A.C.; flight 17.

[redacted]



(b)

Figure 96.- Concluded.

[redacted]

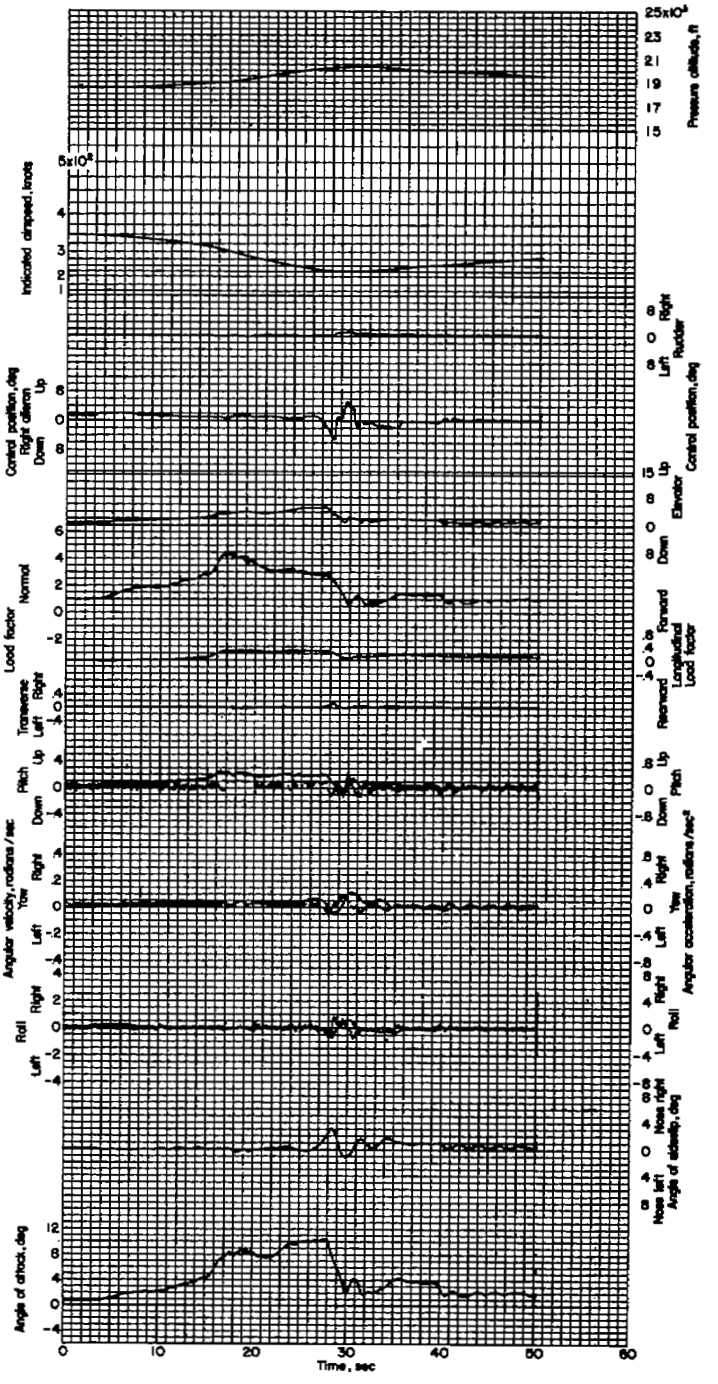


Figure 97.- Right turn. Airplane weight, 15,390 pounds; center of gravity at 23.8 percent M.A.C.; flight 18.

[redacted]

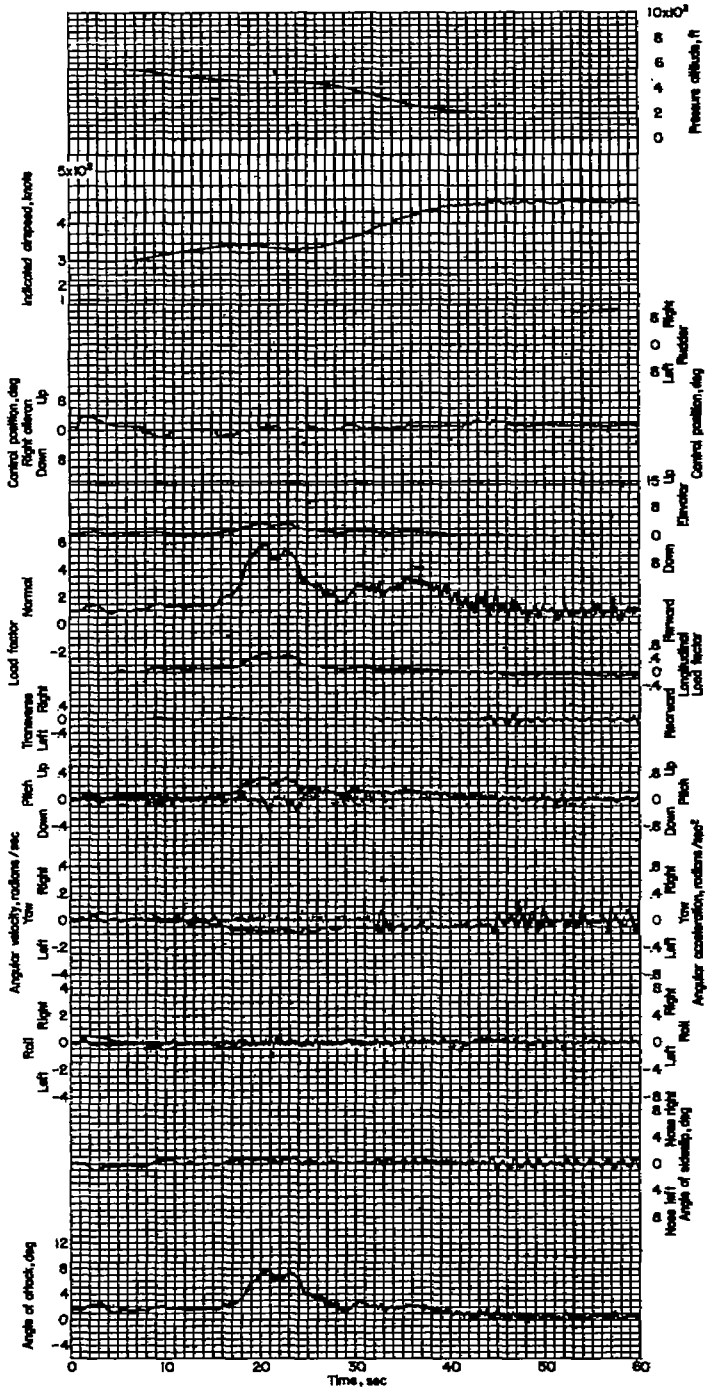


Figure 98.- Maximum performance left turn. Airplane weight, 14,470 pounds; center of gravity at 25.1 percent M.A.C.; flight 18.

[redacted]

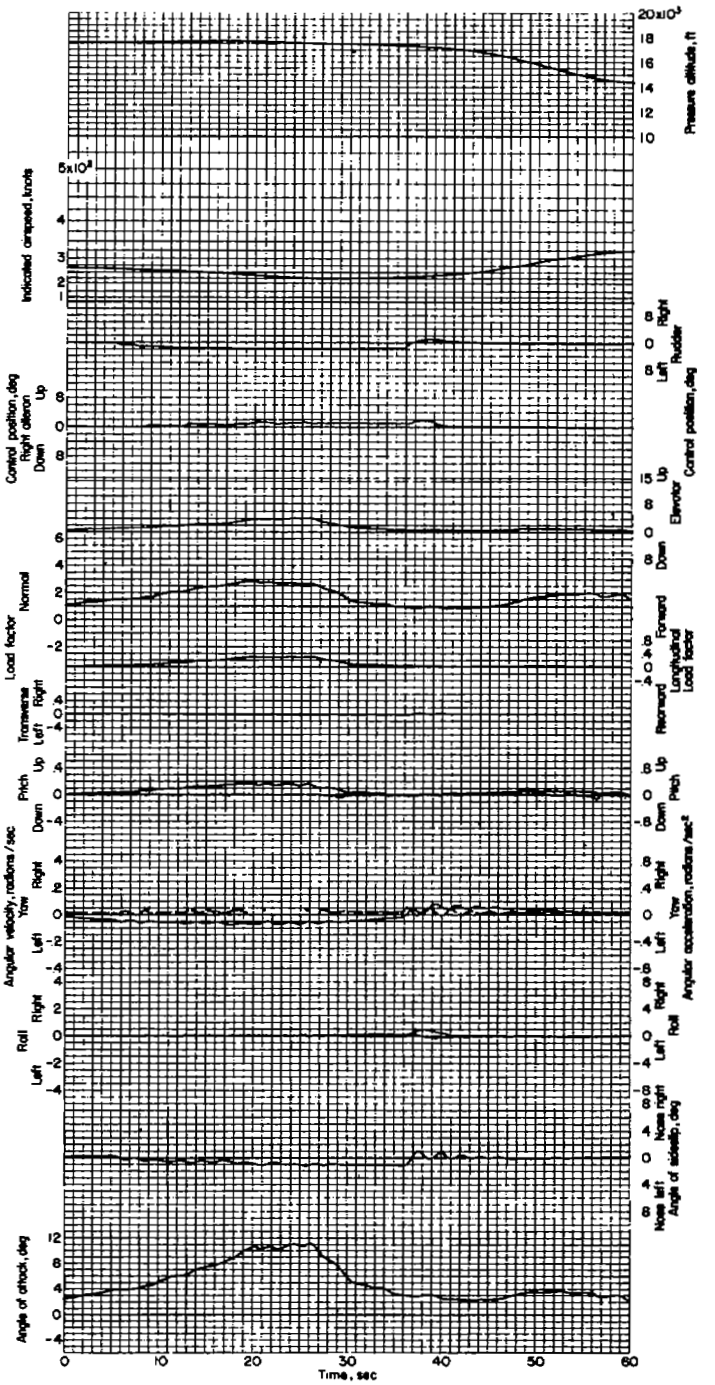
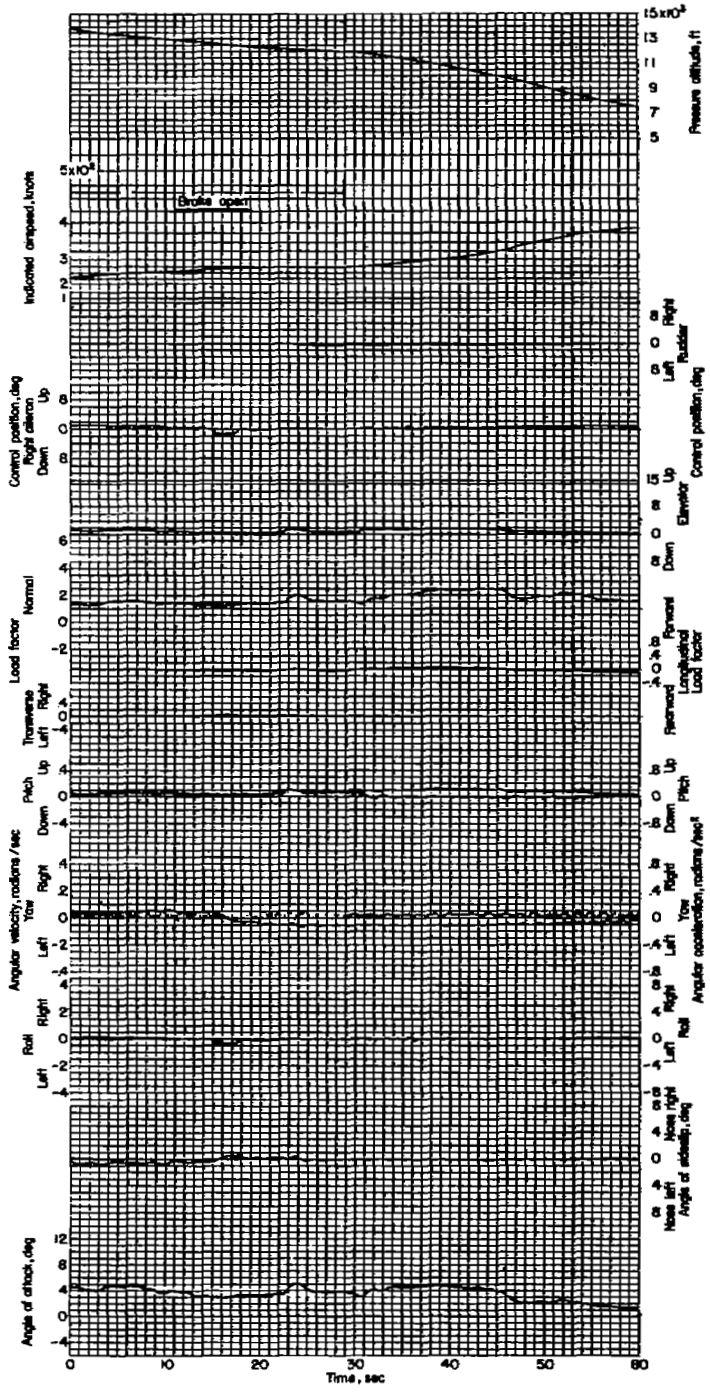


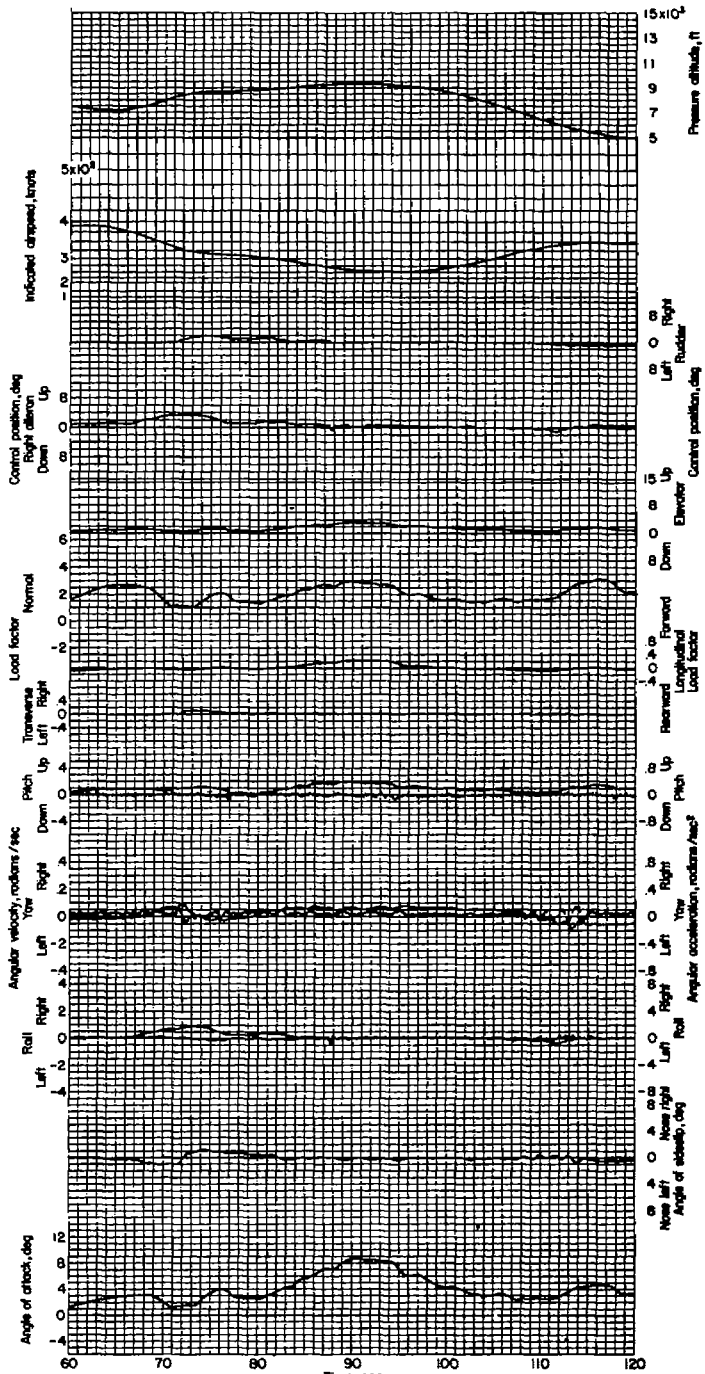
Figure 99.- Left and right turn. Airplane weight, 14,600 pounds; center of gravity at 24.0 percent M.A.C.; flight 19.



(a)

Figure 100.- Right and left turn followed by right aileron roll into right turn. Airplane weight, 14,420 pounds; center of gravity at 24.3 percent M.A.C.; flight 19.

[redacted]



(b)

Figure 100.- Concluded.

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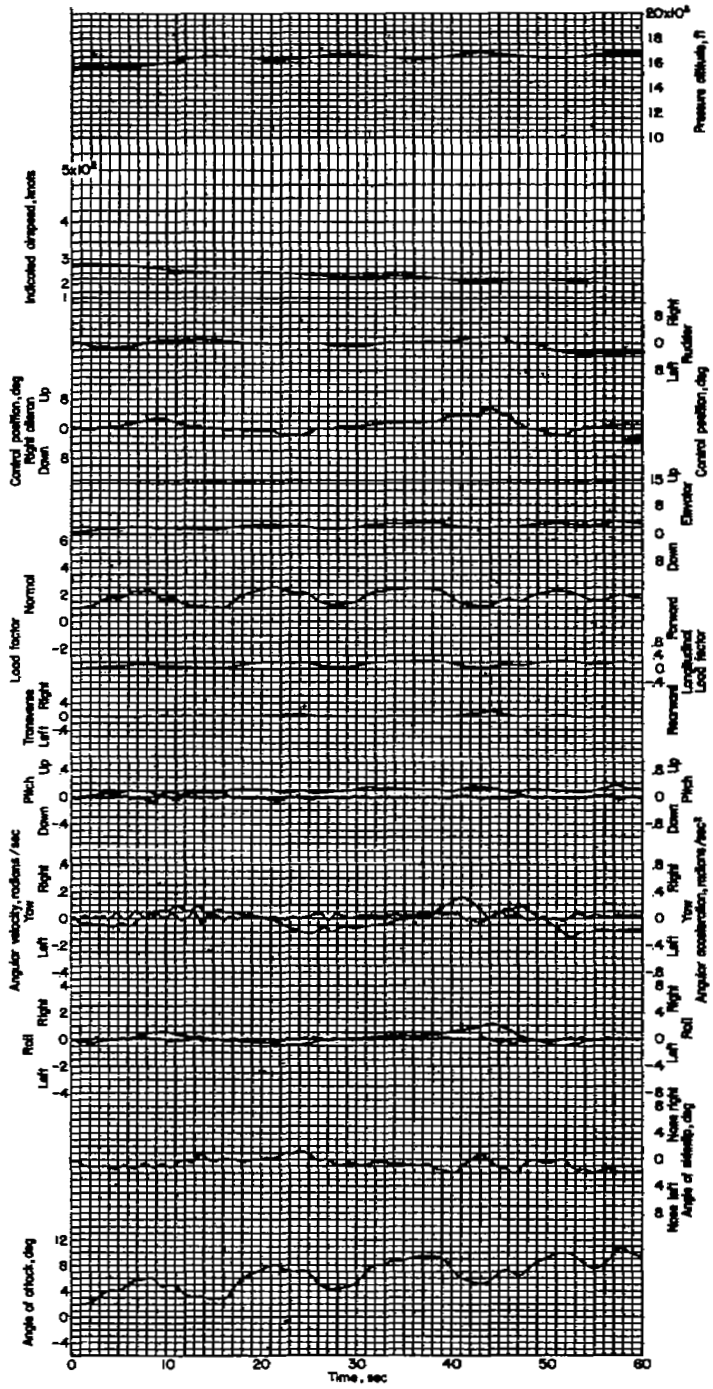
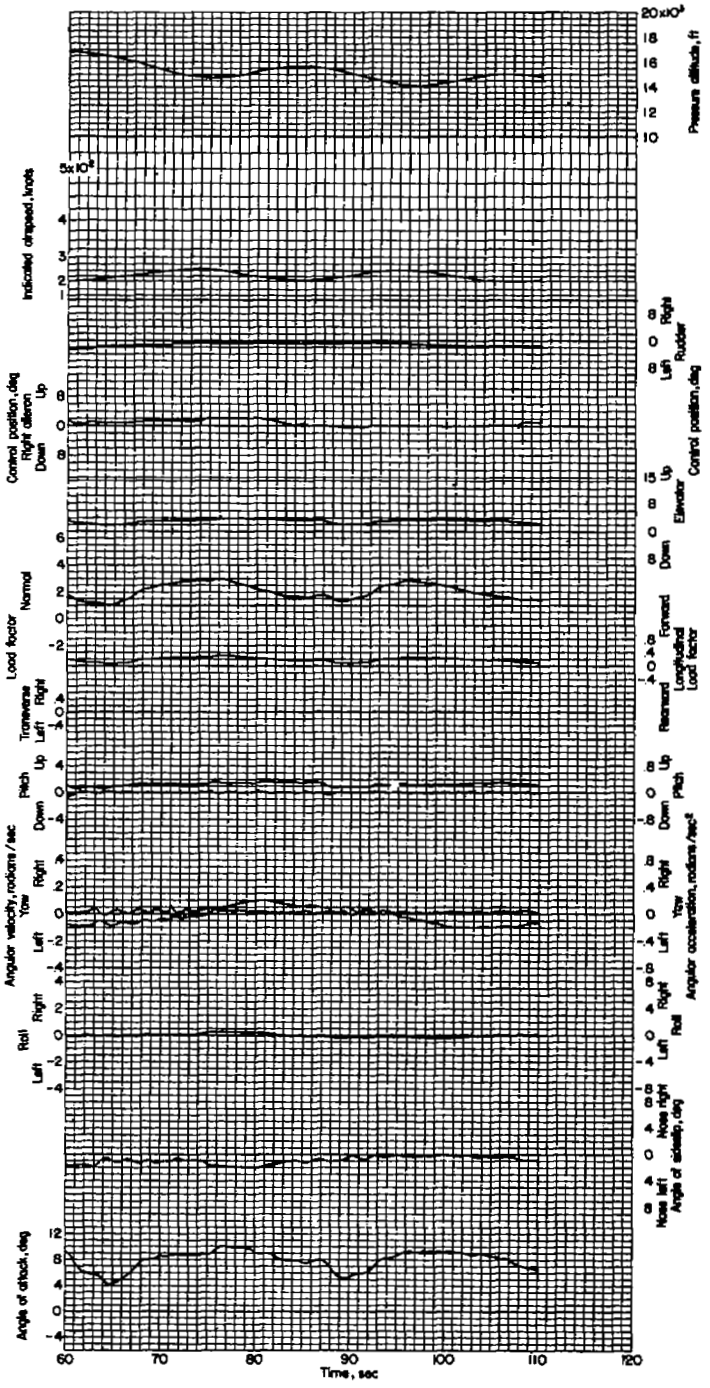


(a)

NACA

Figure 101.- Series of turns including right aileron roll. Airplane weight, 14,780 pounds; center of gravity at 23.8 percent M.A.C.; flight 20.

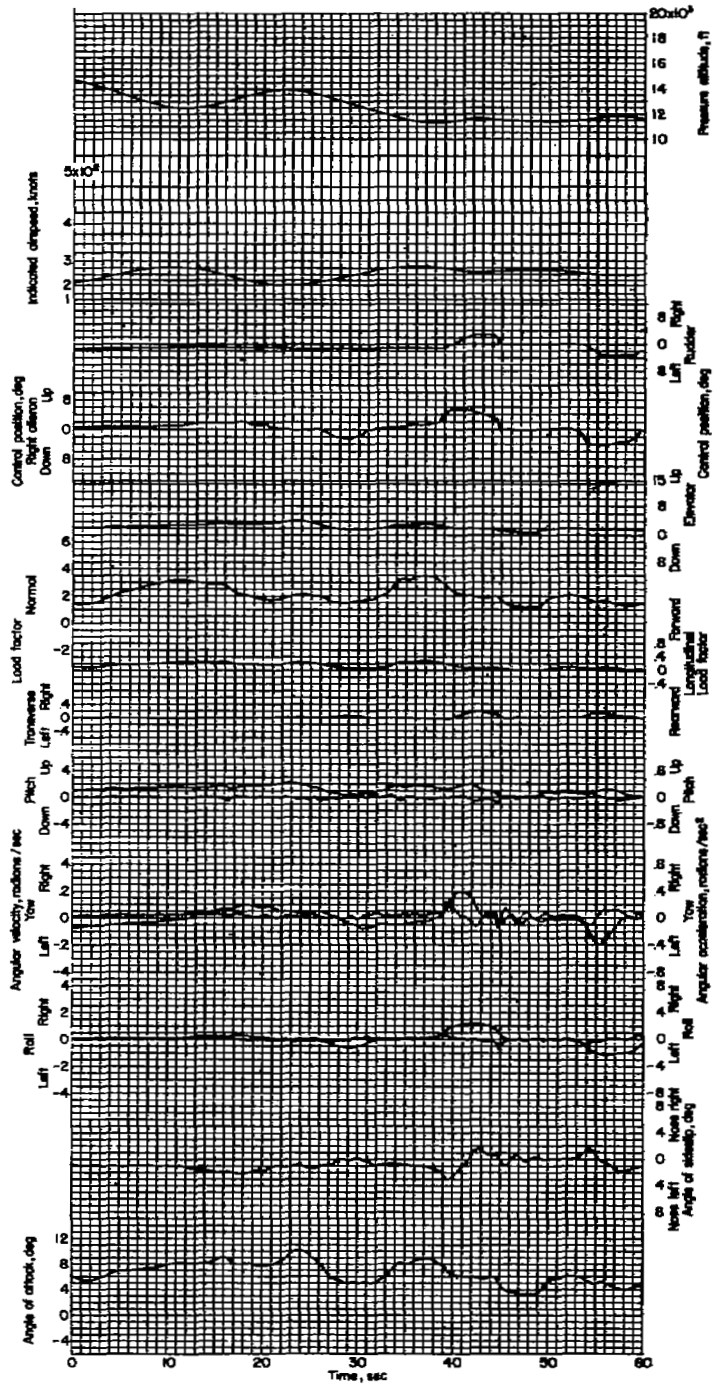
[redacted]



(b)

Figure 101.- Concluded.

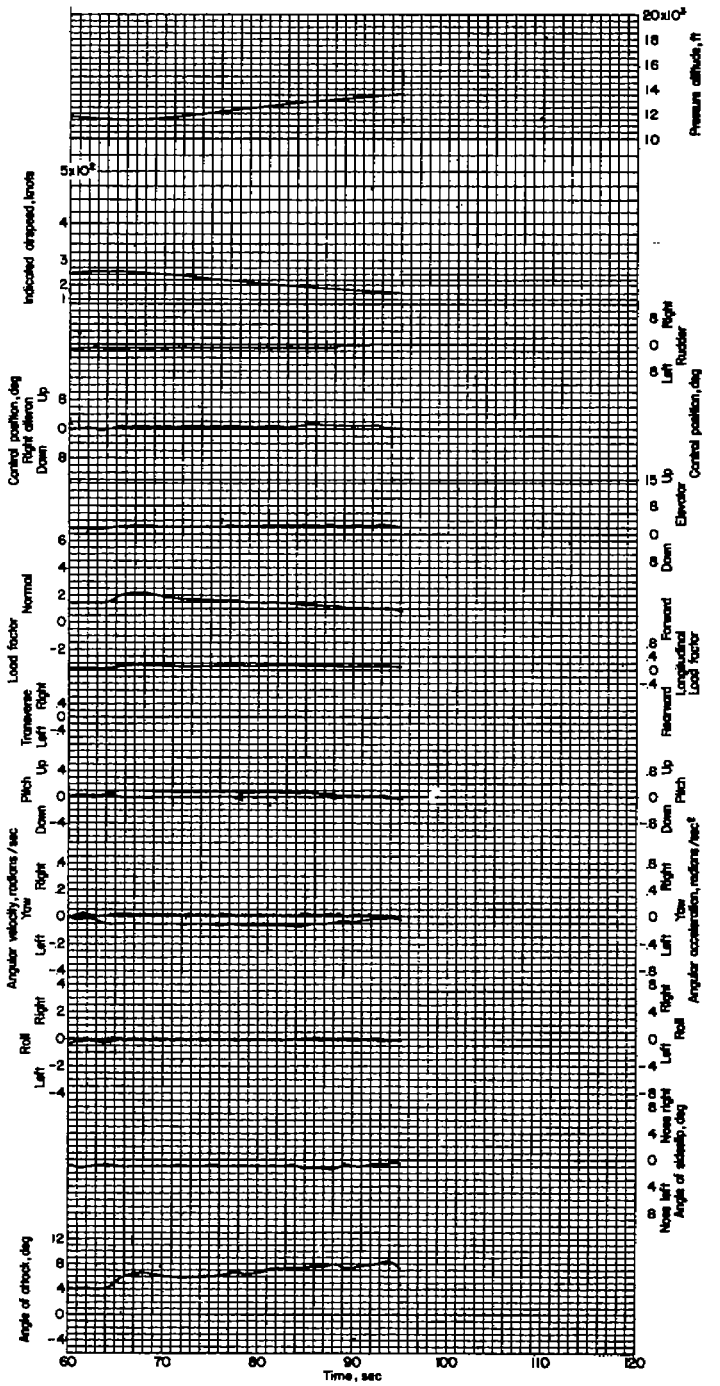
[redacted]



(a)

Figure 102.- Climbing and diving turns into right and left barrel roll followed by climbing left turn. Airplane weight, 14,730 pounds; center of gravity at 23.9 percent M.A.C.; flight 20.

[redacted]



(b)

Figure 102.- Concluded.

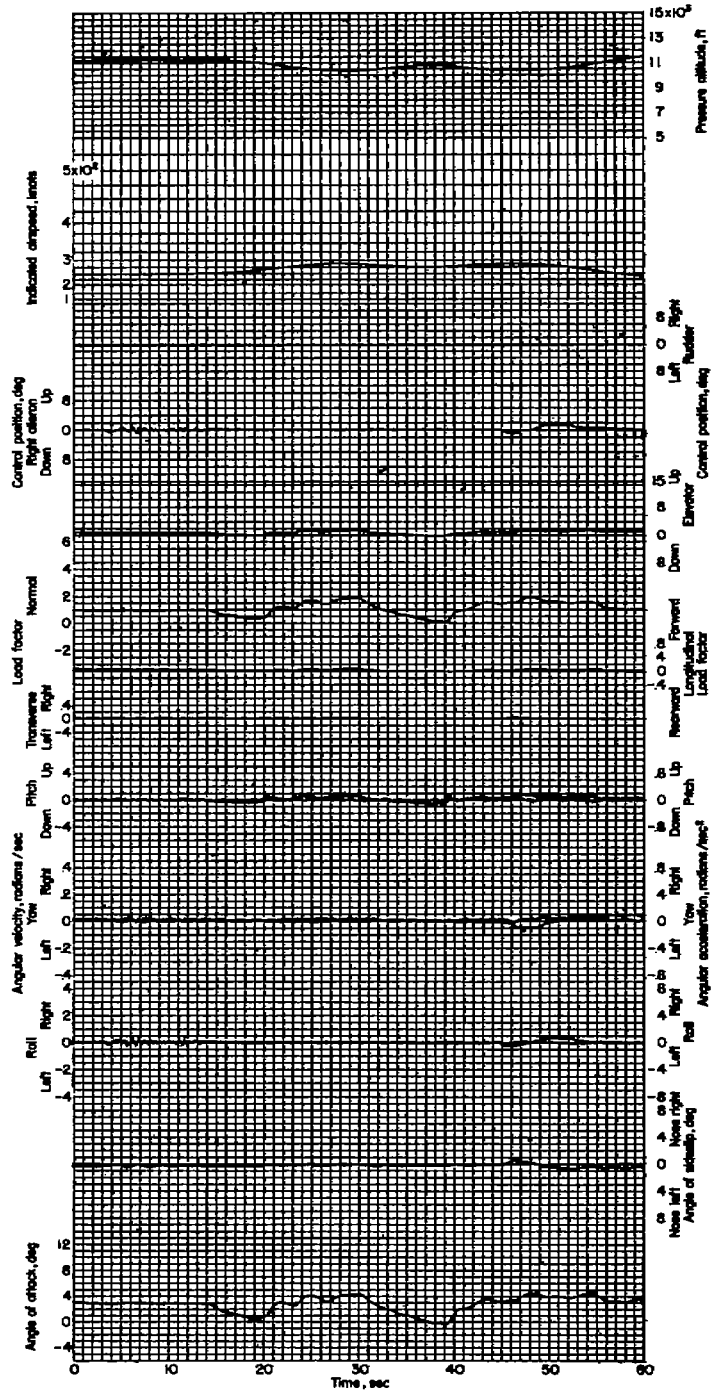
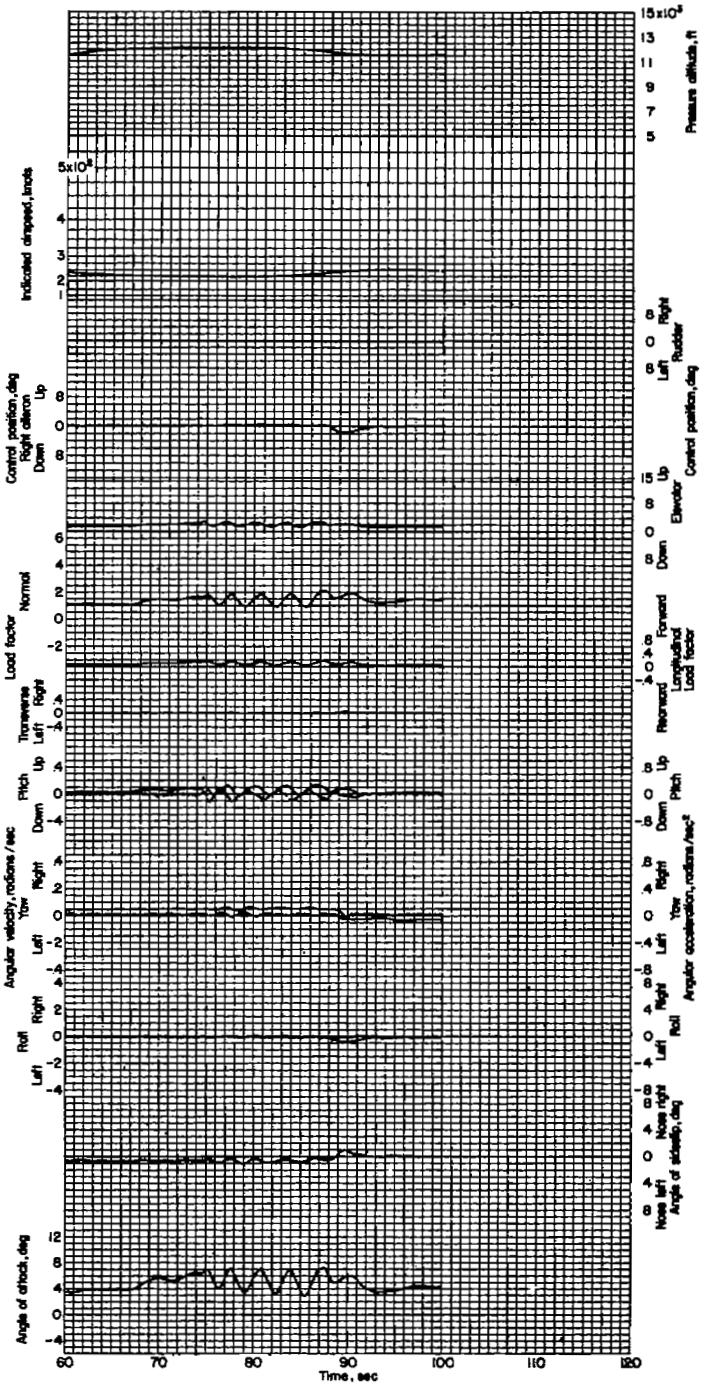


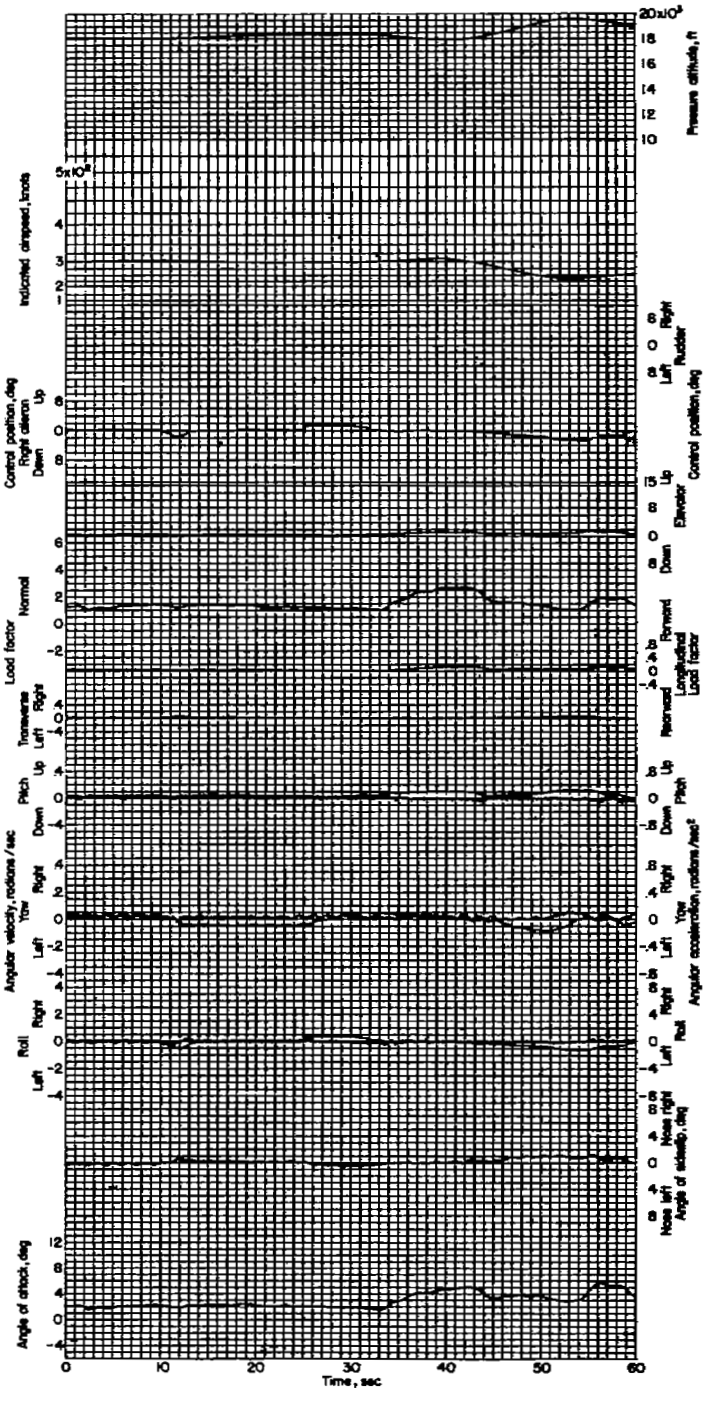
Figure 103.- Two gentle push-downs followed by right turn. Airplane weight, 14,490 pounds; center of gravity at 24.2 percent M.A.C.; flight 20.

[redacted]



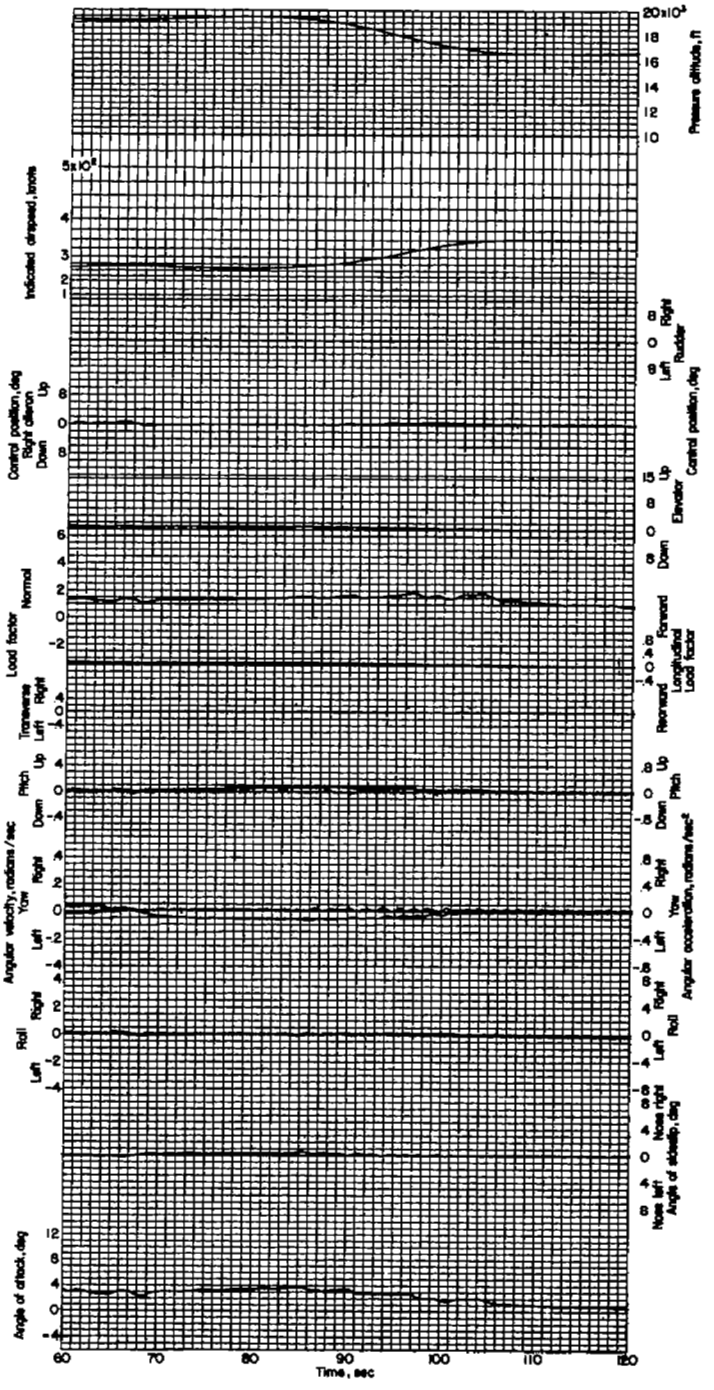
(b)

Figure 103.- Concluded.



(a)

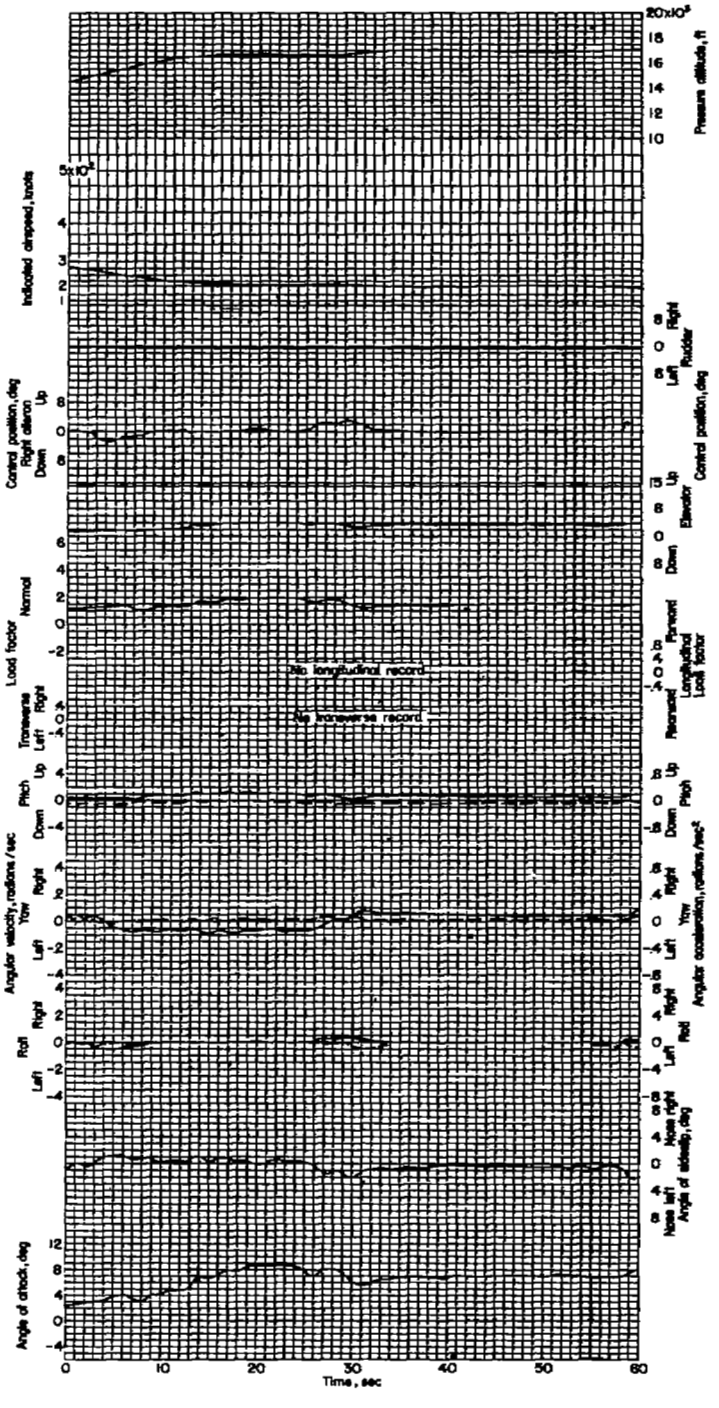
Figure 104.- Left and right turn into left aileron roll followed by left turn. Airplane weight, 14,080 pounds; center of gravity at 24.7 percent M.A.C.; flight 20.



(b)

Figure 104.- Concluded.

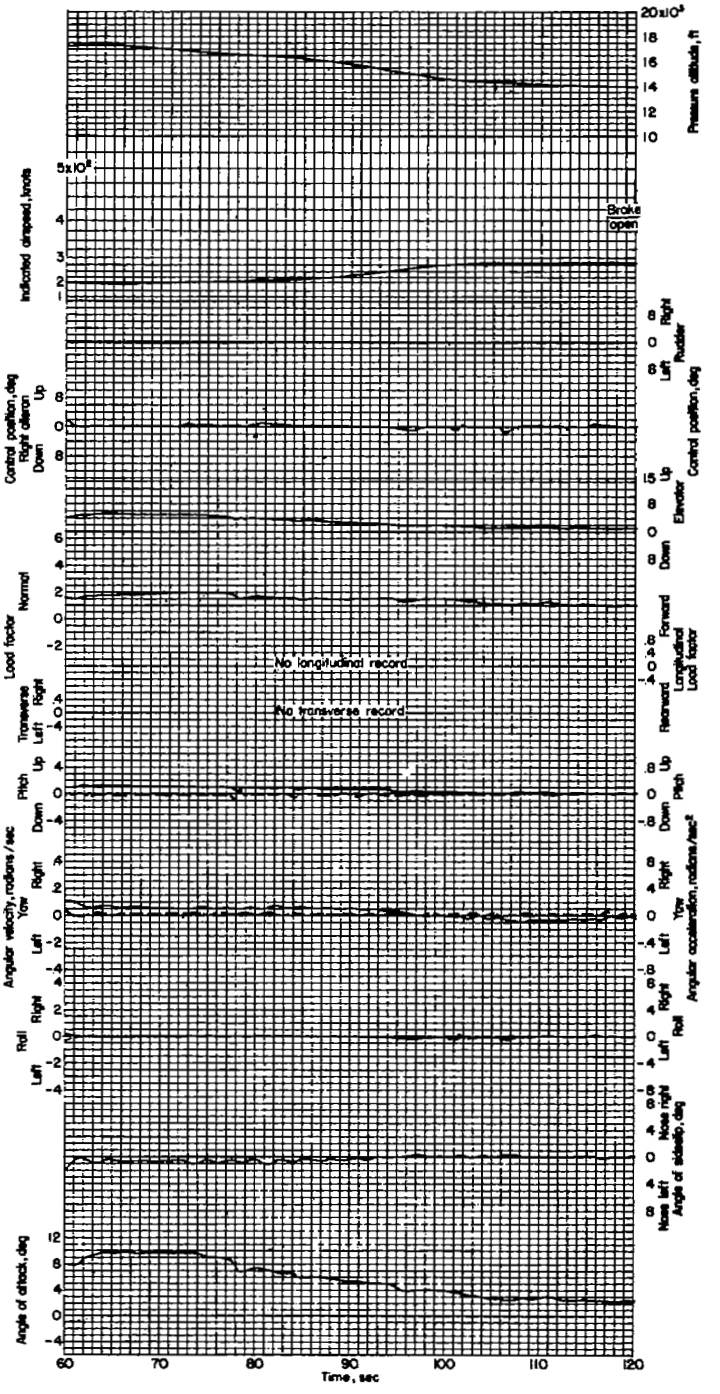
[redacted]



(a)

Figure 105.- Chandelle followed by right turn into dive. Airplane weight, 15,400 pounds; center of gravity at 23.8 percent M.A.C.; flight 1.

[redacted]



(b)

Figure 105.- Concluded.

[redacted]

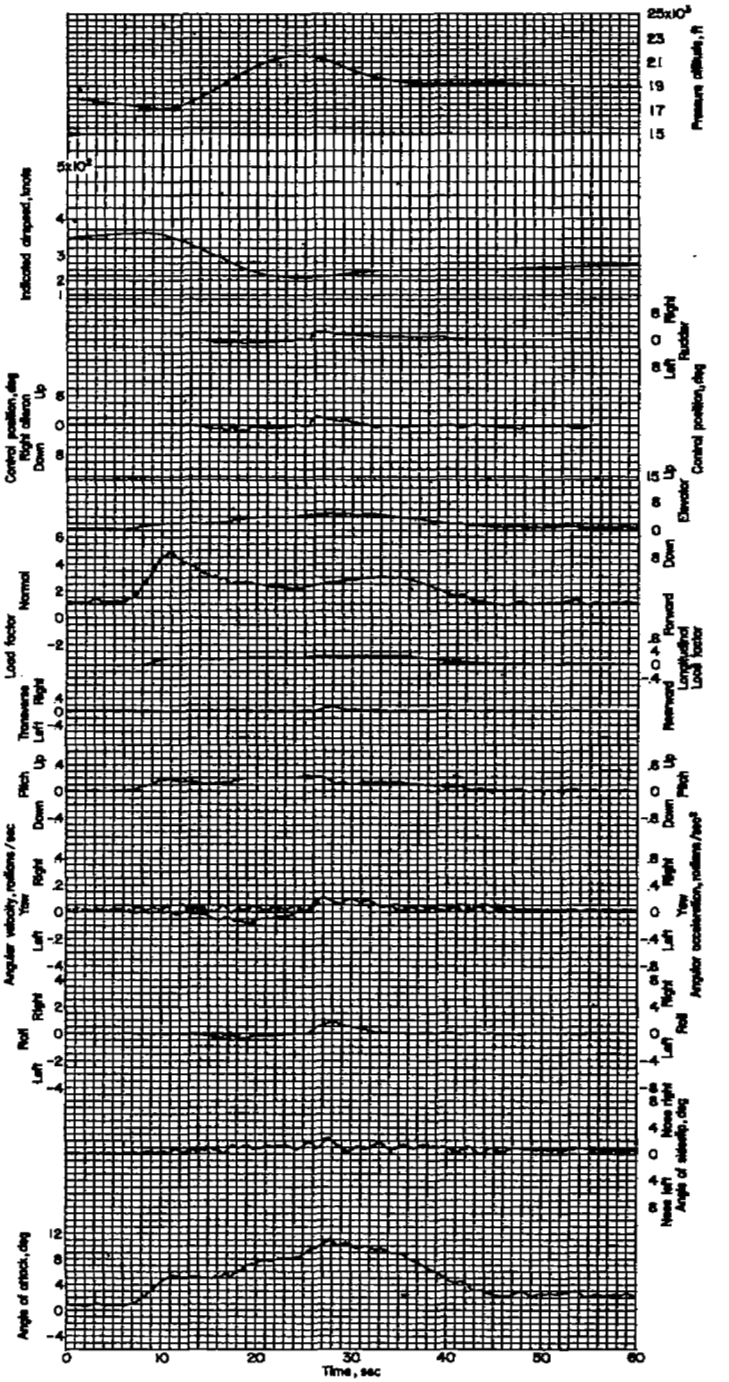
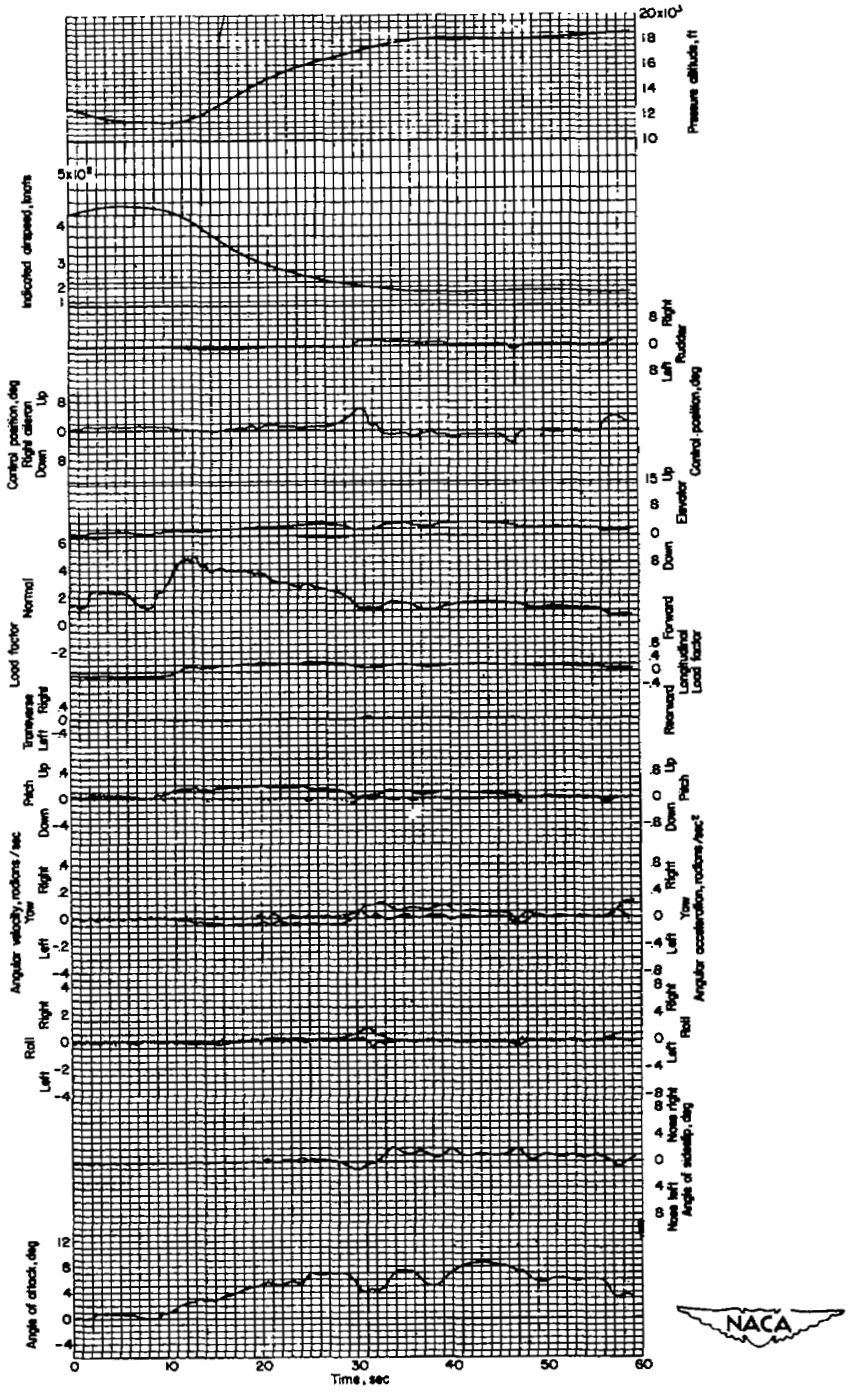
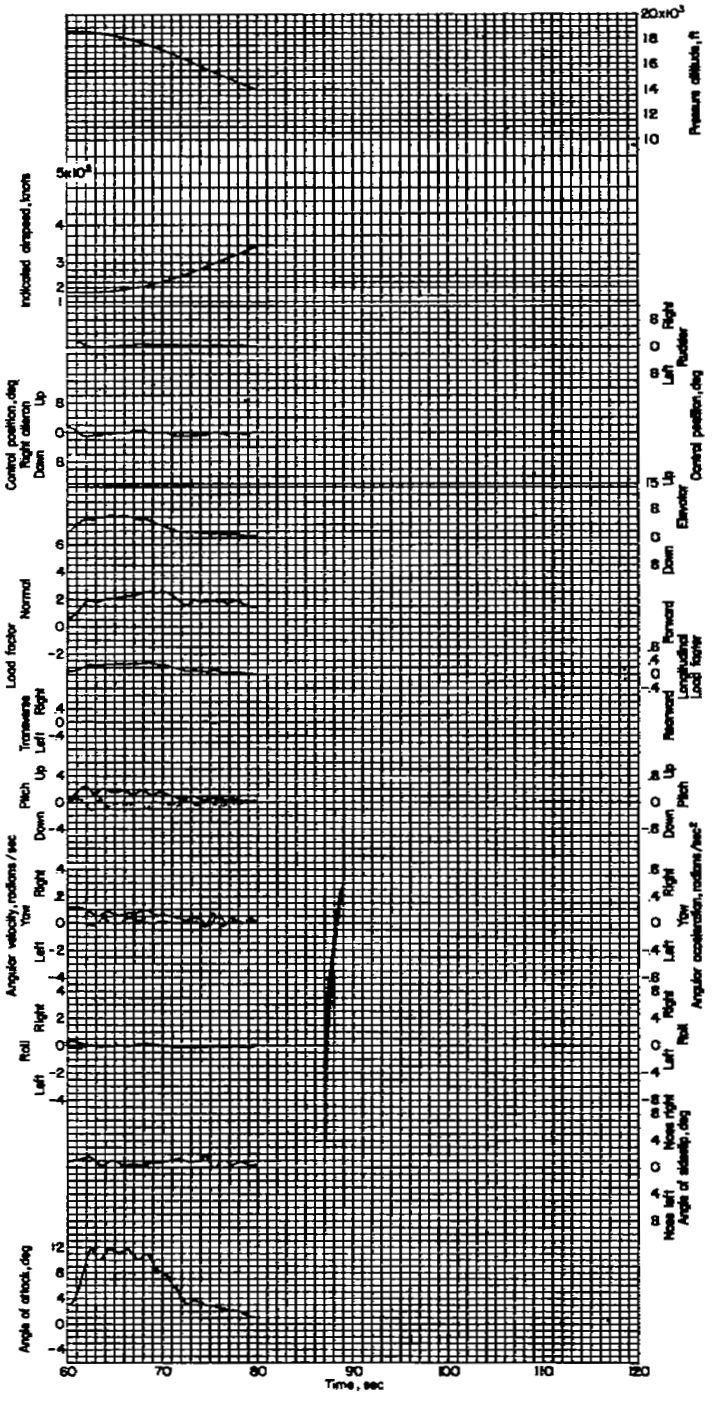


Figure 106.- Chandelle into right turn. Airplane weight, 15,600 pounds; center of gravity at 23.9 percent M.A.C.; flight 3.



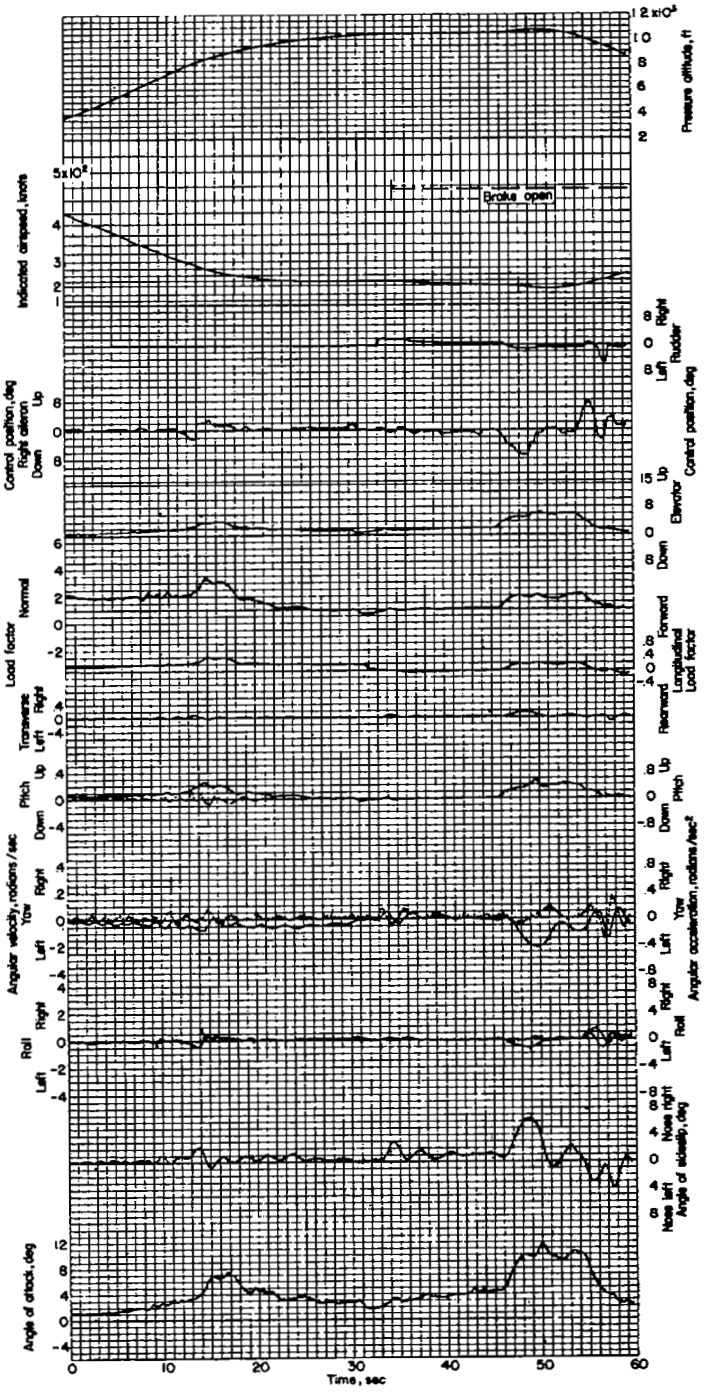
(a)

Figure 107.- Chandelle followed by peel-off. Airplane weight, 14,770 pounds; center of gravity at 24.7 percent M.A.C.; flight 6.



(b)

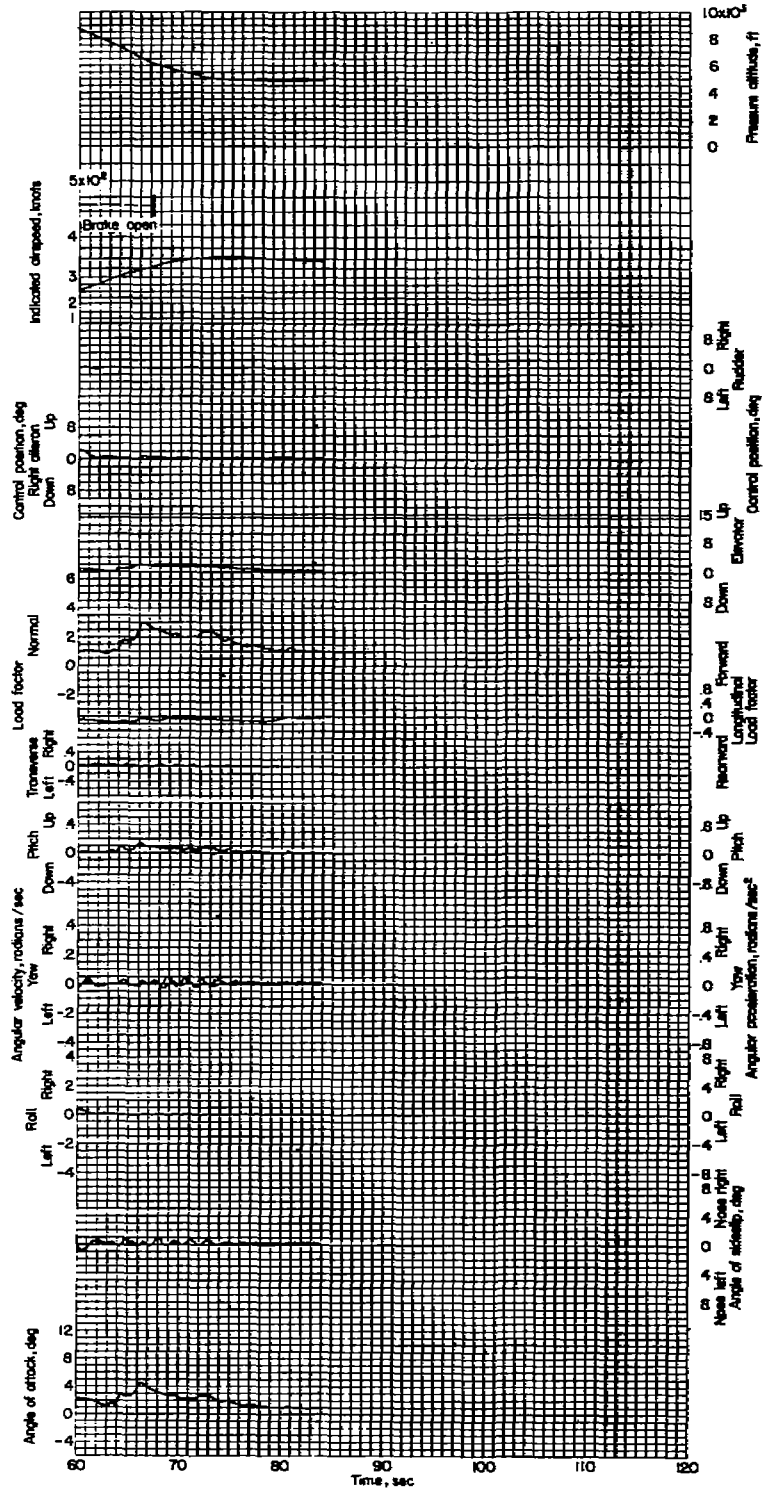
Figure 107.- Concluded.



(a)

NACA

Figure 108.- Chandelle followed by peel-off into dive. Airplane weight, 15,450 pounds; center of gravity at 23.8 percent M.A.C.; flight 8.



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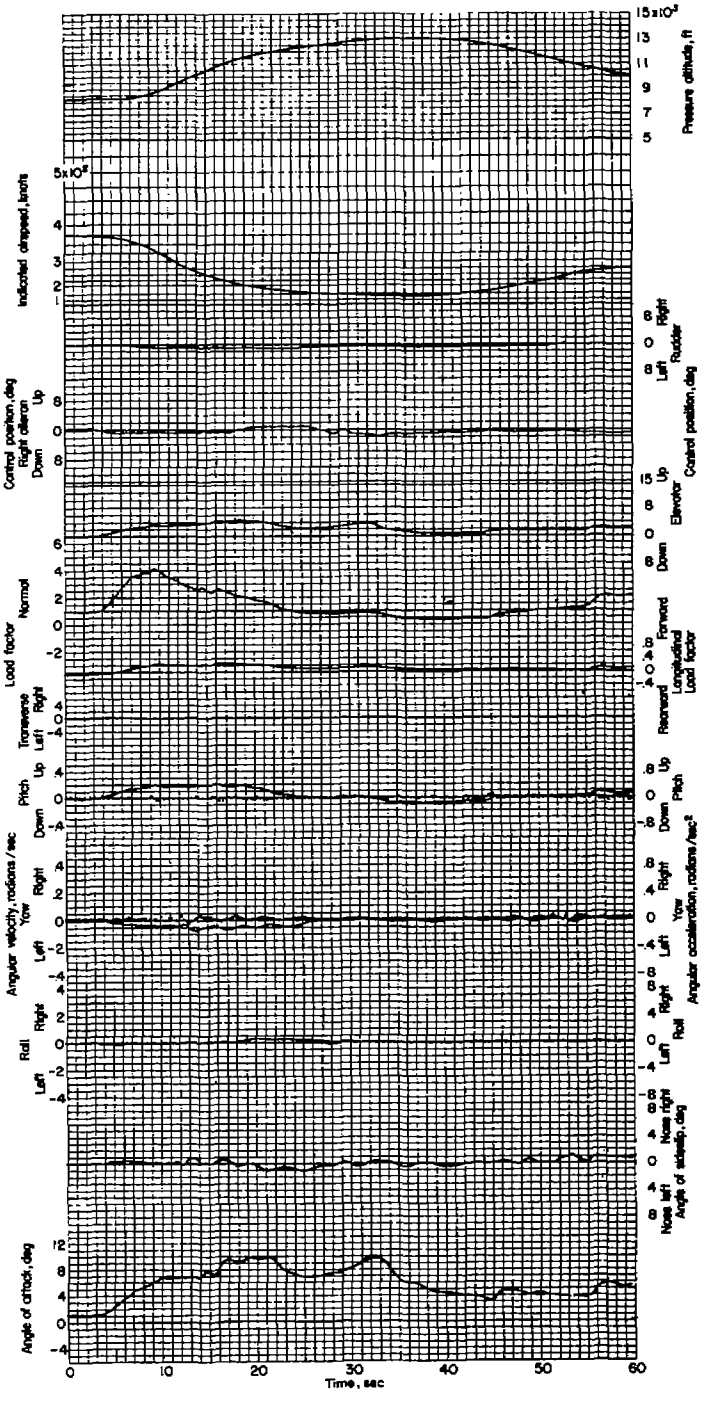

Figure 109.- Chandelle followed by shallow dive entry into wing-over. Airplane weight, 16,000 pounds; center of gravity at 24.1 percent M.A.C.; flight 11.

[redacted]

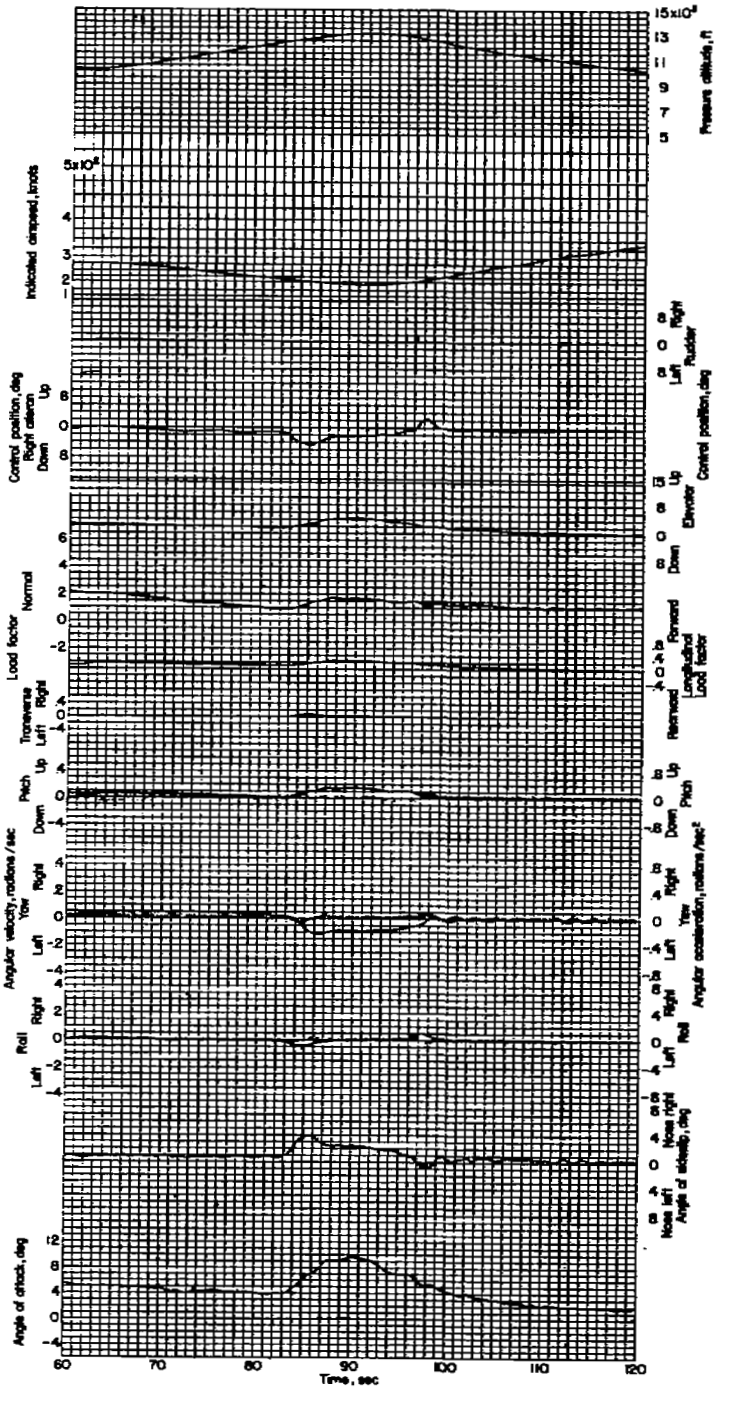

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Figure 109.- Concluded.

[redacted]

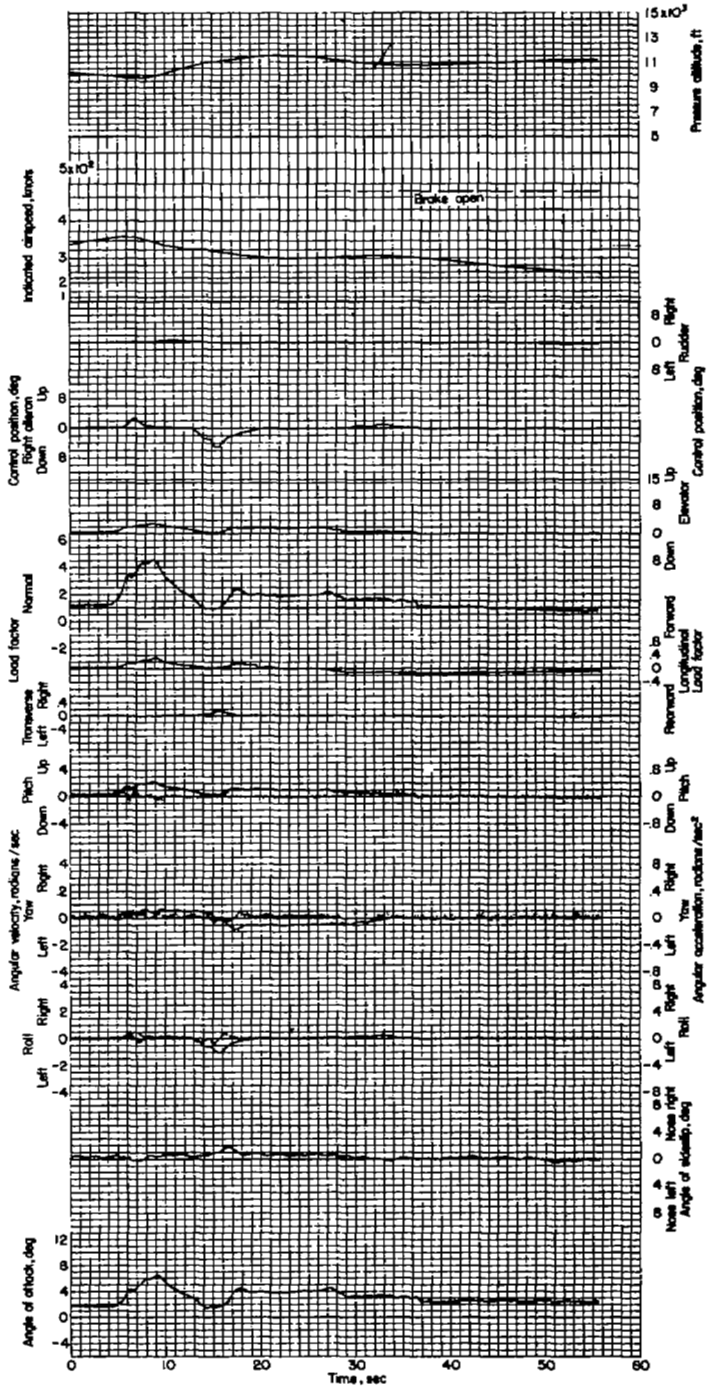
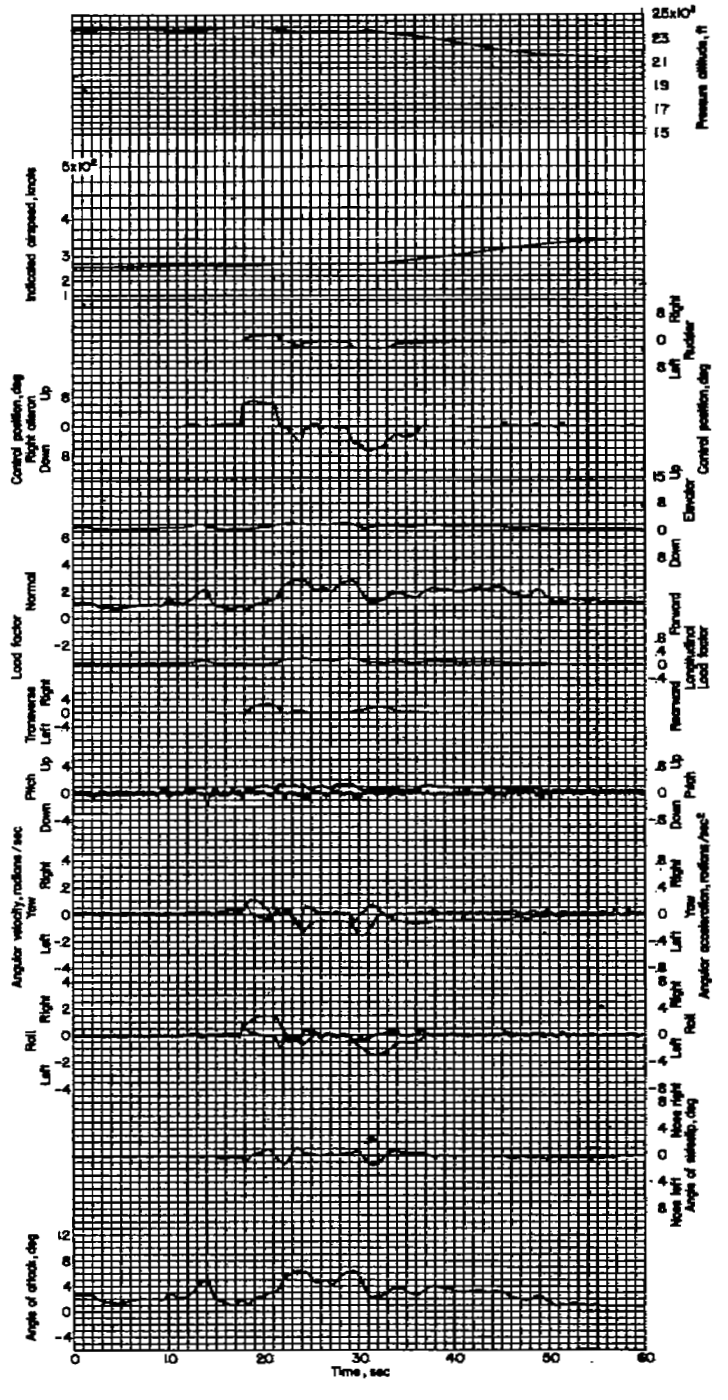


Figure 110.- Chandelle. Airplane weight, 15,930 pounds; center of gravity at 24.1 percent M.A.C.; flight 11.

[redacted]



(a)

Figure 111.- Right and left aileron roll followed by chandelle. Airplane weight, 16,170 pounds; center of gravity at 24.2 percent M.A.C.; flight 15.

[redacted]

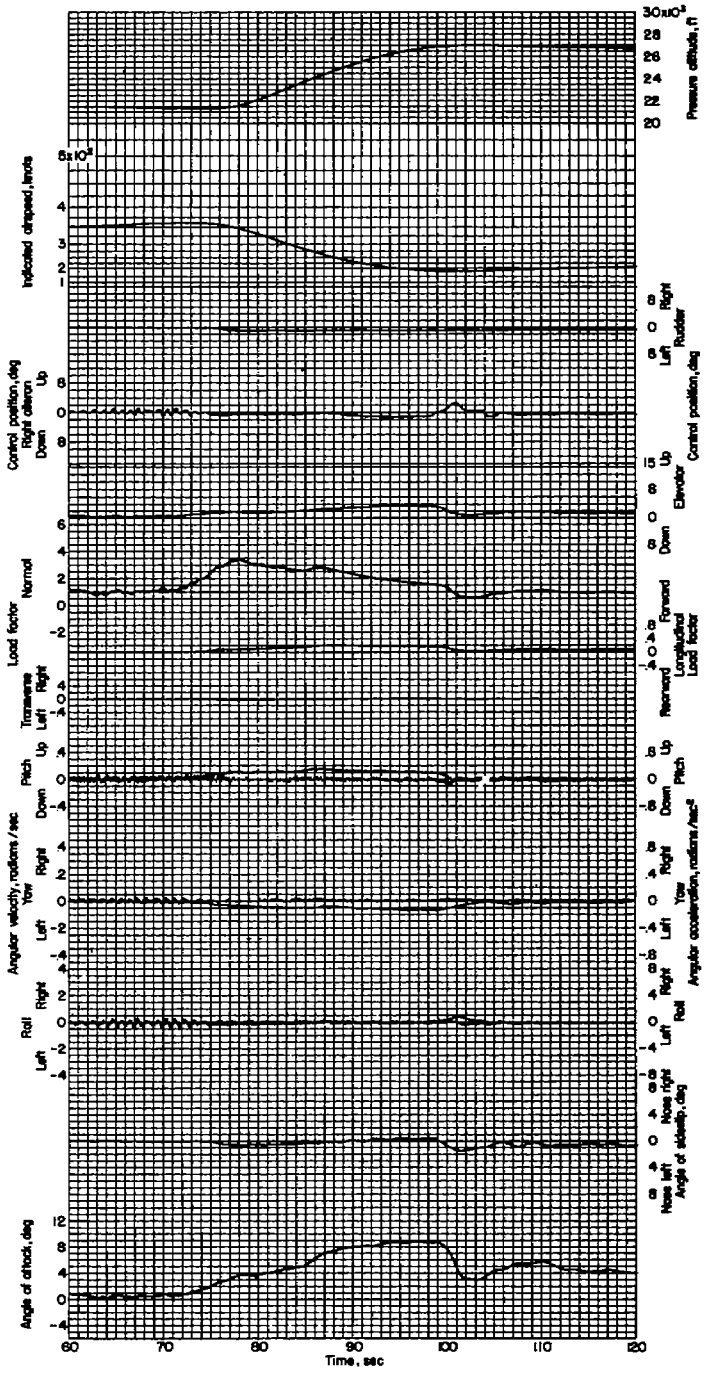


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Figure 111.- Concluded.

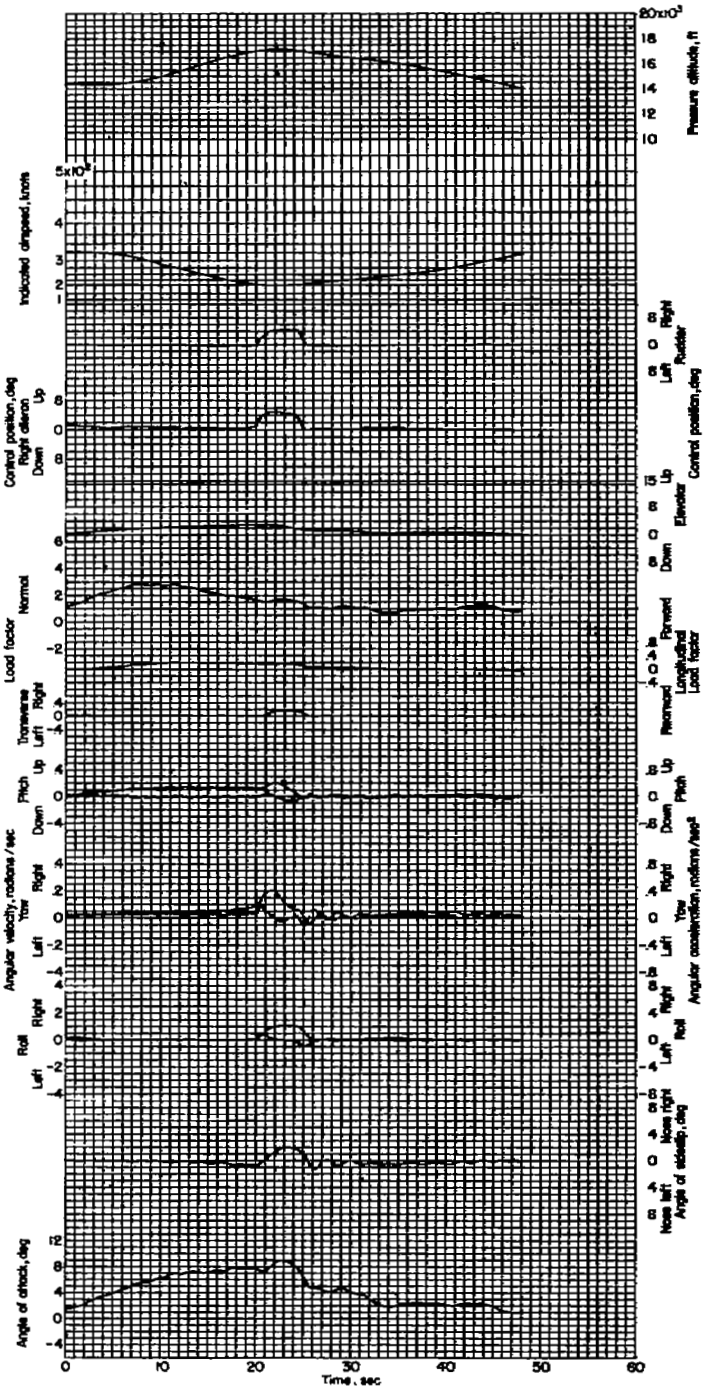
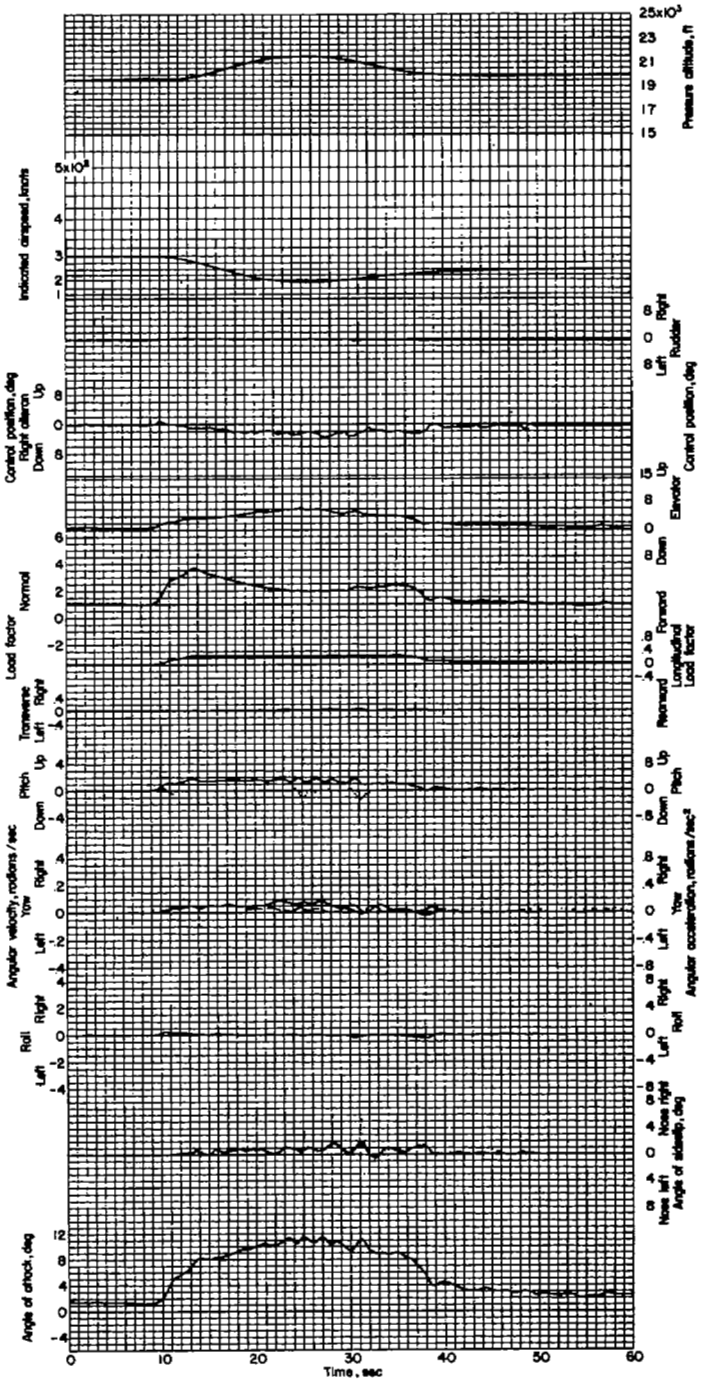


Figure 112.- Chandelle with three-quarter right-roll recovery. Airplane weight, 14,560 pounds; center of gravity at 24.1 percent M.A.C.; flight 19.

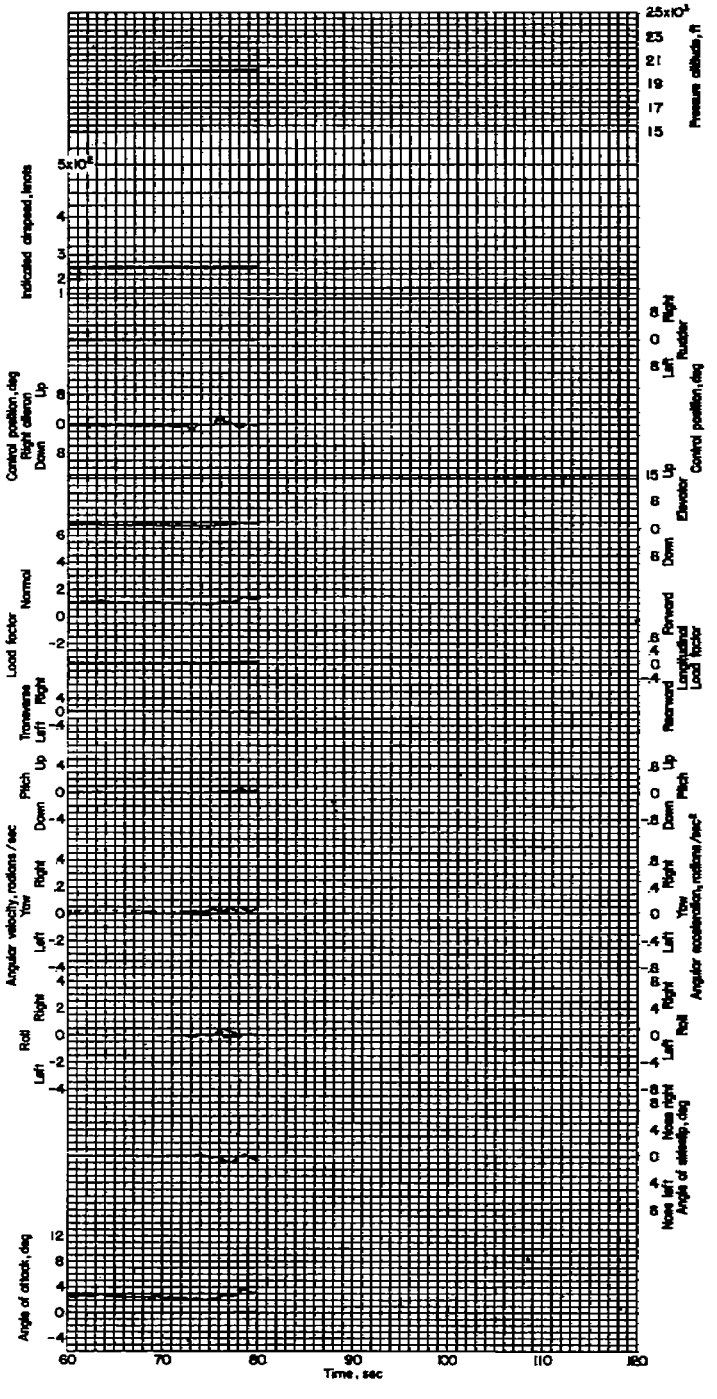
[redacted]



(a)

NACA

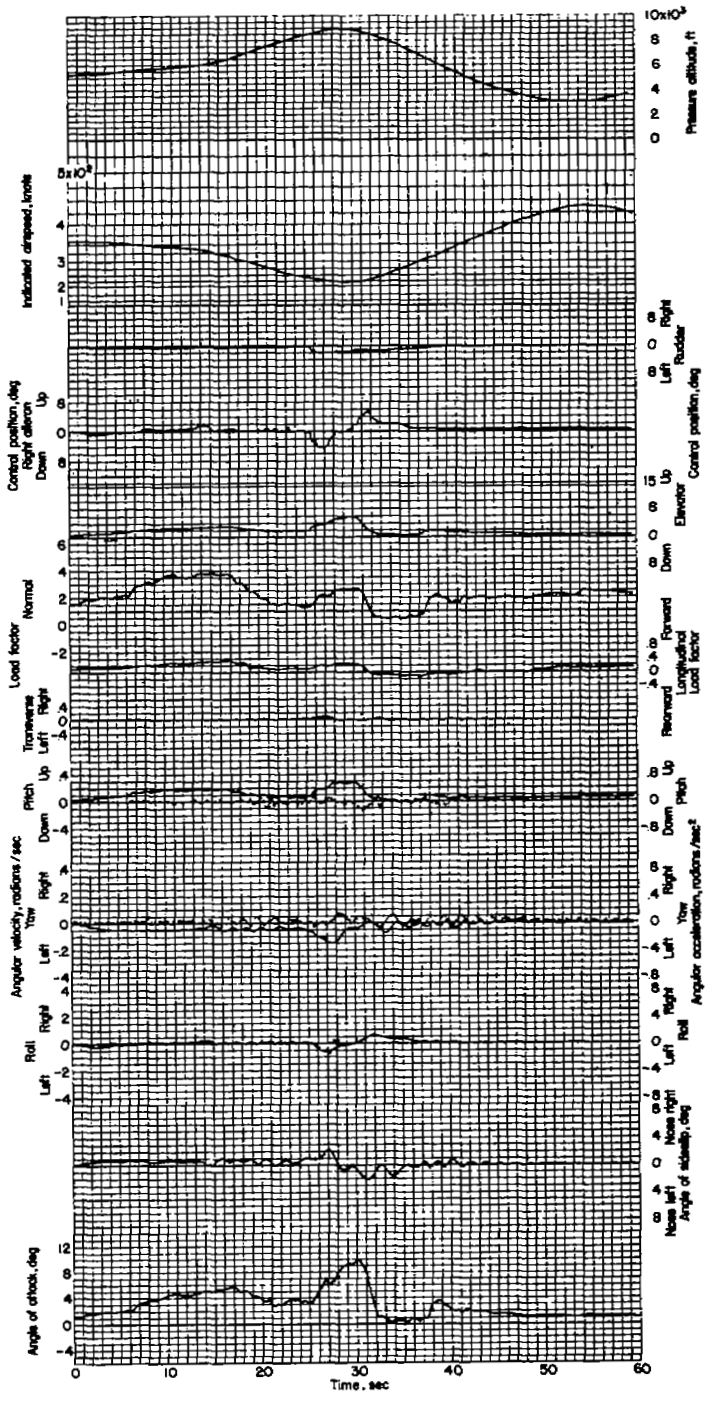
Figure 113.- Wing-over. Airplane weight, 16,050 pounds; center of gravity at 24.2 percent M.A.C.; flight 3.



(b)

Figure 113.- Concluded.

[redacted]



NACA

Figure 114.- Wing-over into dive-bombing run. Airplane weight, 15,510 pounds; center of gravity at 23.8 percent M.A.C.; flight 8.

[redacted]

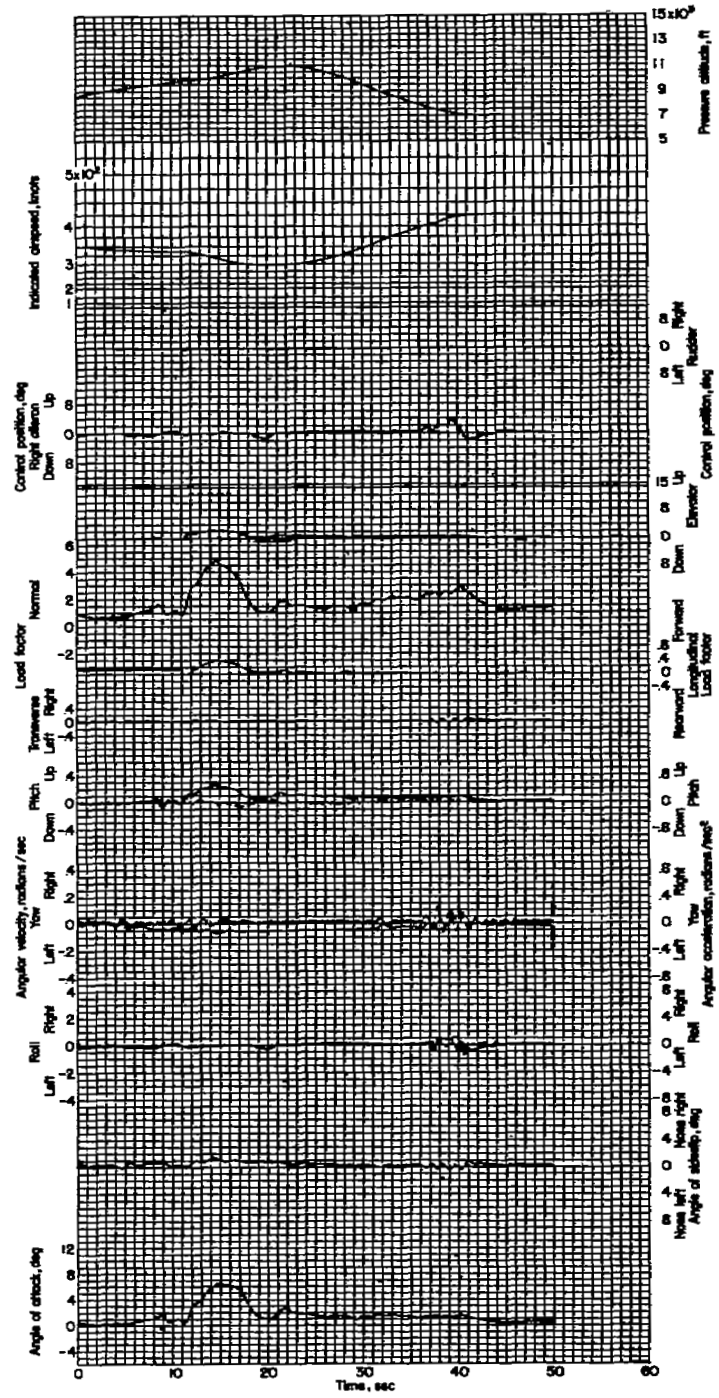


Figure 115.- Wing-over. Airplane weight, 14,110 pounds; center of gravity at 25.6 percent M.A.C.; flight 8.

[redacted]

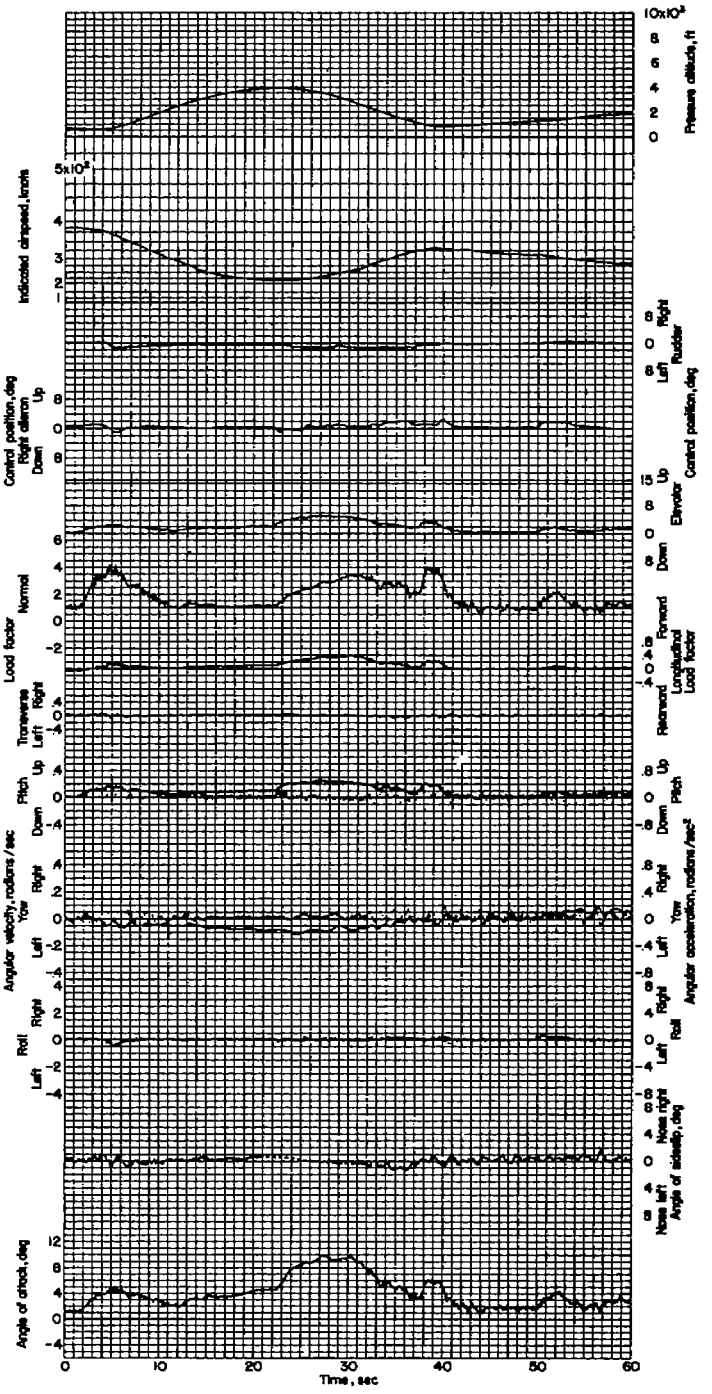


Figure 116.- Wing-over. Airplane weight, 15,150 pounds; center of gravity at 24.1 percent M.A.C.; flight 11.

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[redacted]

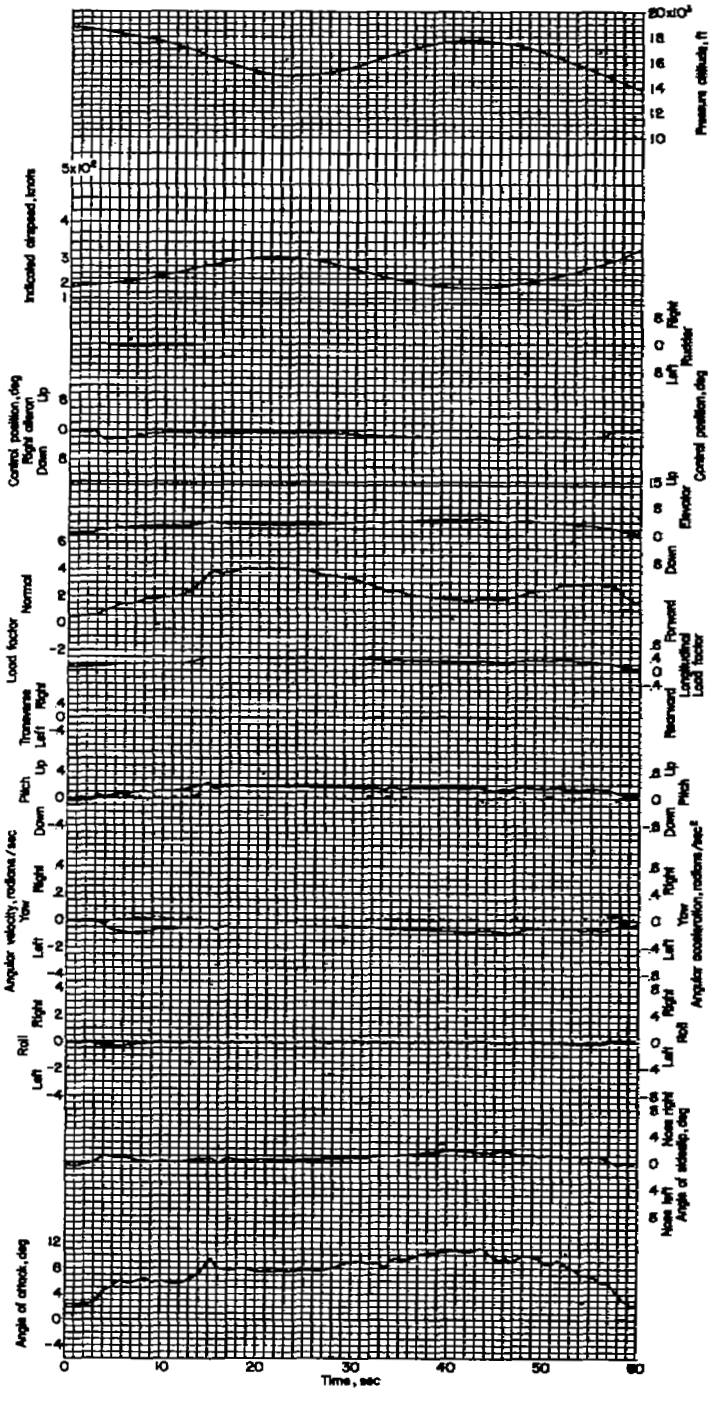


Figure 117.- Wing-over. Airplane weight, 16,110 pounds; center of gravity at 24.2 percent M.A.C.; flight 14.

[redacted]

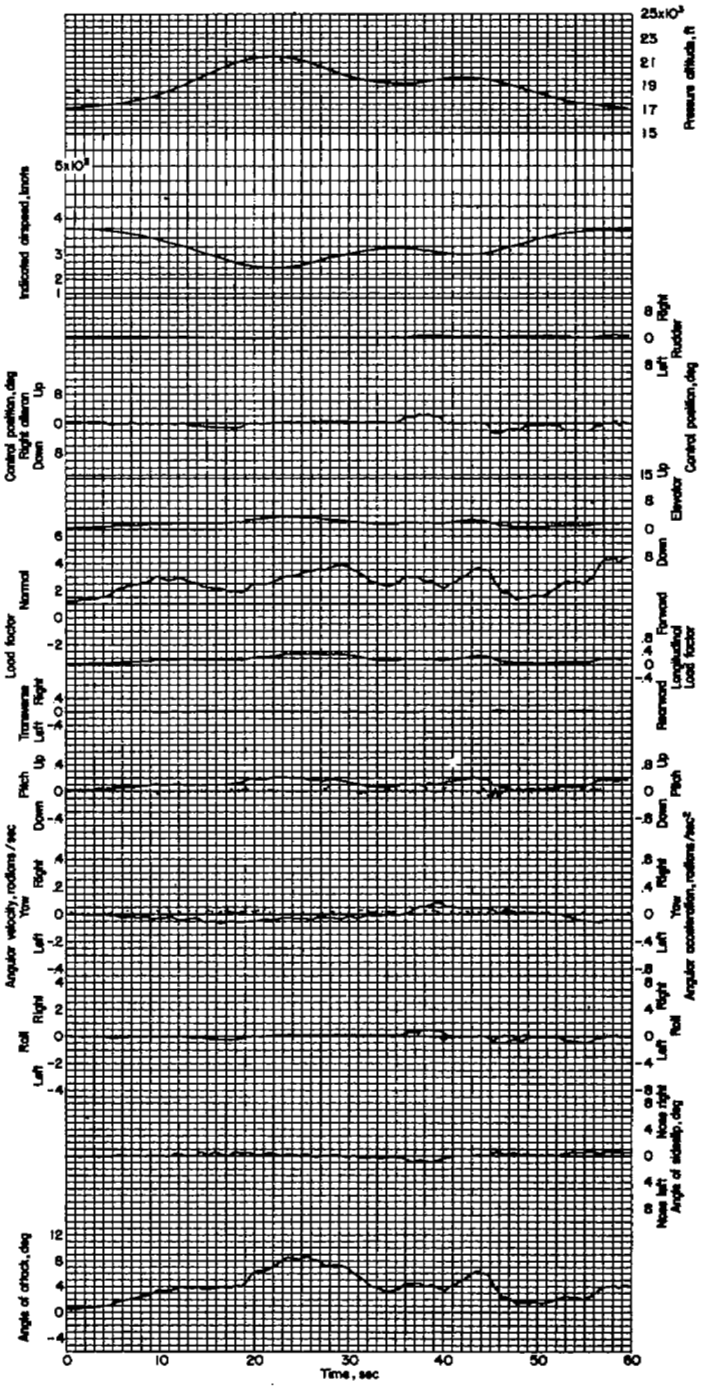
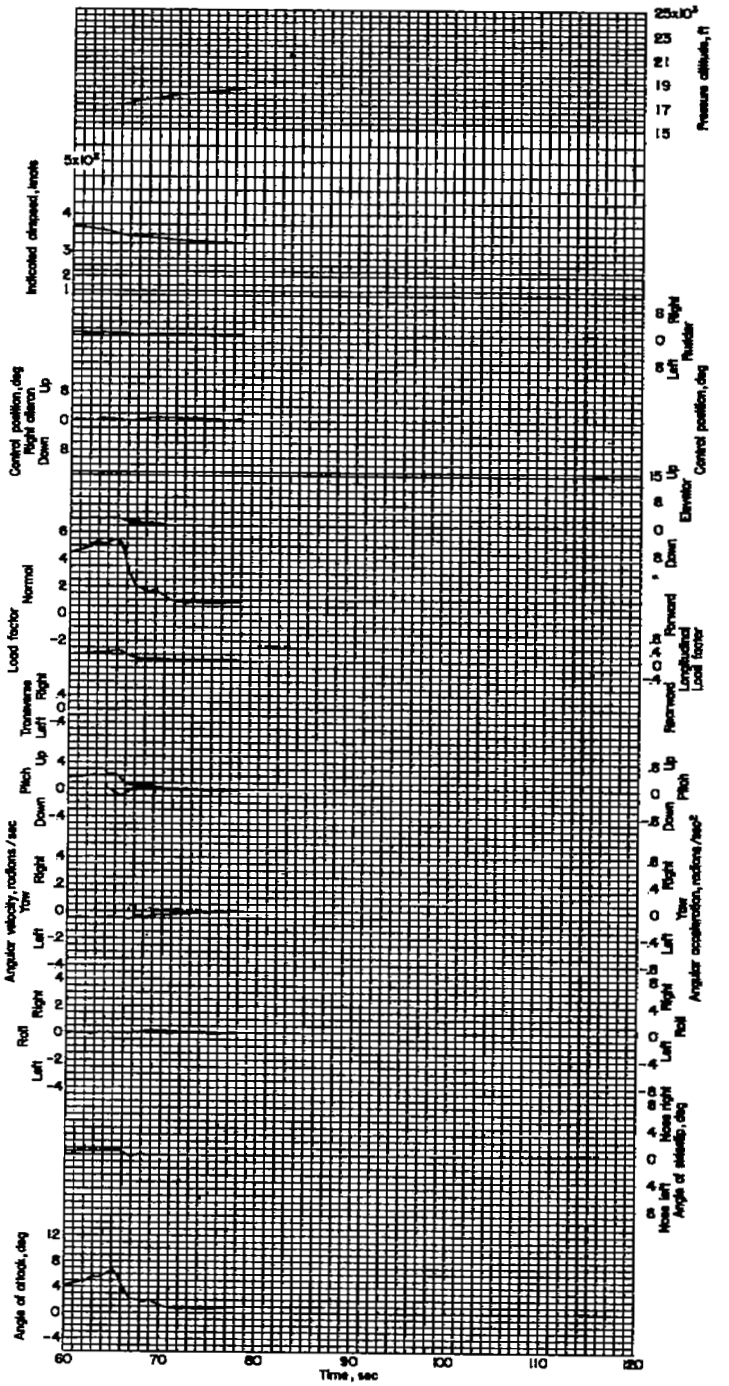
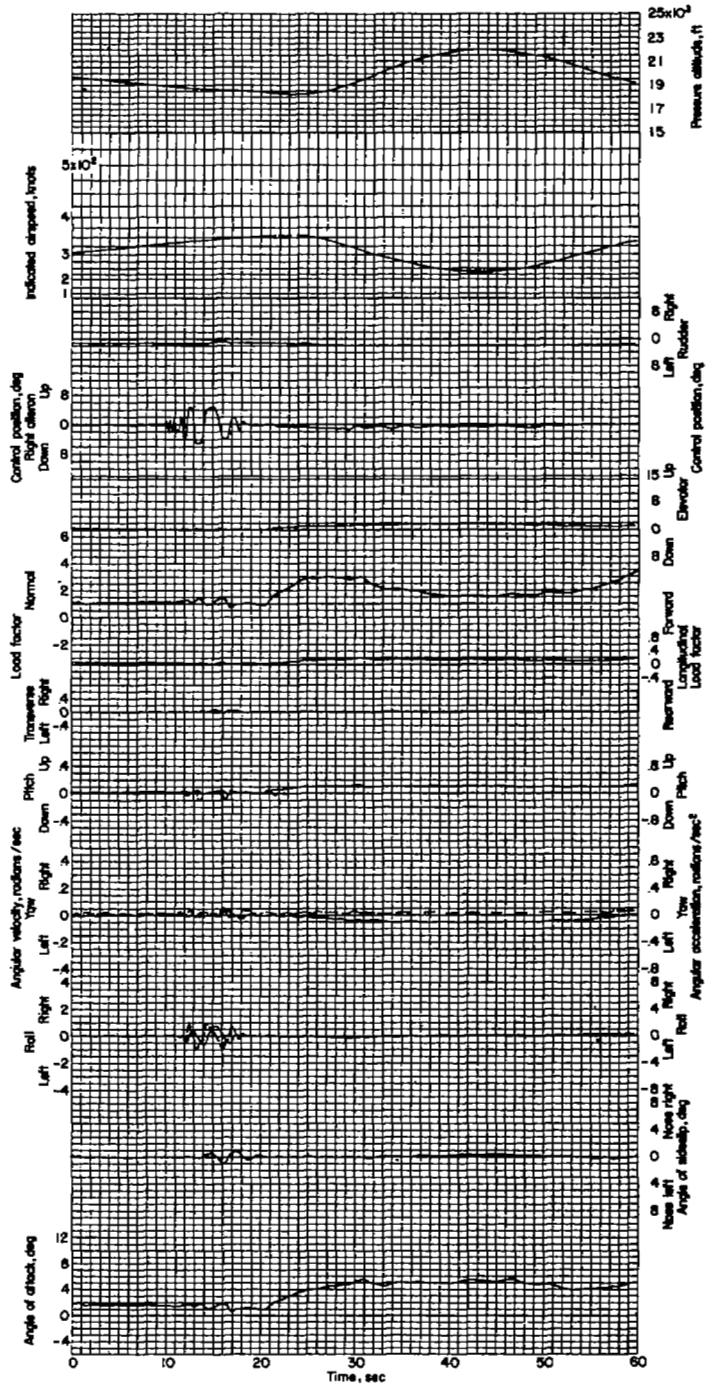


Figure 118.- Wing-over followed by right and left turn. Airplane weight, 15,740 pounds; center of gravity at 24.0 percent M.A.C.; flight 14.



(b)

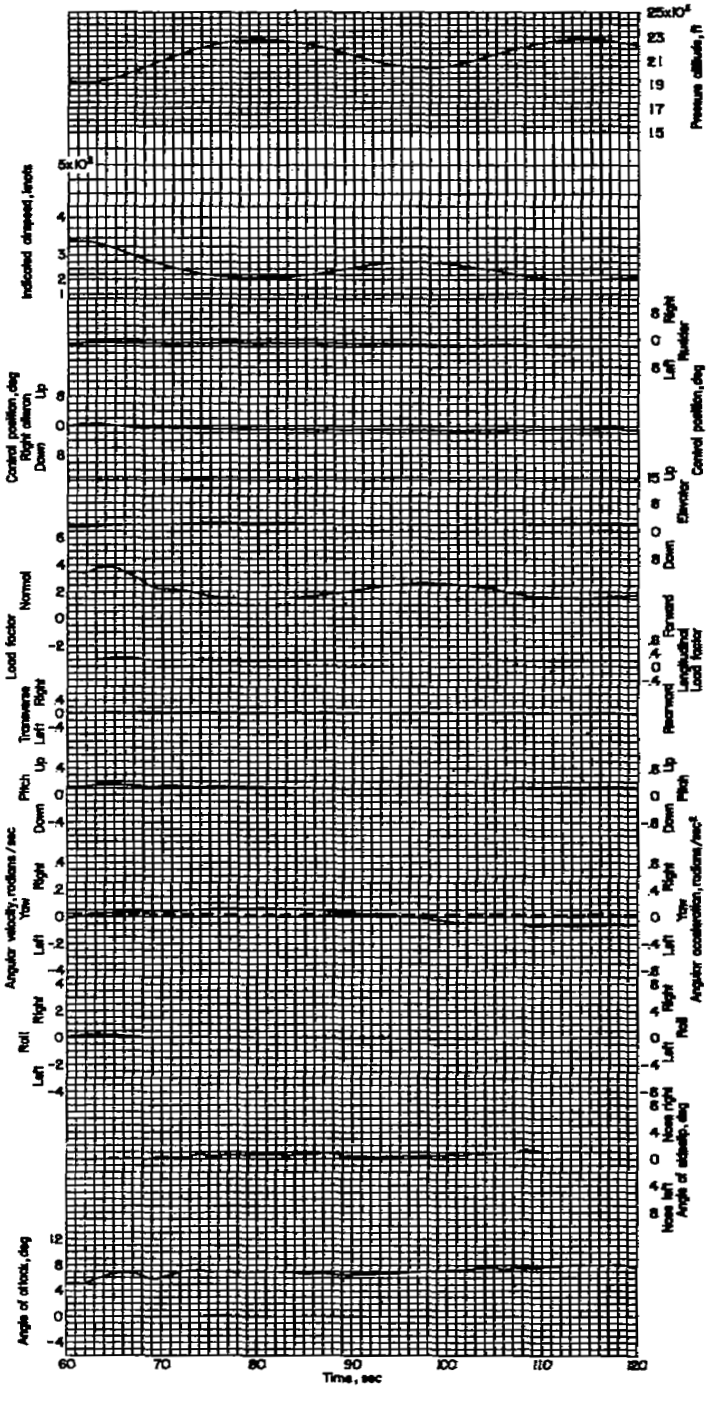
Figure 118.- Concluded.



(a)

Figure 119.- Lazy eight. Airplane weight, 17,580 pounds; center of gravity at 25.0 percent M.A.C.; flight 2.

[redacted]



(b)

Figure 119.- Concluded.

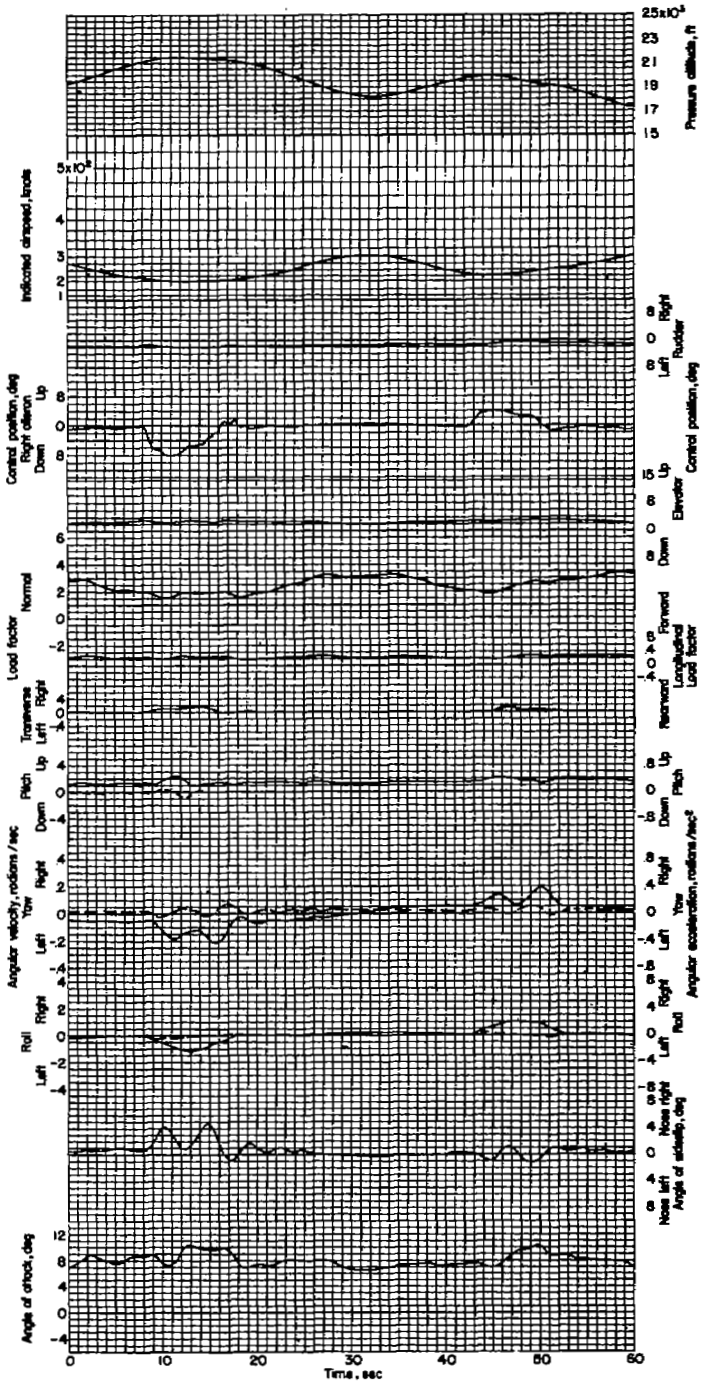
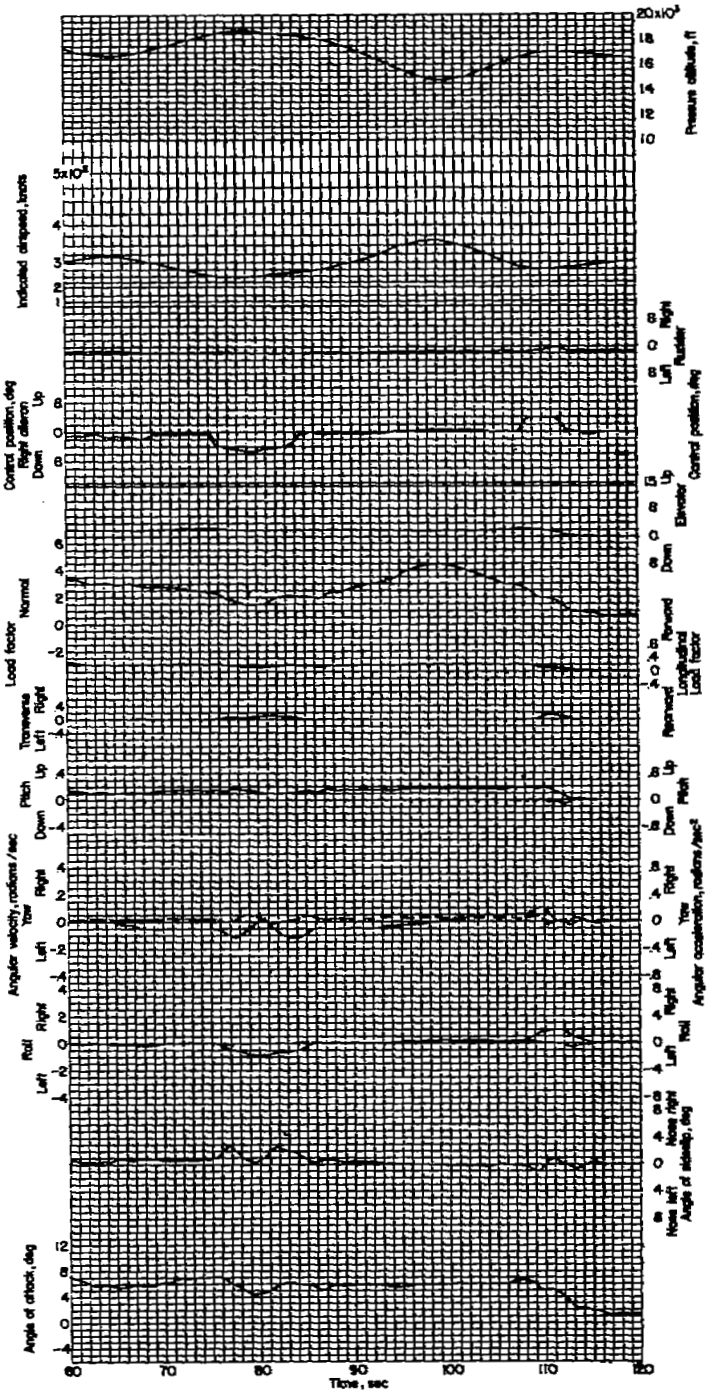


Figure 120.- Two lazy eights with aileron rolls. Airplane weight, 17,450 pounds; center of gravity at 24.9 percent M.A.C.; flight 2.

[redacted]

5X



(b)

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Figure 120.- Concluded.

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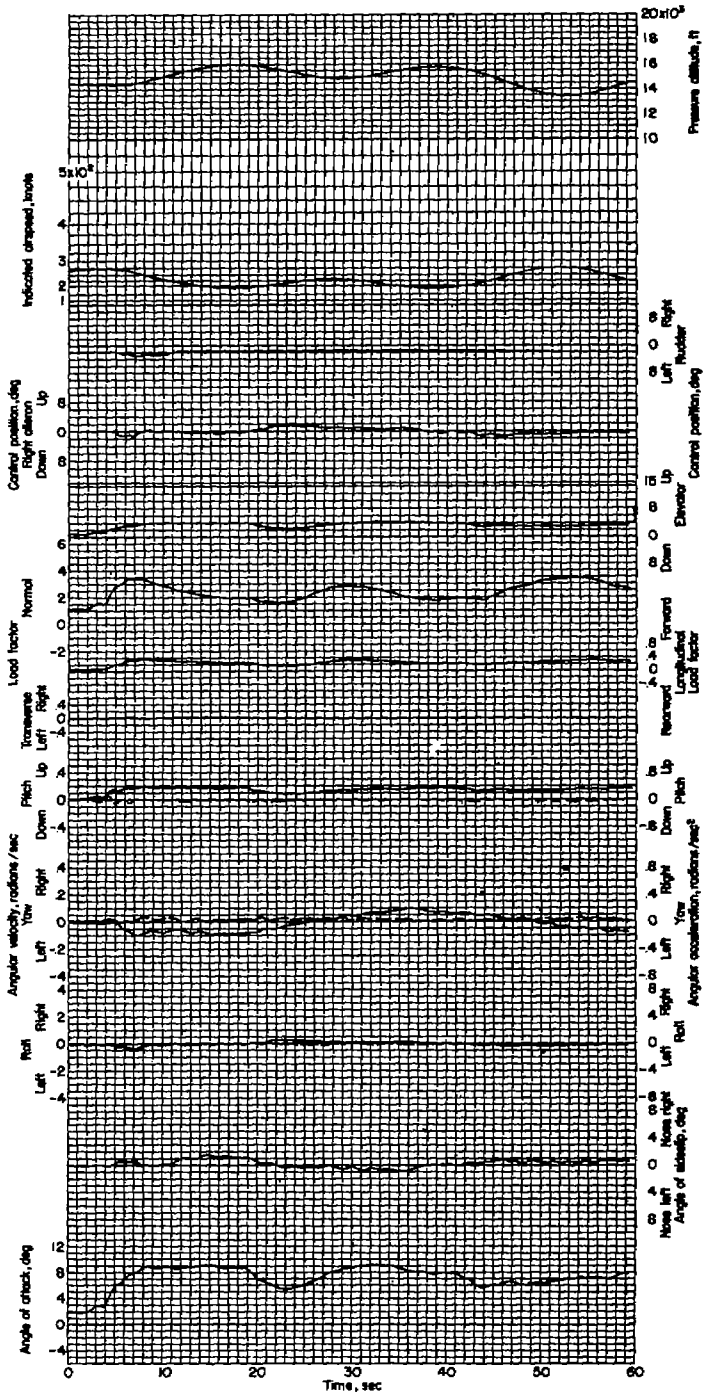
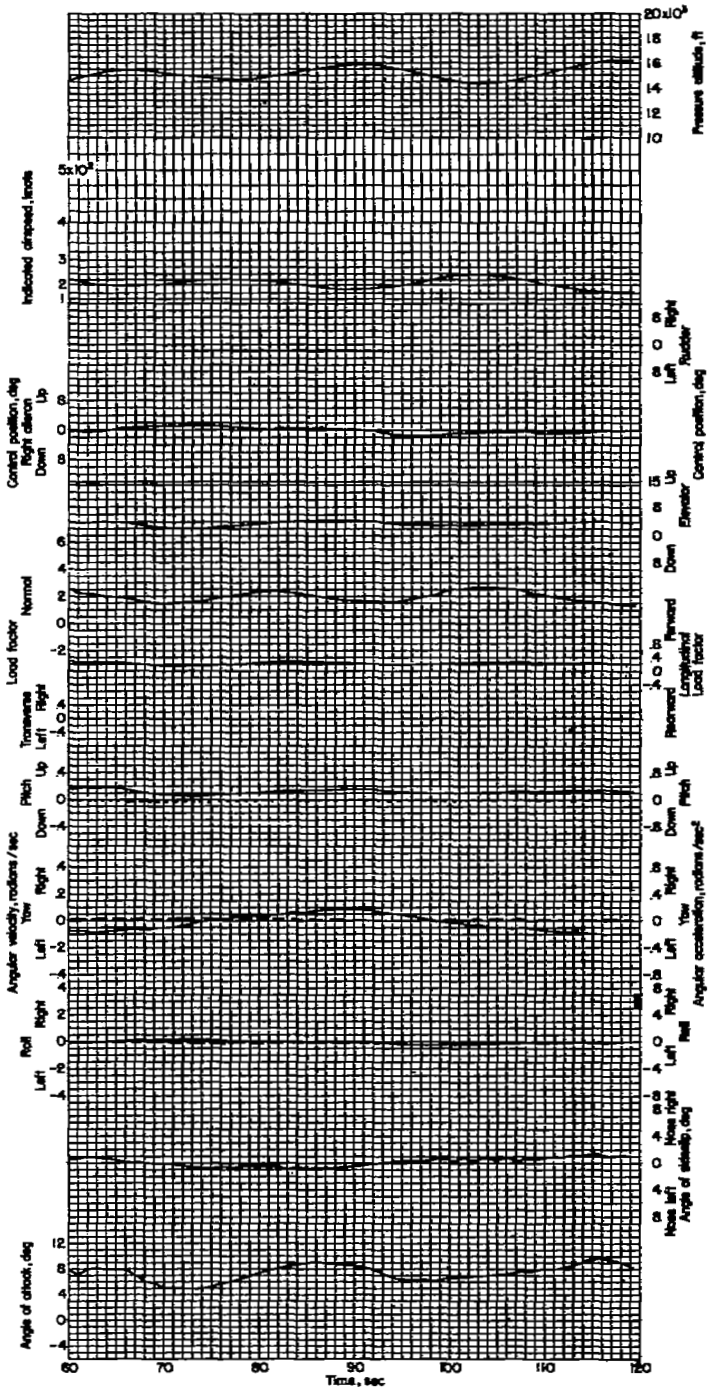


Figure 121.- Two lazy eights. Airplane weight, 15,510 pounds; center of gravity at 23.8 percent M.A.C.; flight 2.

[redacted]



(b)

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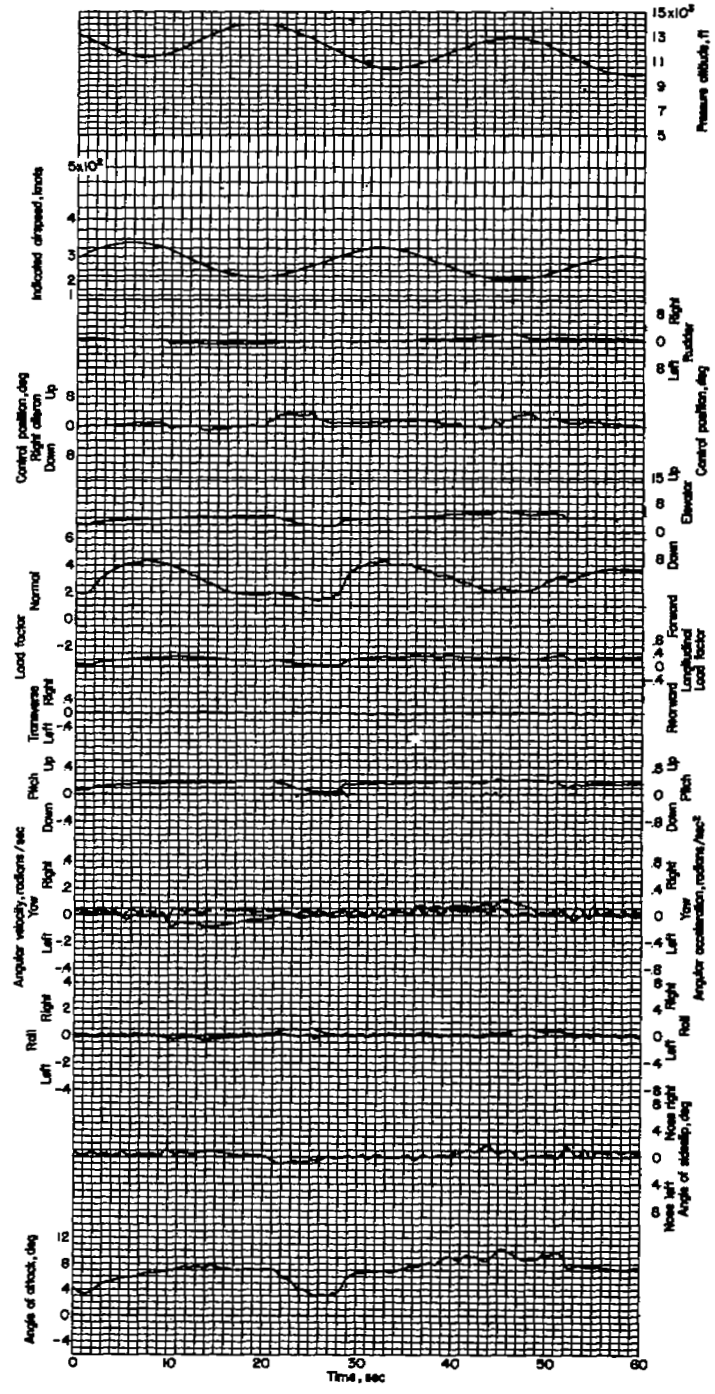
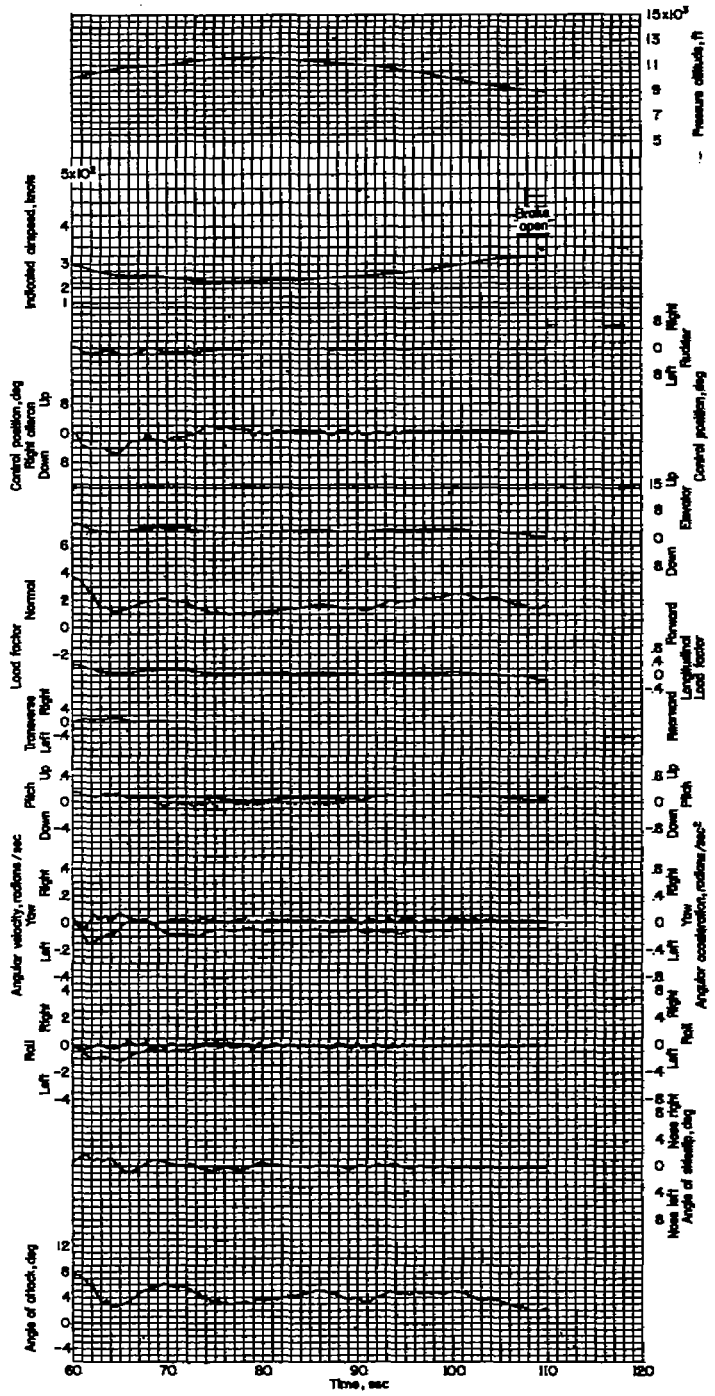
Figure 121.- Concluded.



(a)

Figure 122.- Lazy eight followed by left barrel roll into left turn. Airplane weight, 15,560 pounds; center of gravity at 23.9 percent M.A.C.; flight 17.

[redacted]



(b)

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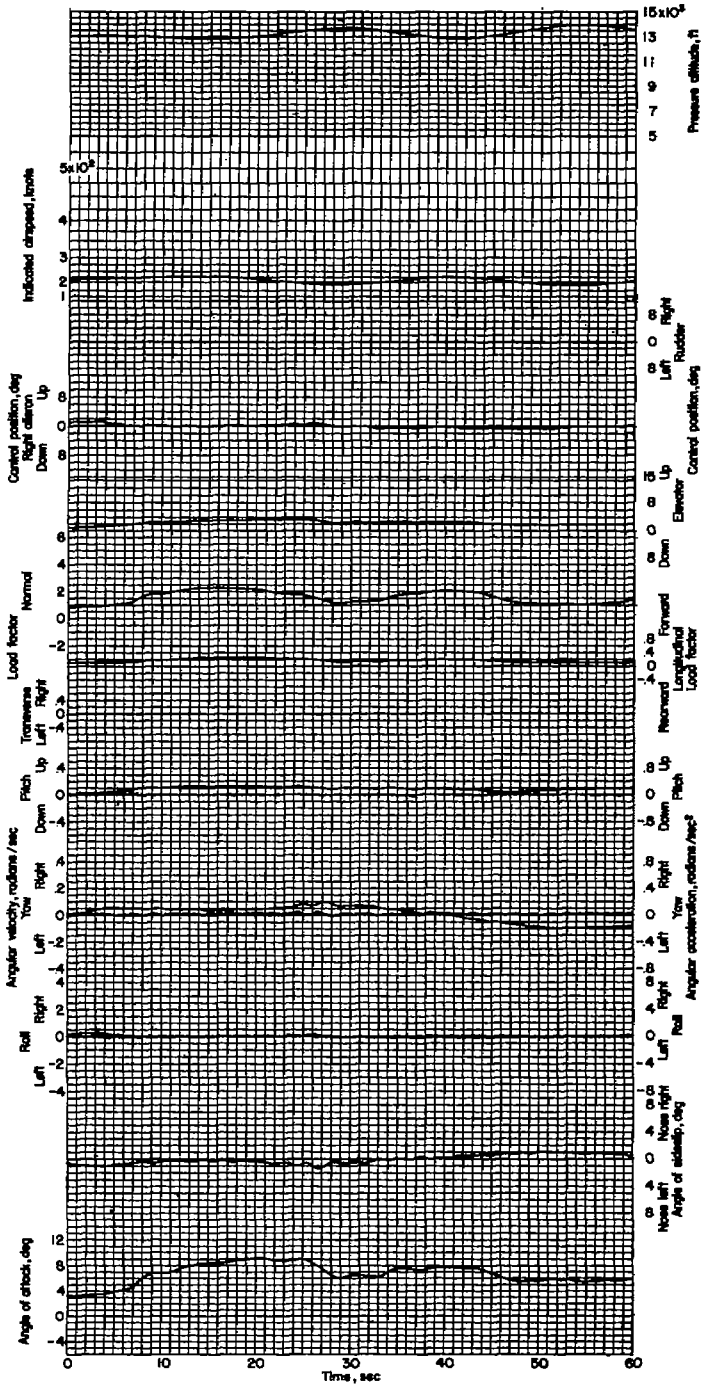
Figure 122.- Concluded.

[redacted]



(a)

Figure 123.- Right turn into lazy eight. Airplane weight, 14,410 pounds; center of gravity at 24.3 percent M.A.C.; flight 20.

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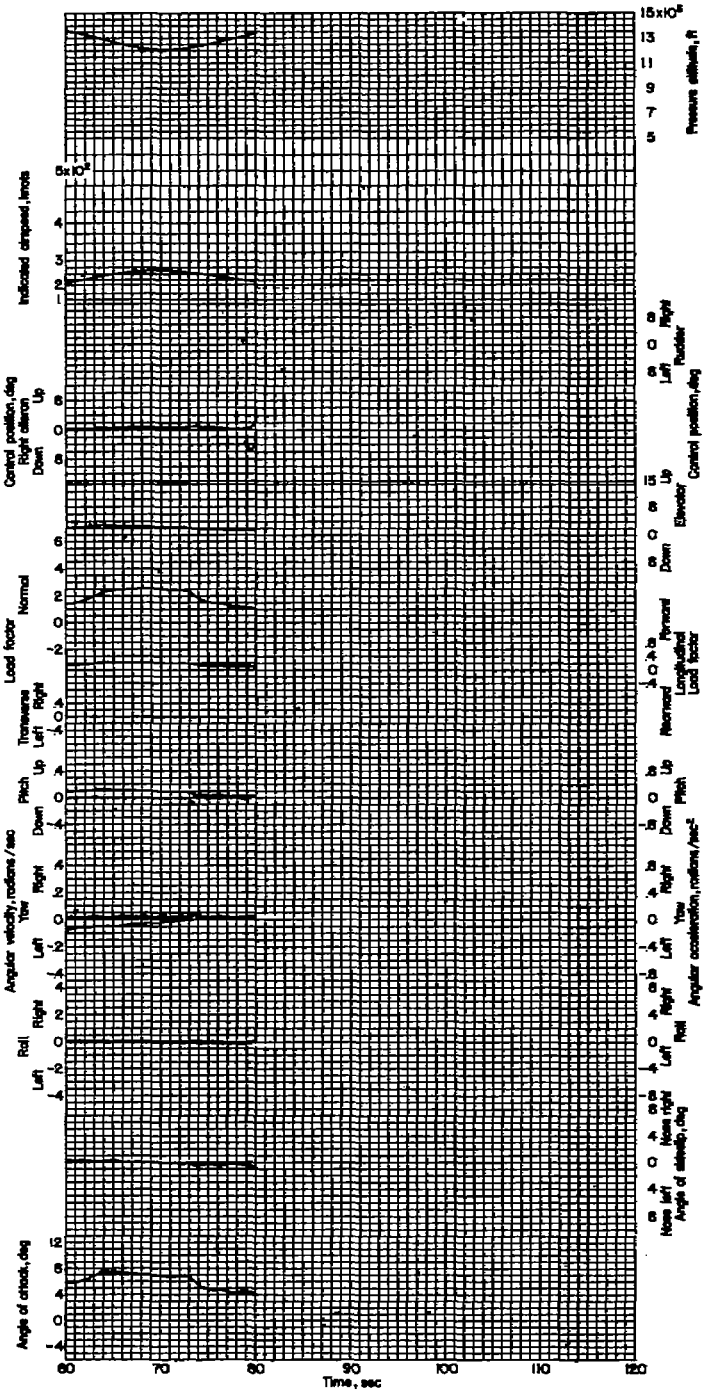
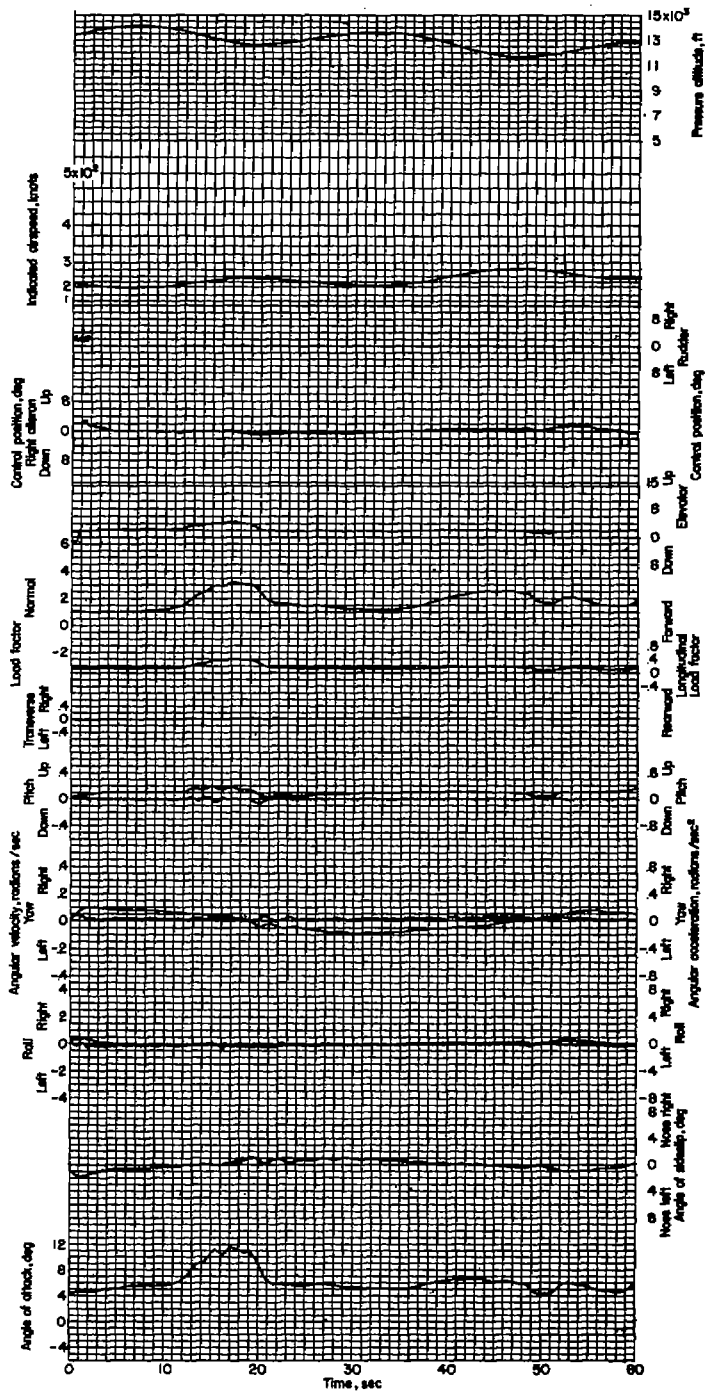


(b)

NACA

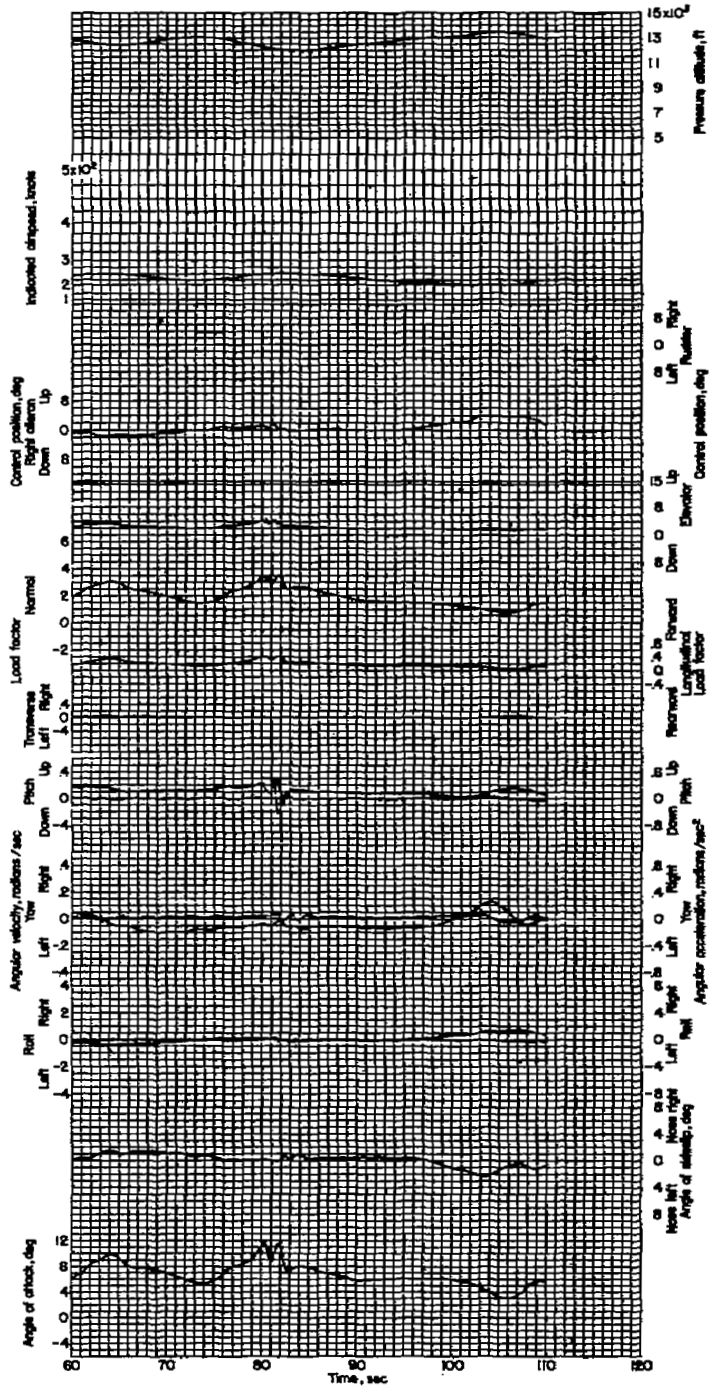
Figure 123.- Concluded.



(a)

Figure 124.- Two lazy eights into left turn and right aileron roll. Airplane weight, 14,370 pounds; center of gravity at 24.3 percent M.A.C.; flight 20.

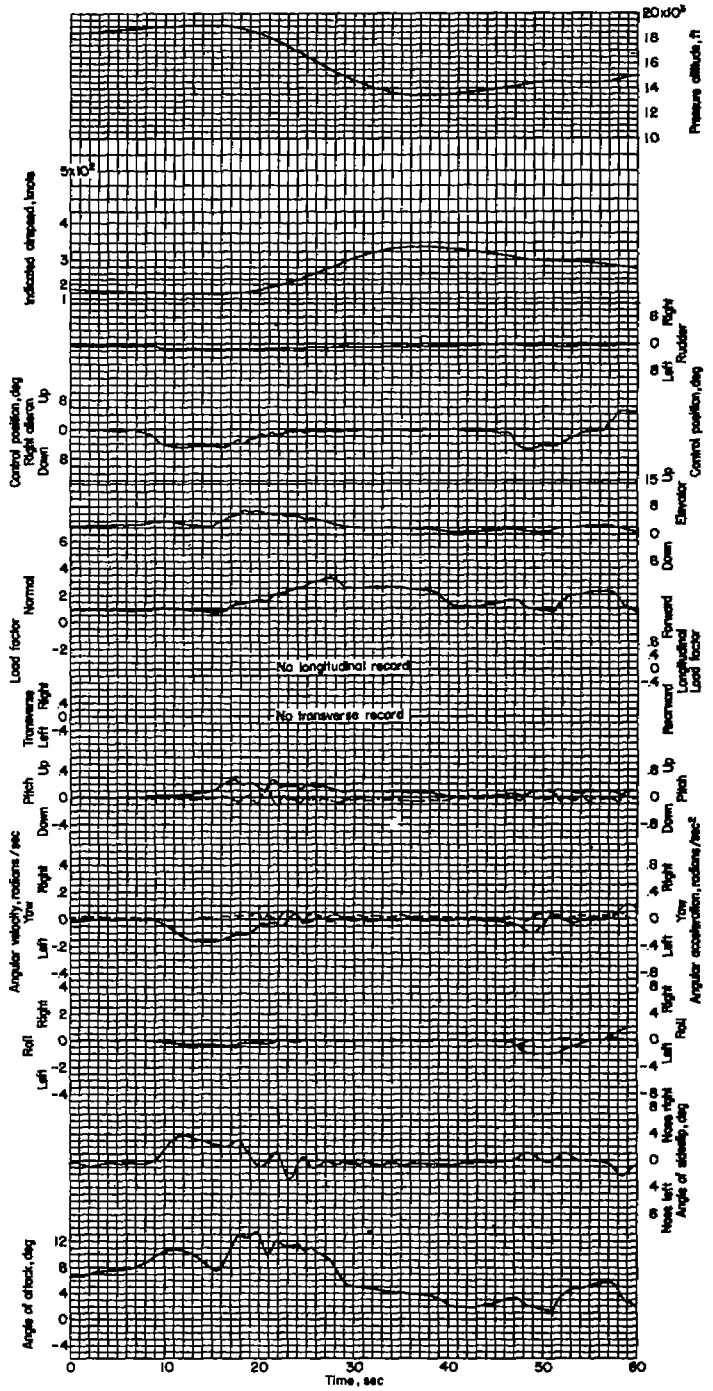
[redacted]



(b)

Figure 124.- Concluded.

[redacted]

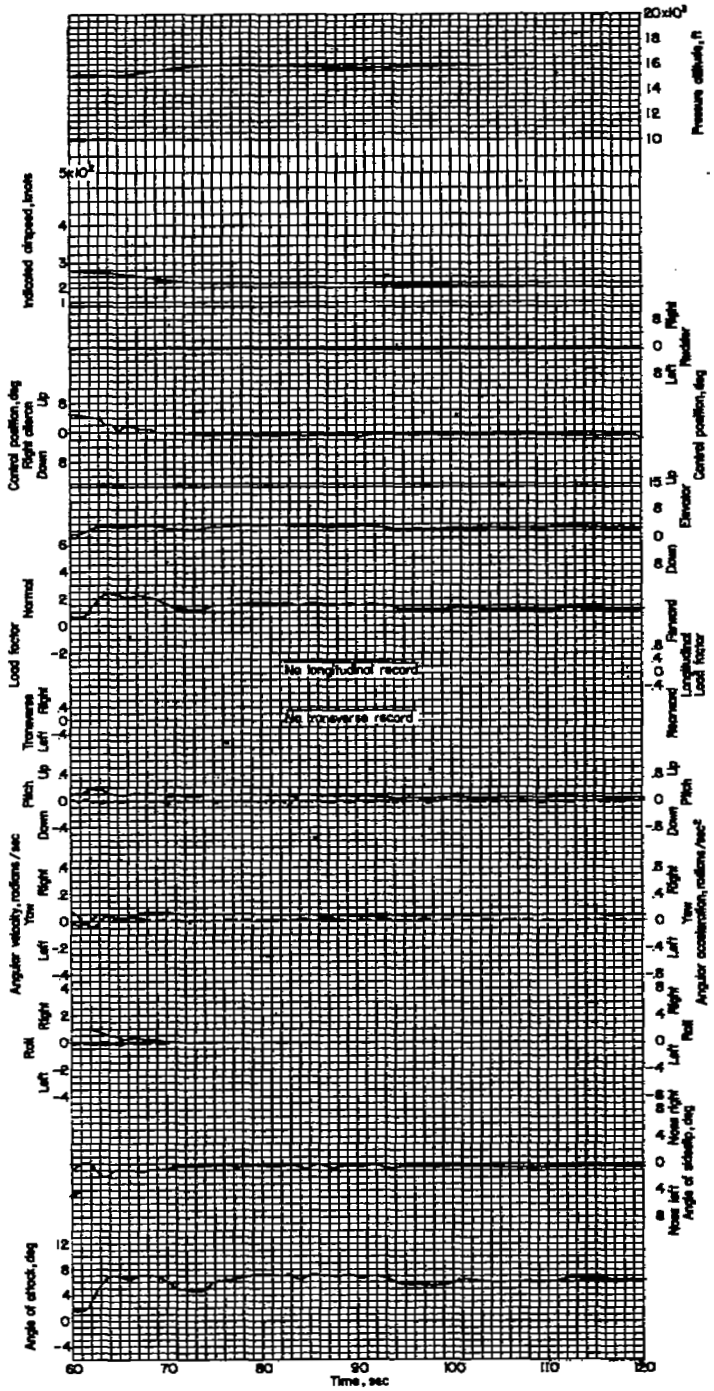


(a)

NACA

Figure 125.- Peel-off into dive with pull-out into left and right aileron roll. Airplane weight, 16,470 pounds; center of gravity at 24.4 percent M.A.C.; flight 1.

[redacted]L



(b)

Figure 125.- Concluded.

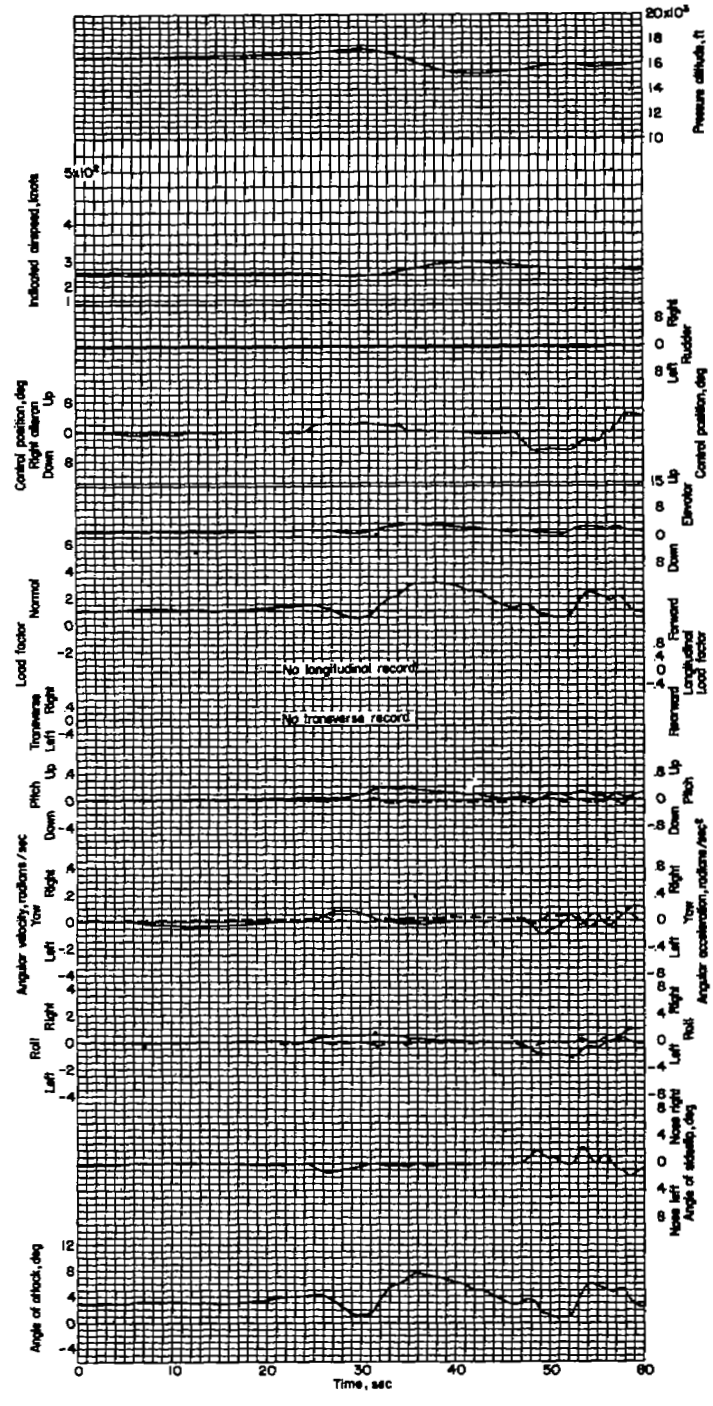
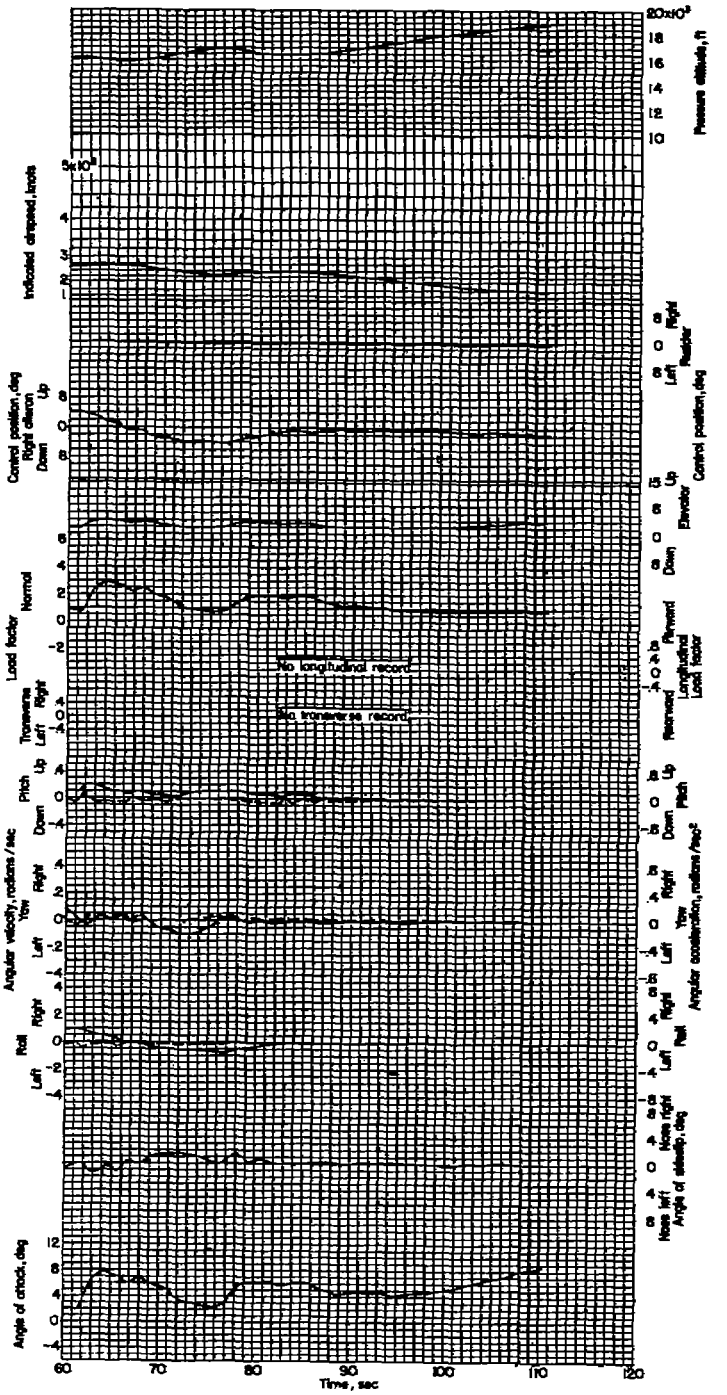


Figure 126.- Peel-off into diving turn followed by series of aileron rolls. Airplane weight, 16,000 pounds; center of gravity at 24.1 percent M.A.C.; flight 1.

[redacted]



(b)

Figure 126.- Concluded.

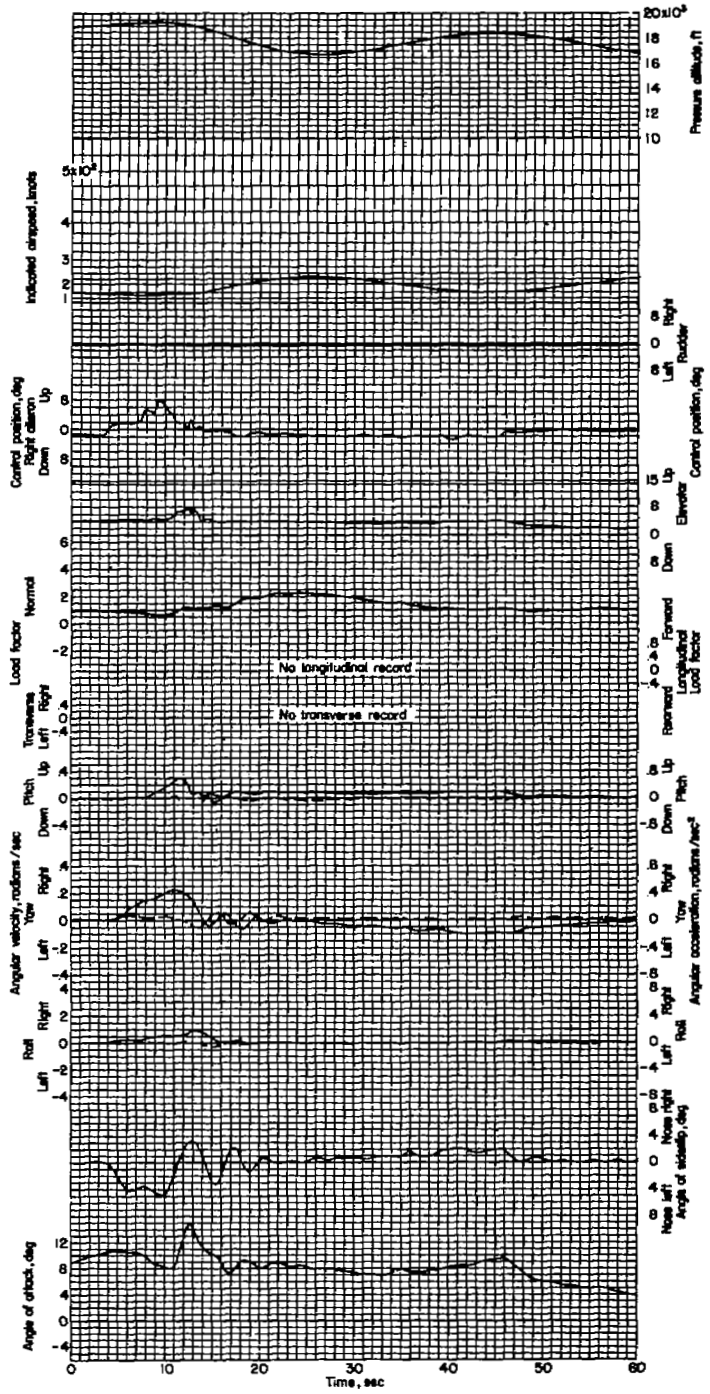


Figure 127.- Right aileron roll followed by left turn. Airplane weight, 15,950 pounds; center of gravity at 24.1 percent M.A.C.; flight 1.

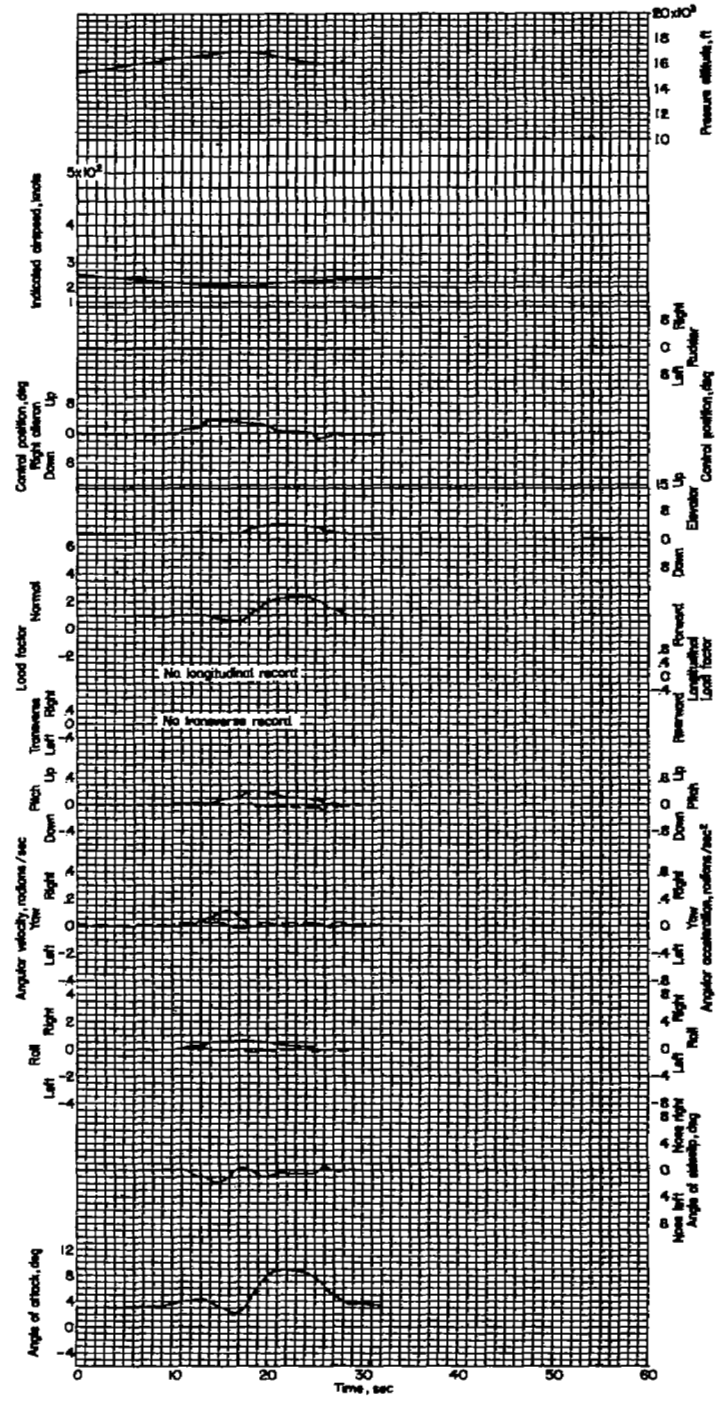
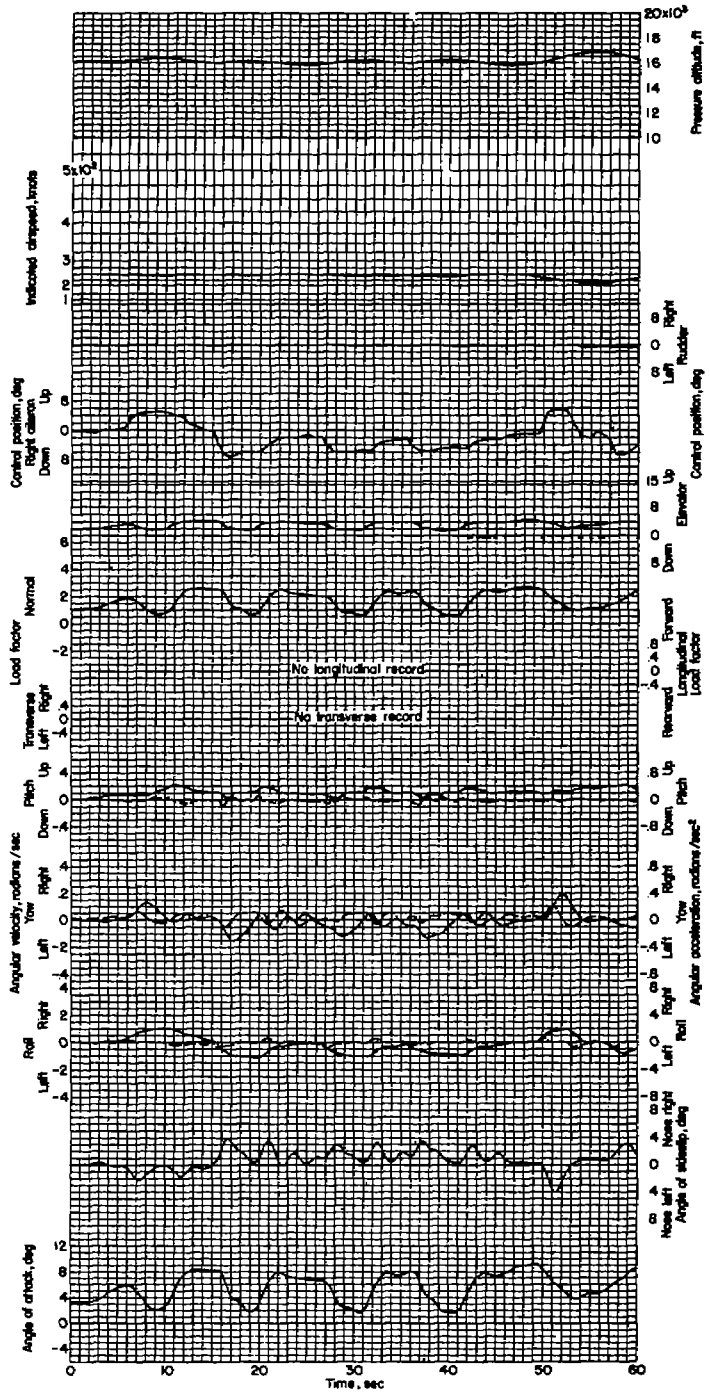


Figure 128.- Right aileron roll. Airplane weight, 15,820 pounds; center of gravity at 24.0 percent M.A.C.; flight 1.

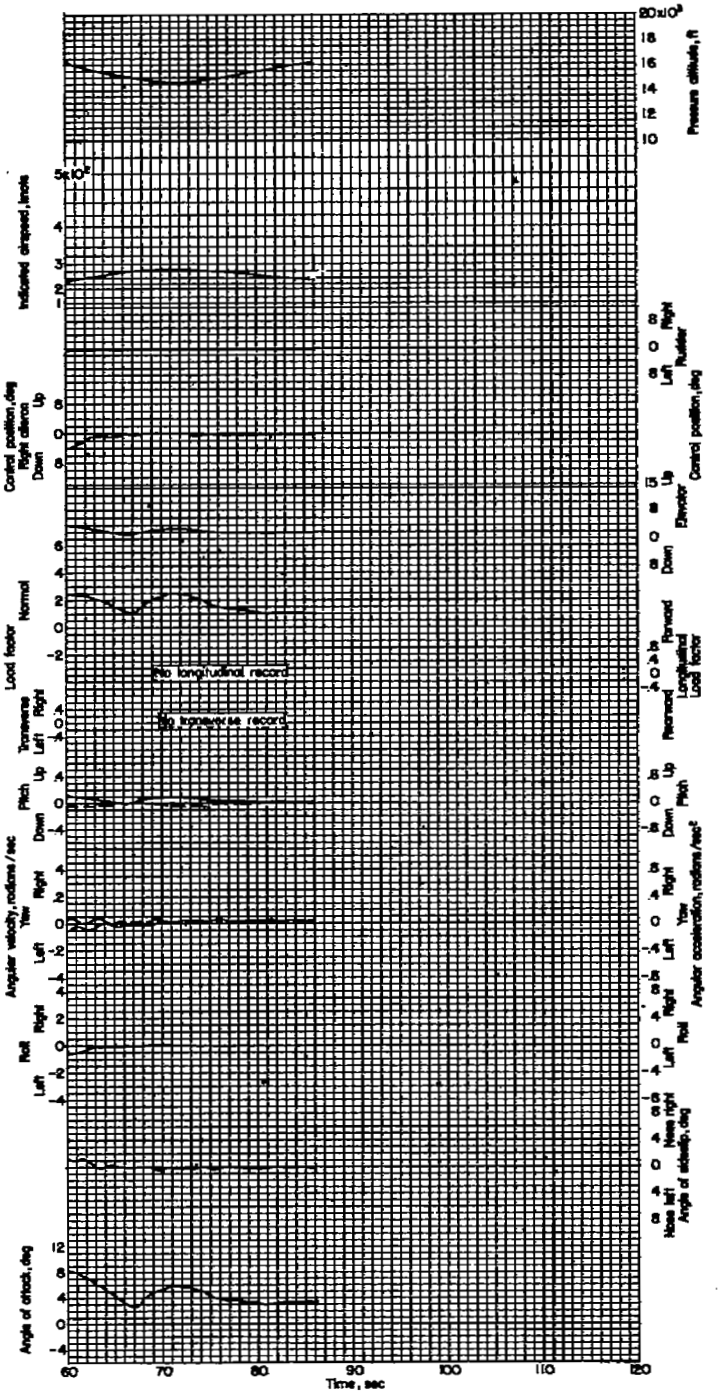


(a)

NACA

Figure 129.- Right aileron roll followed by three left aileron rolls with vertical recovery and pull-out. Airplane weight, 15,780 pounds; center of gravity at 24.0 percent M.A.C.; flight 1.

[redacted]

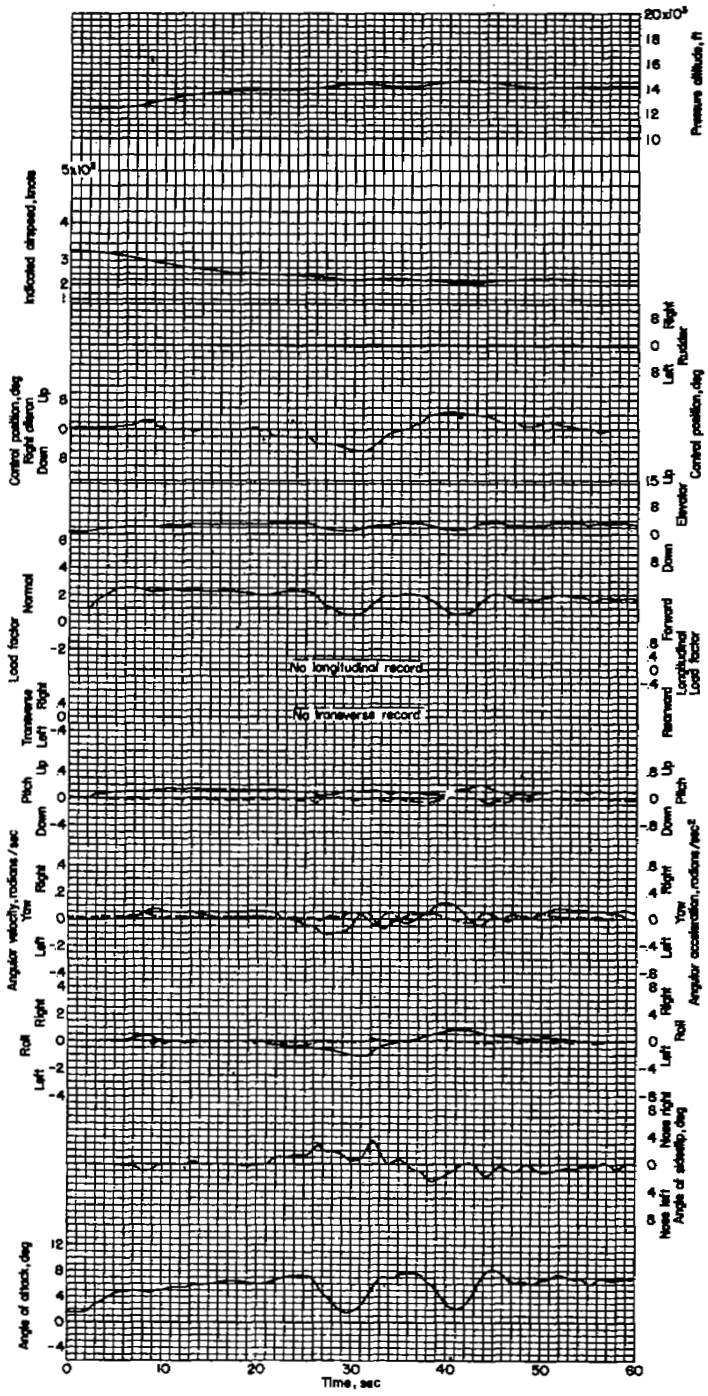


(b)

NACA

Figure 129.- Concluded.

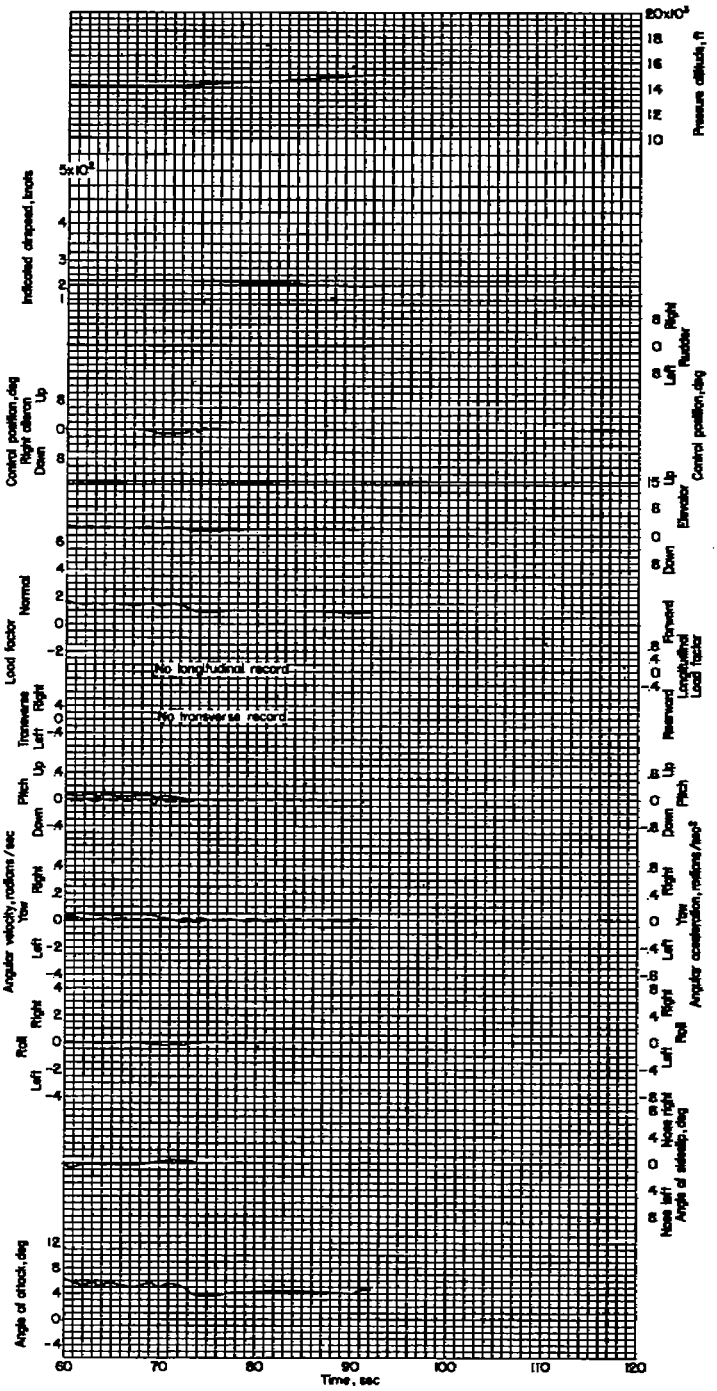
[redacted]



(a)

NACA

Figure 130.- Right turn followed by left and right aileron roll. Airplane weight, 14,870 pounds; center of gravity at 24.5 percent M.A.C.; flight 1.



(b)

Figure 130.- Concluded.

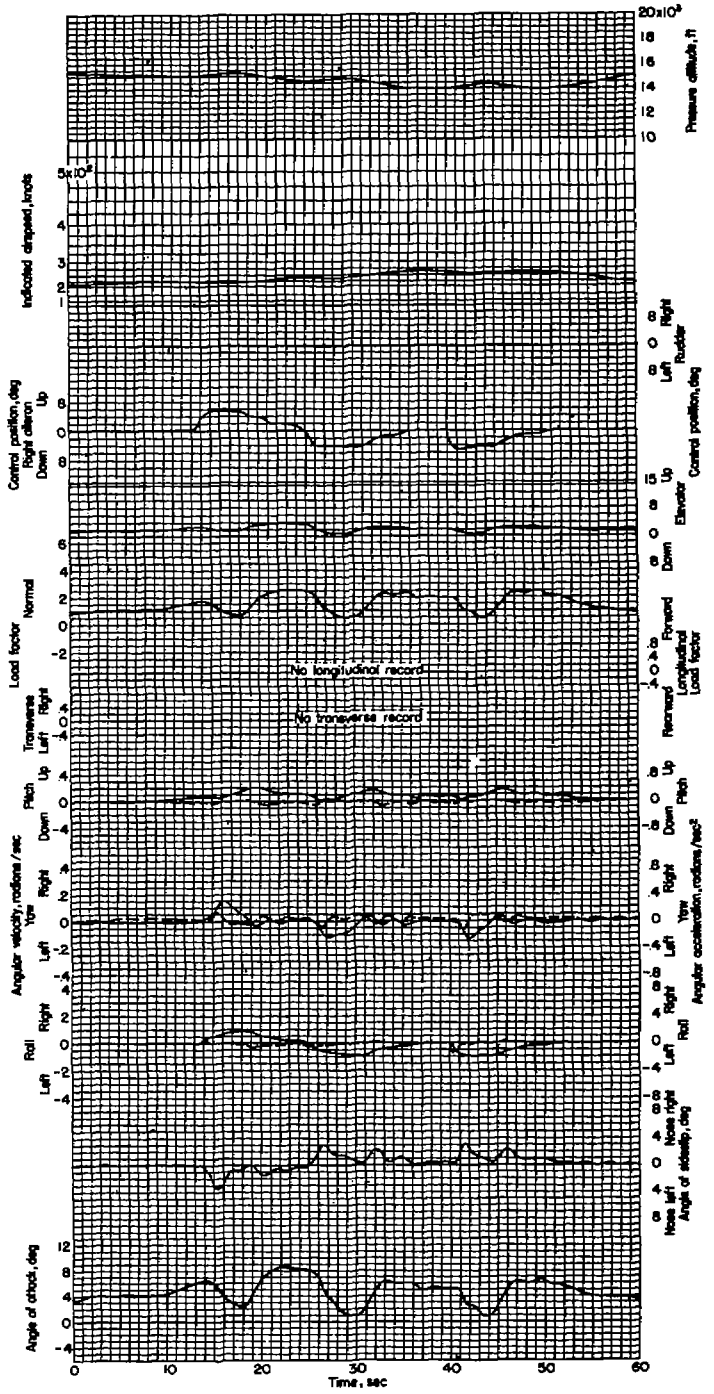
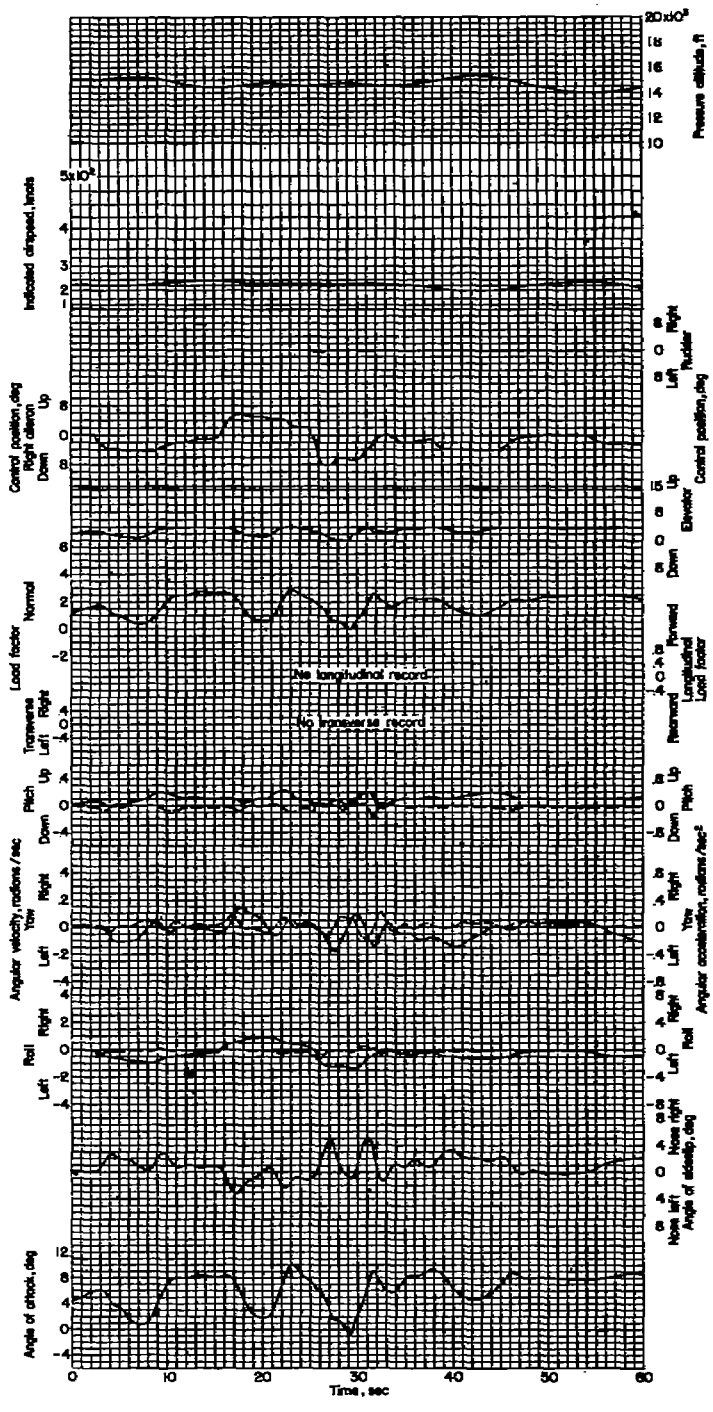
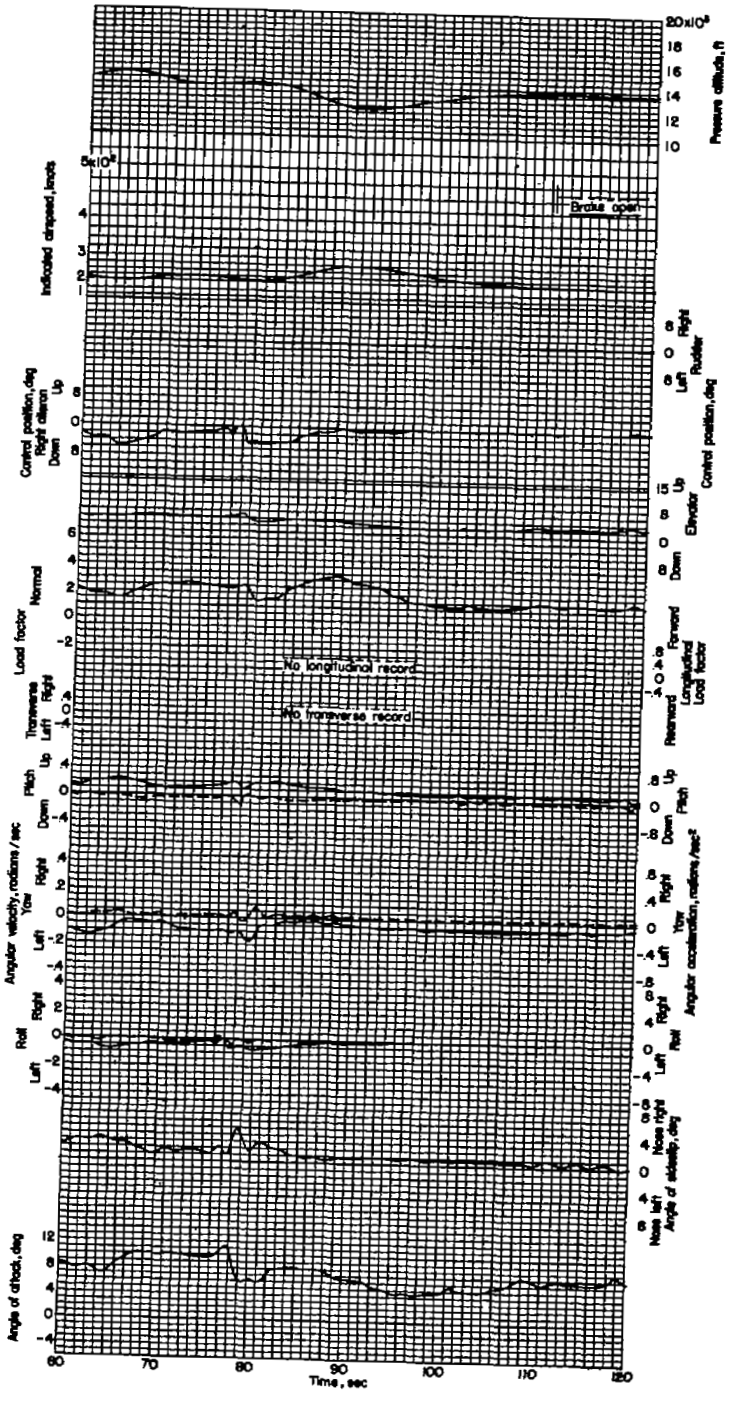


Figure 131.- Right aileron roll followed by two left aileron rolls. Airplane weight, 14,800 pounds; center of gravity at 24.6 percent M.A.C.; flight 1.



(a)

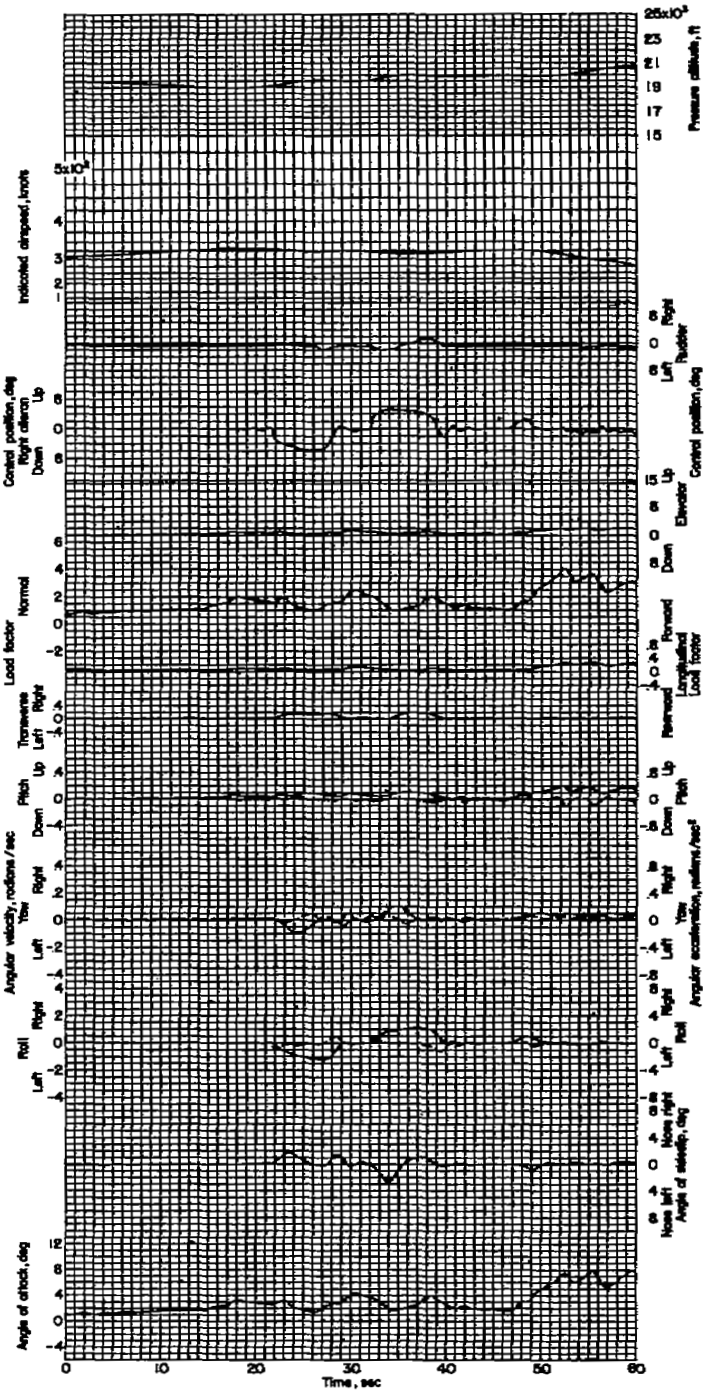
Figure 132.- Series of aileron rolls. Airplane weight, 14,610 pounds; center of gravity at 24.9 percent M.A.C.; flight 1.



(b)

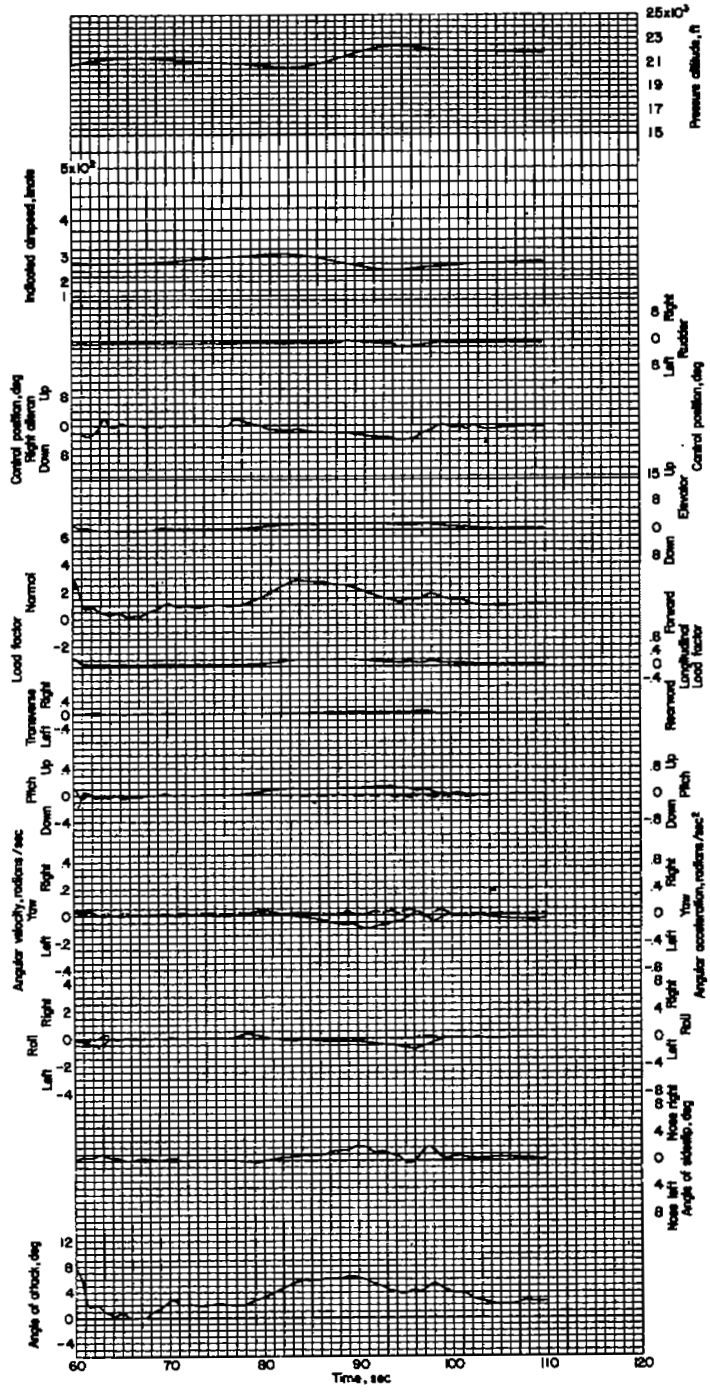
NACA

Figure 132.- Concluded.



(a)

Figure 133.- Left and right aileron roll followed by left barrel roll. Airplane weight, 17,820 pounds; center of gravity at 25.1 percent M.A.C.; flight 2.



(b)

Figure 133.- Concluded.

[redacted]

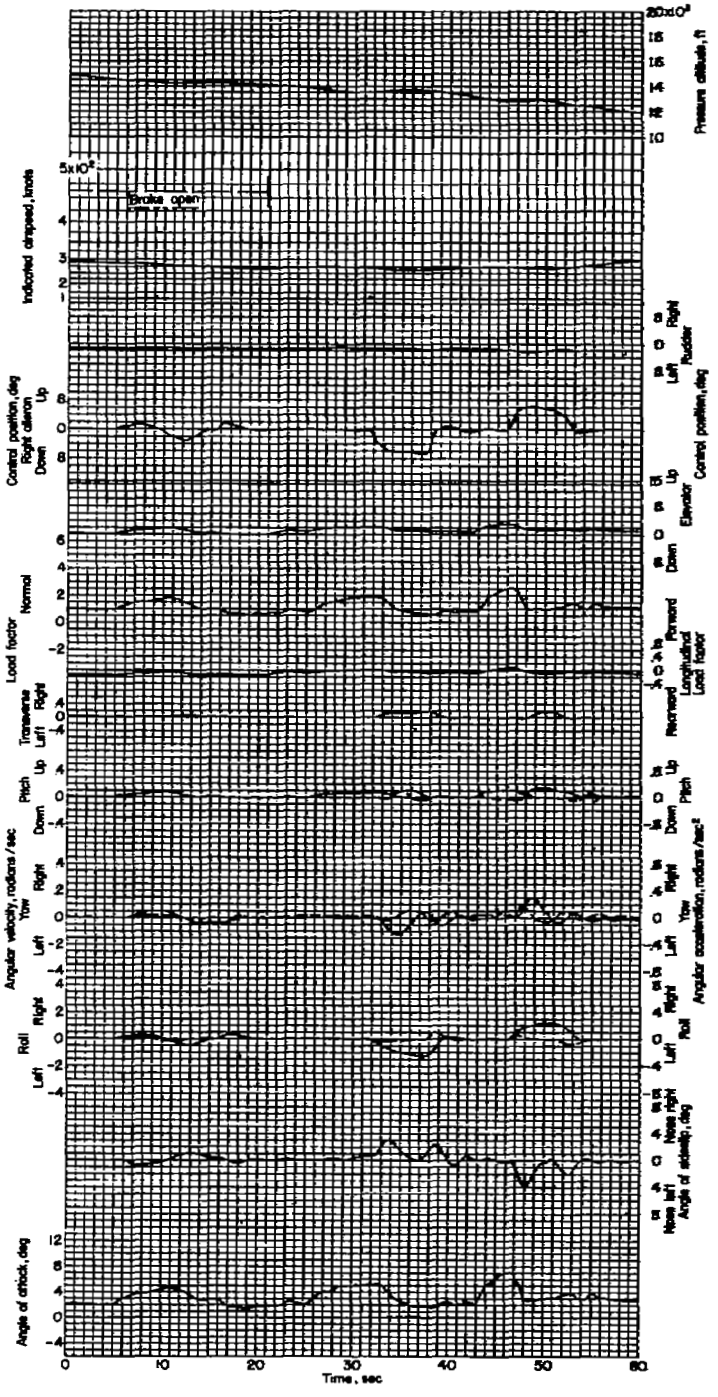


Figure 134.- Left and right aileron roll. Airplane weight, 17,200 pounds; center of gravity at 24.8 percent M.A.C.; flight 2.

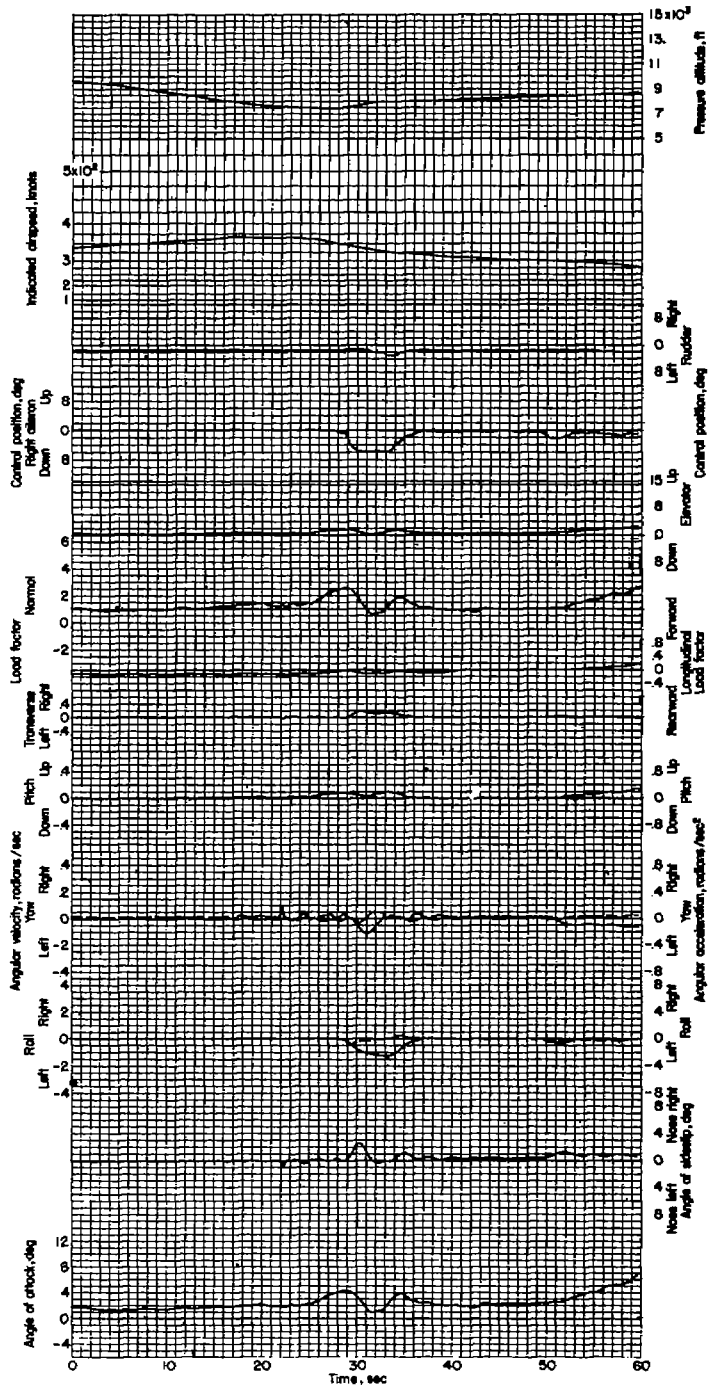
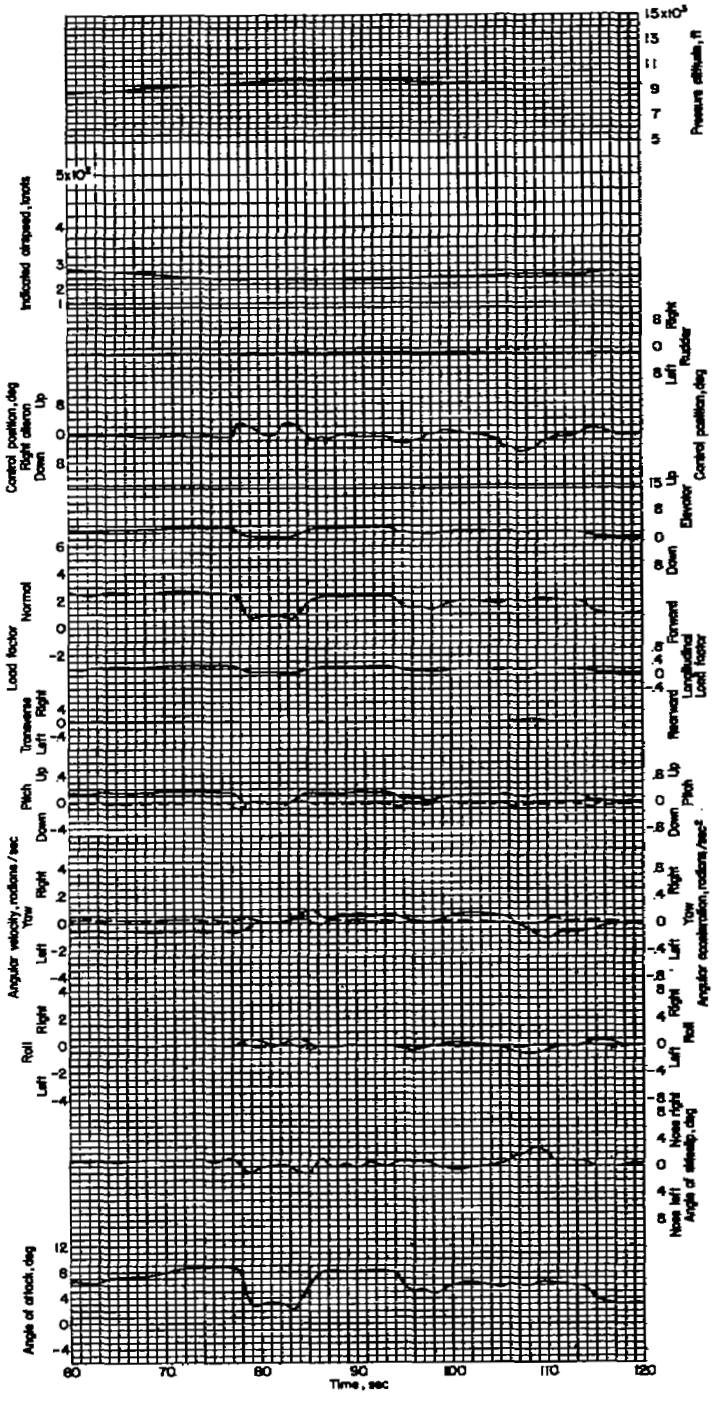


Figure 135.- Left aileron roll followed by series of turns. Airplane weight, 17,130 pounds; center of gravity at 24.7 percent M.A.C.; flight 2.

[redacted]

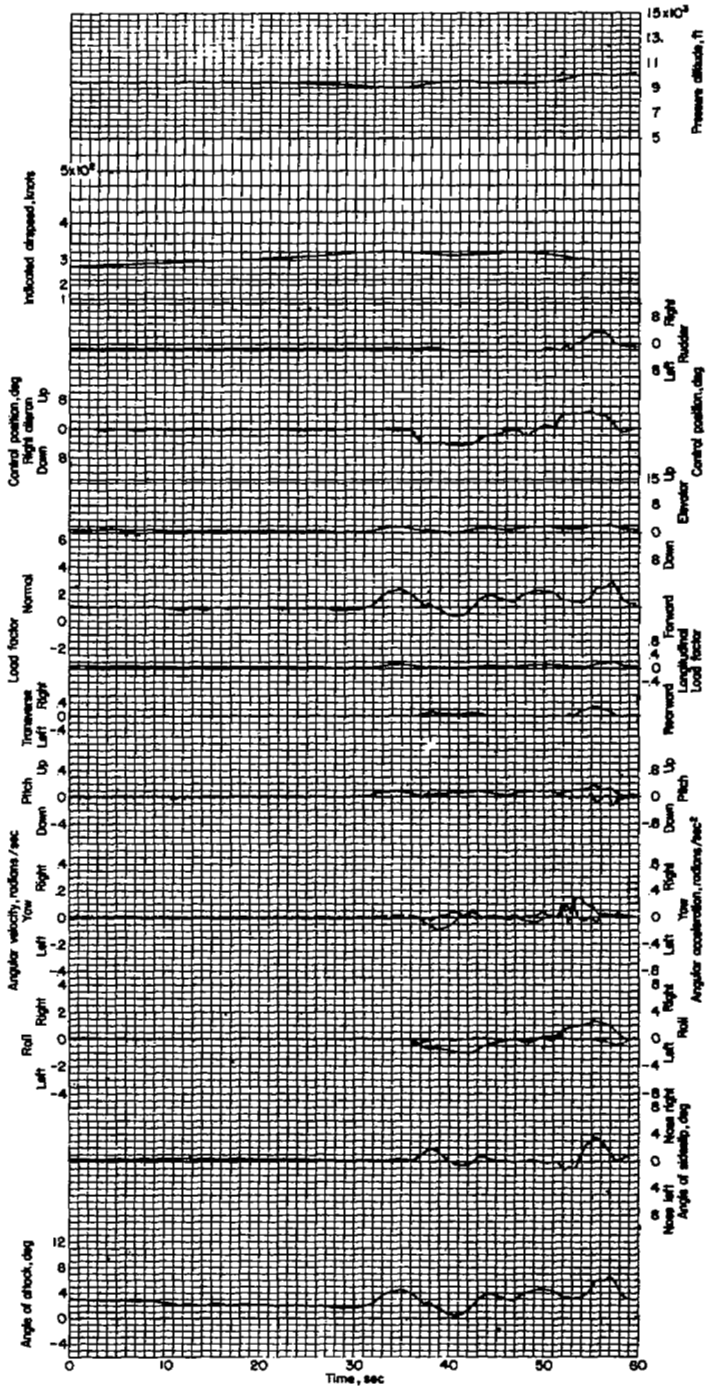


(b)

NACA

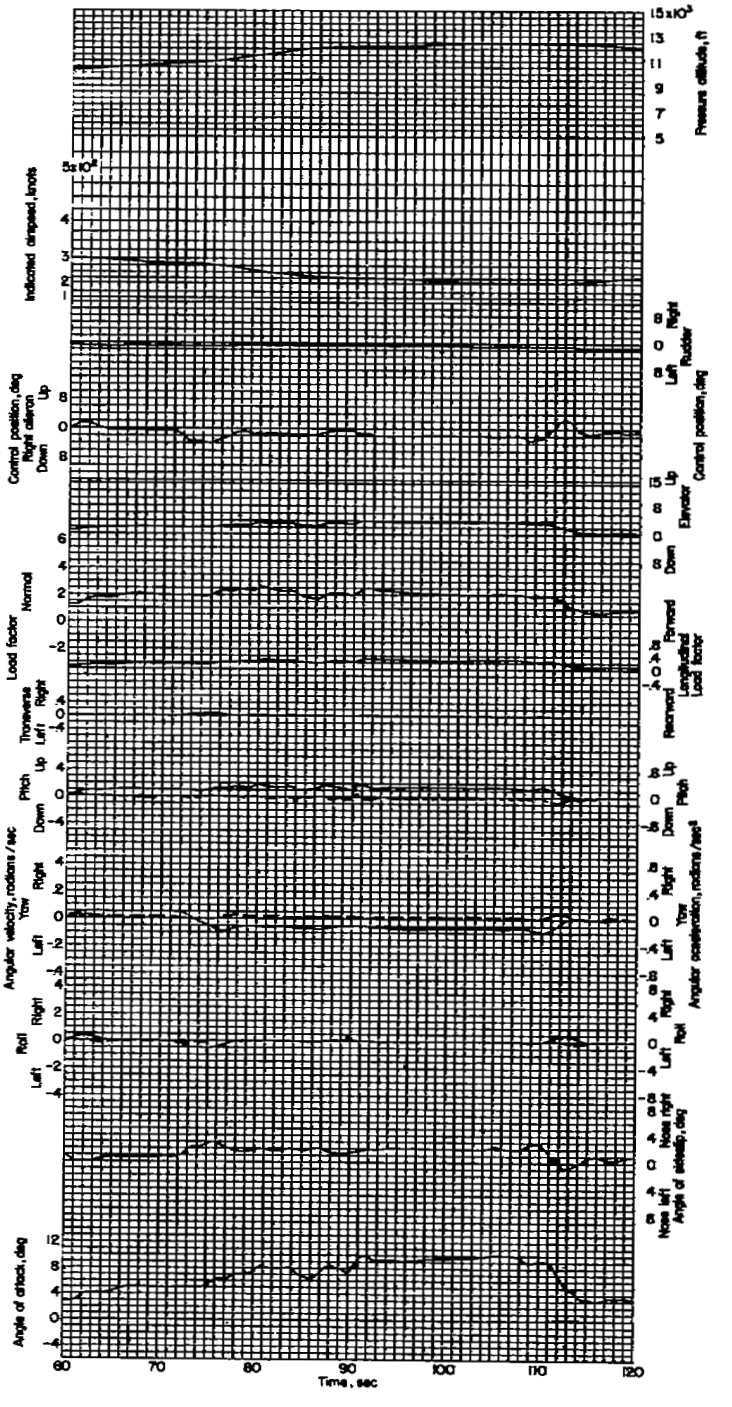
Figure 135.- Concluded.

[redacted]



(a)

Figure 136.- Left and right aileron roll followed by left turn. Airplane weight, 17,040 pounds; center of gravity at 24.7 percent M.A.C.; flight 2.



(b)

Figure 136.- Concluded.

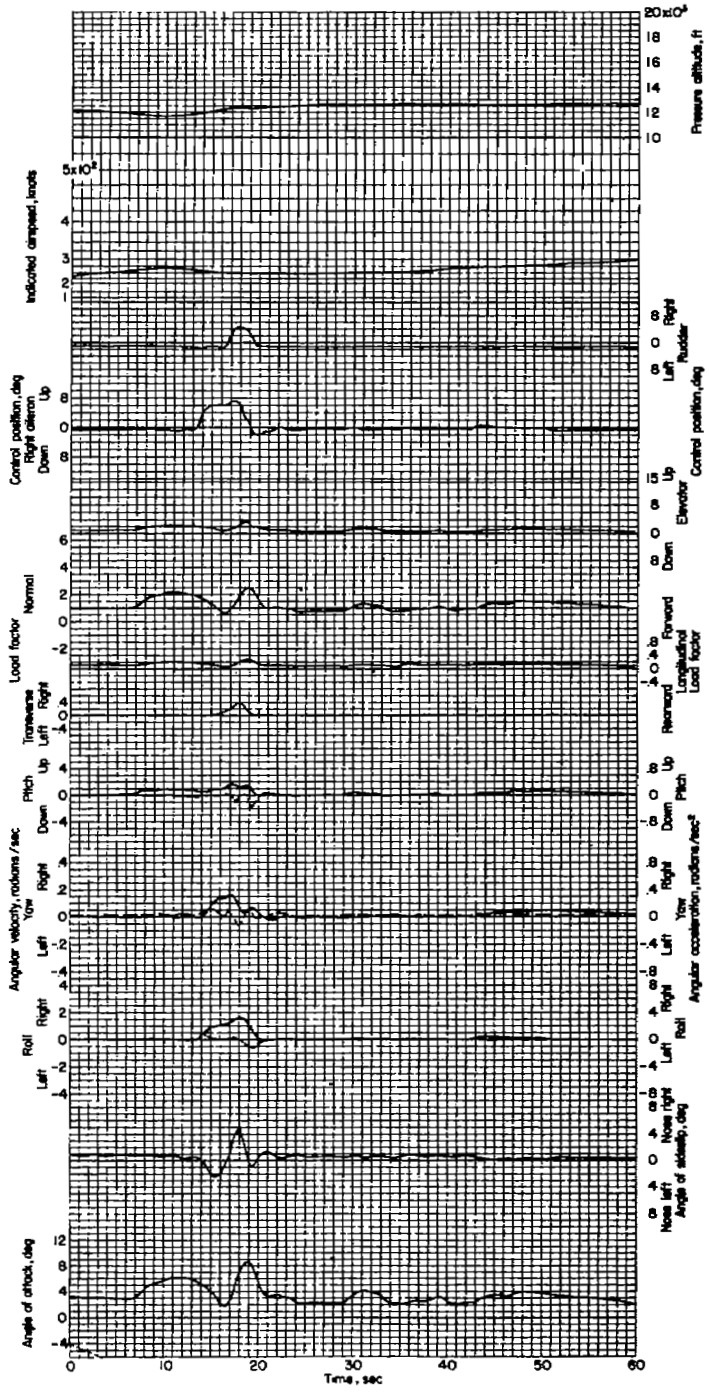


Figure 137.- Right aileron roll. Airplane weight, 16,980 pounds; center of gravity at 24.7 percent M.A.C.; flight 2.

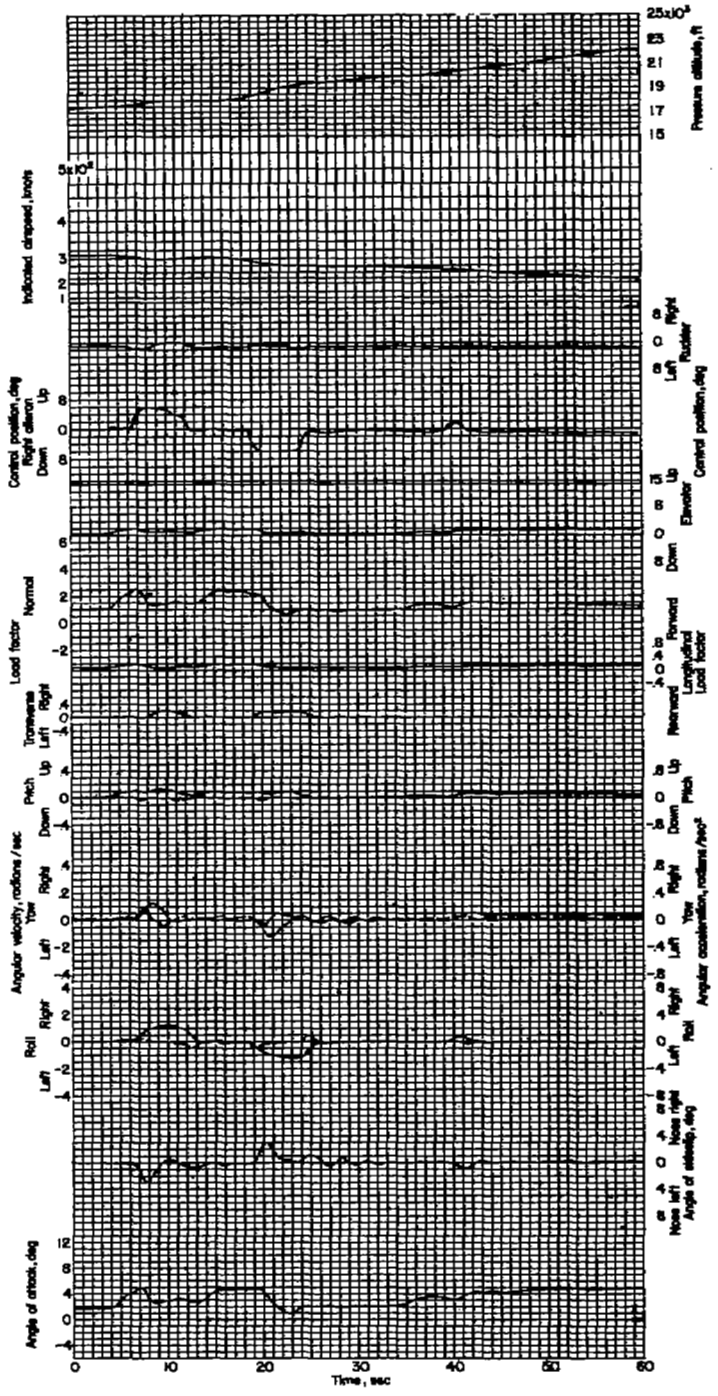


Figure 138.- Right and left aileron roll. Airplane weight, 16,870 pounds; center of gravity at 24.6 percent M.A.C.; flight 2.

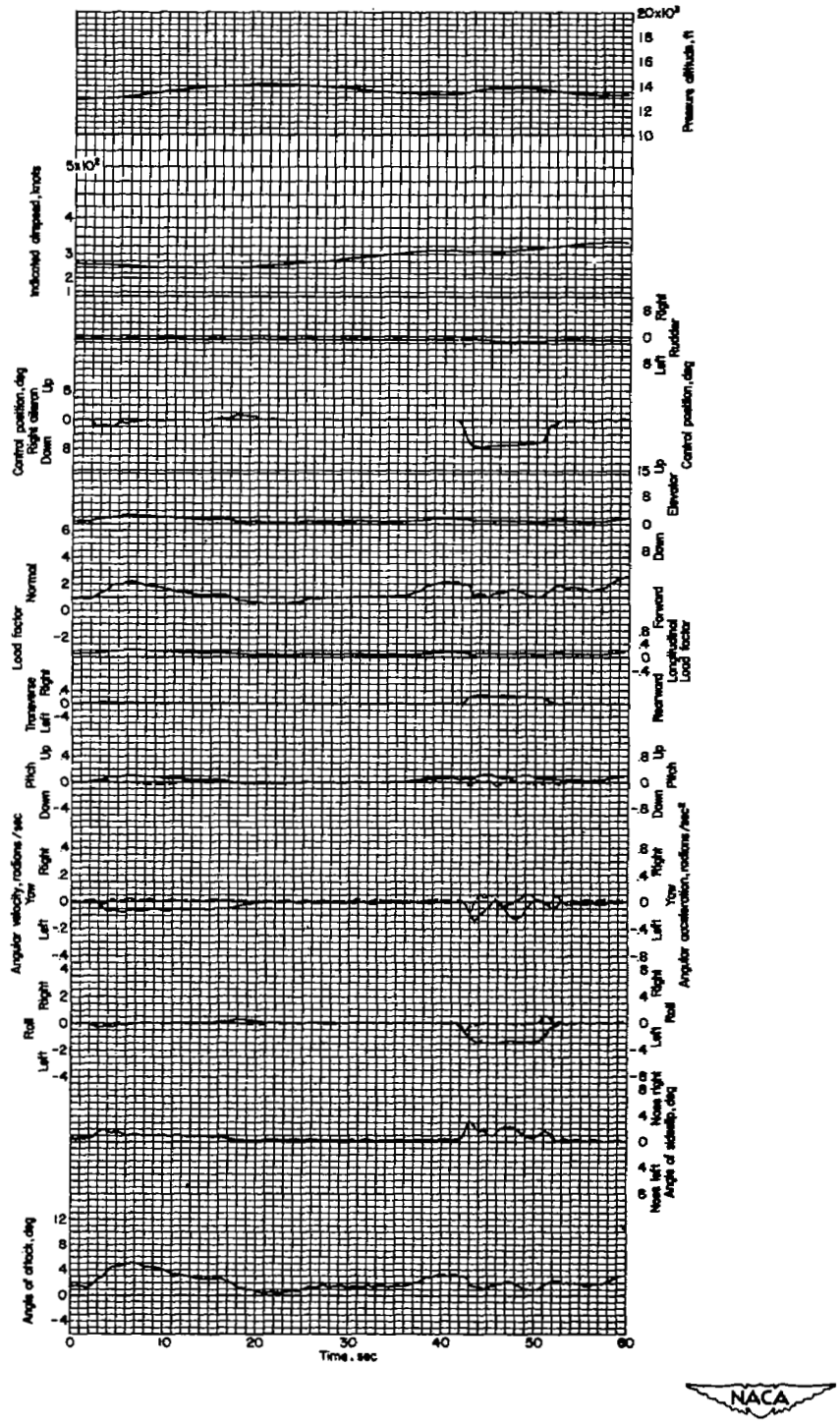


Figure 139.- Two consecutive left aileron rolls. Airplane weight, 16,060 pounds; center of gravity at 24.2 percent M.A.C.; flight 2.

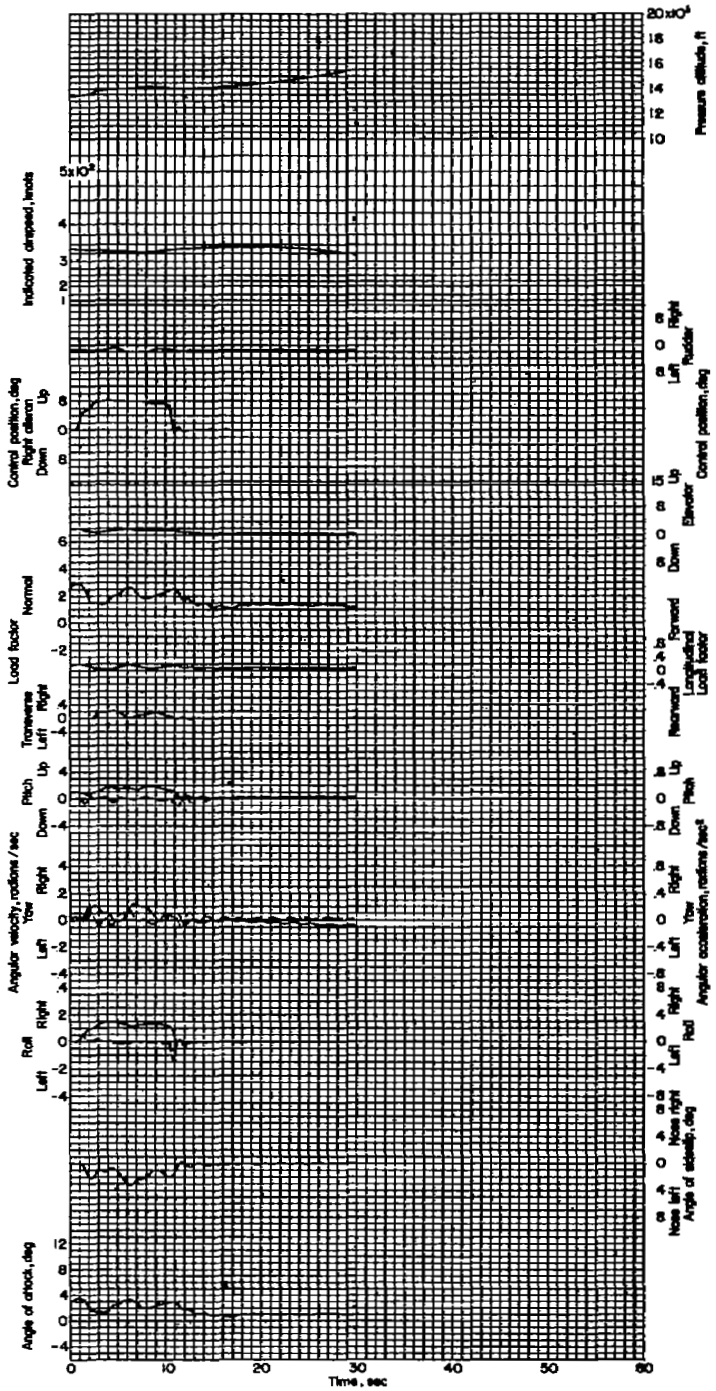
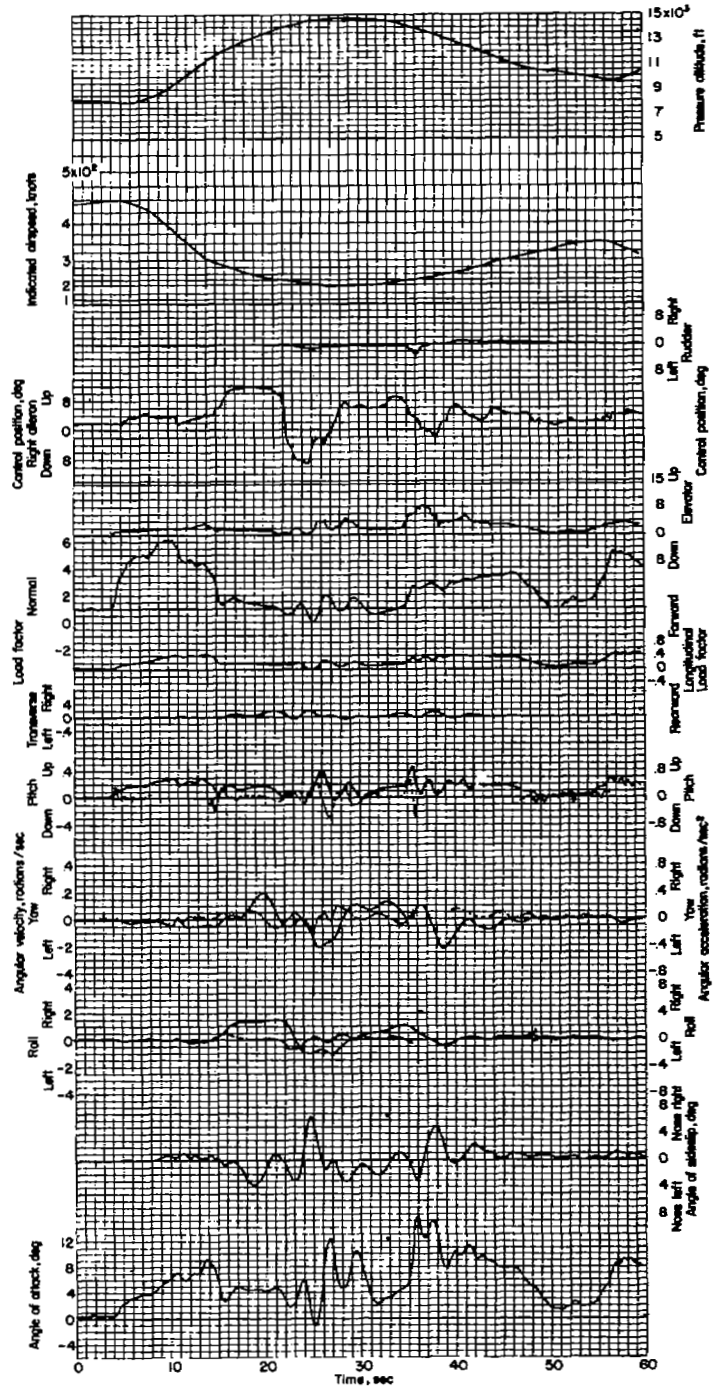


Figure 140.- Two consecutive right aileron rolls. Airplane weight, 16,030 pounds; center of gravity at 24.1 percent M.A.C.; flight 2.

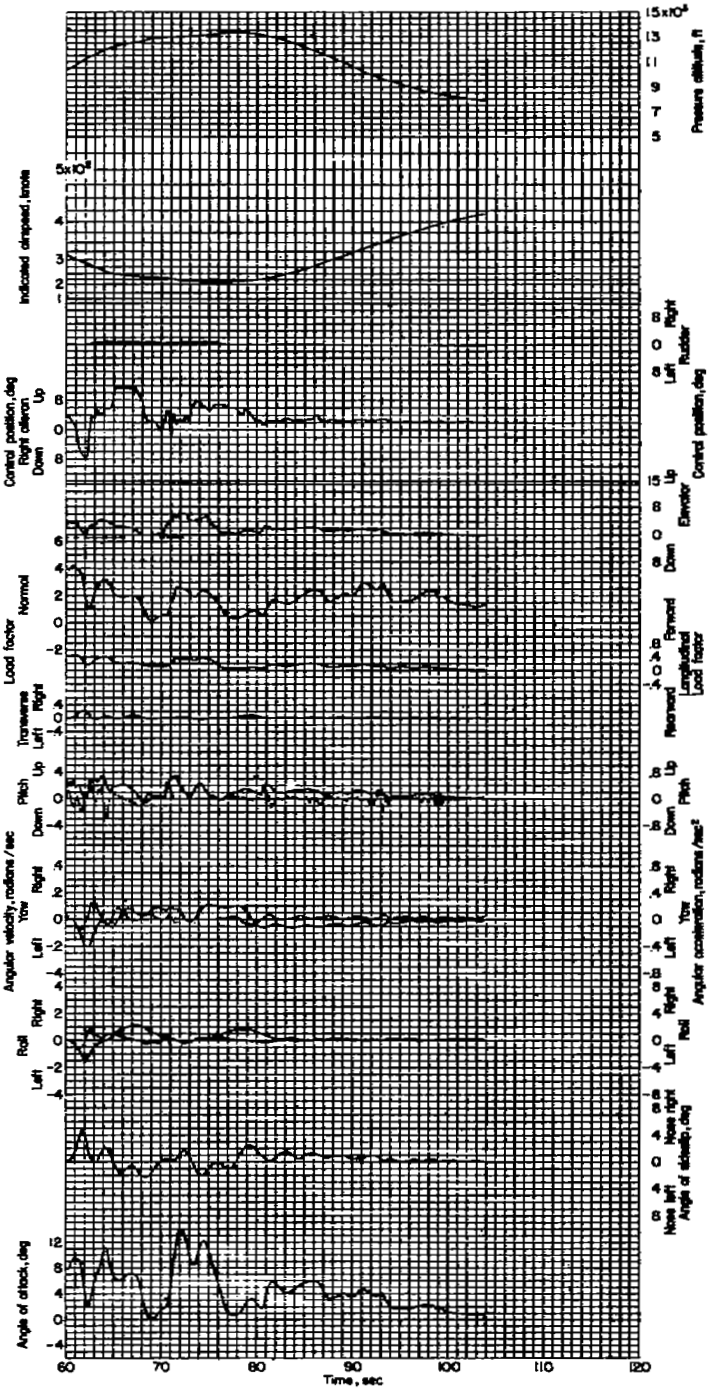


(a)

NACA

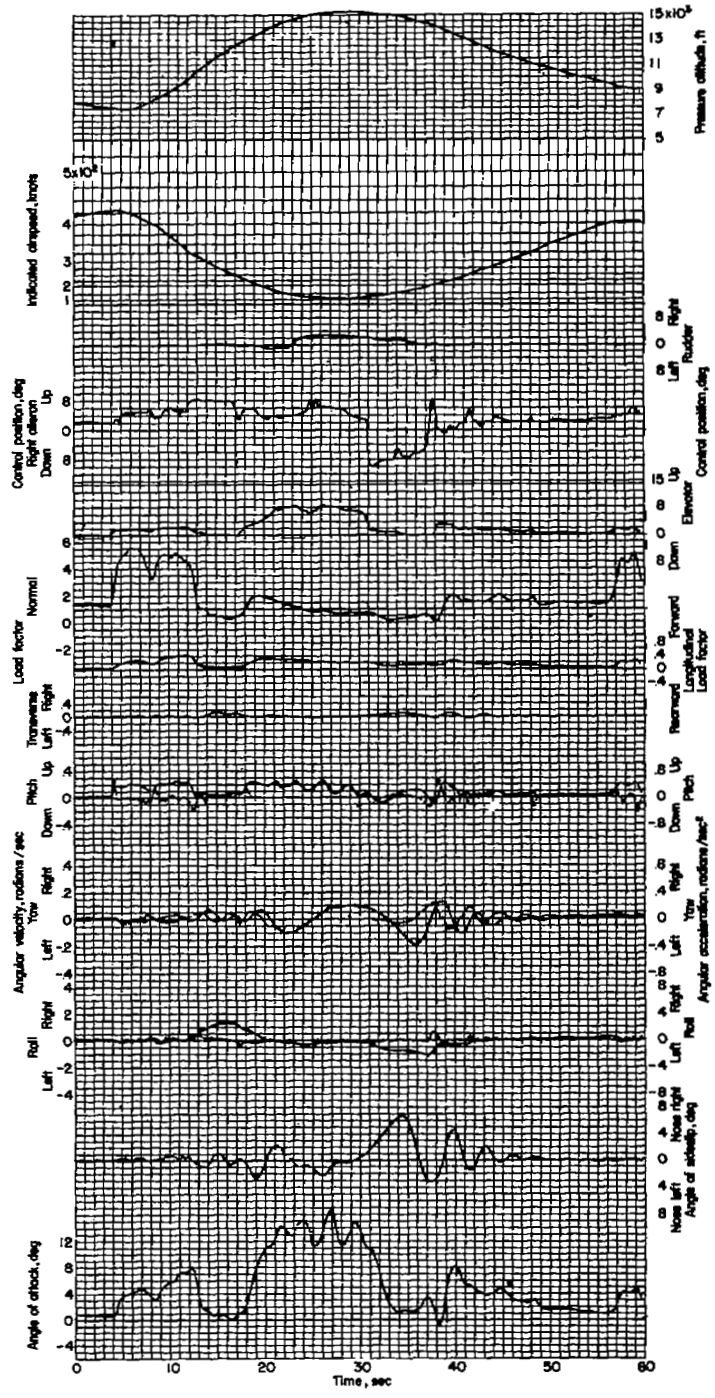
Figure 141.- Pull-ups into series of climbing aileron rolls. Airplane weight, 17,850 pounds; center of gravity at 25.1 percent M.A.C.; flight 4.

[redacted]



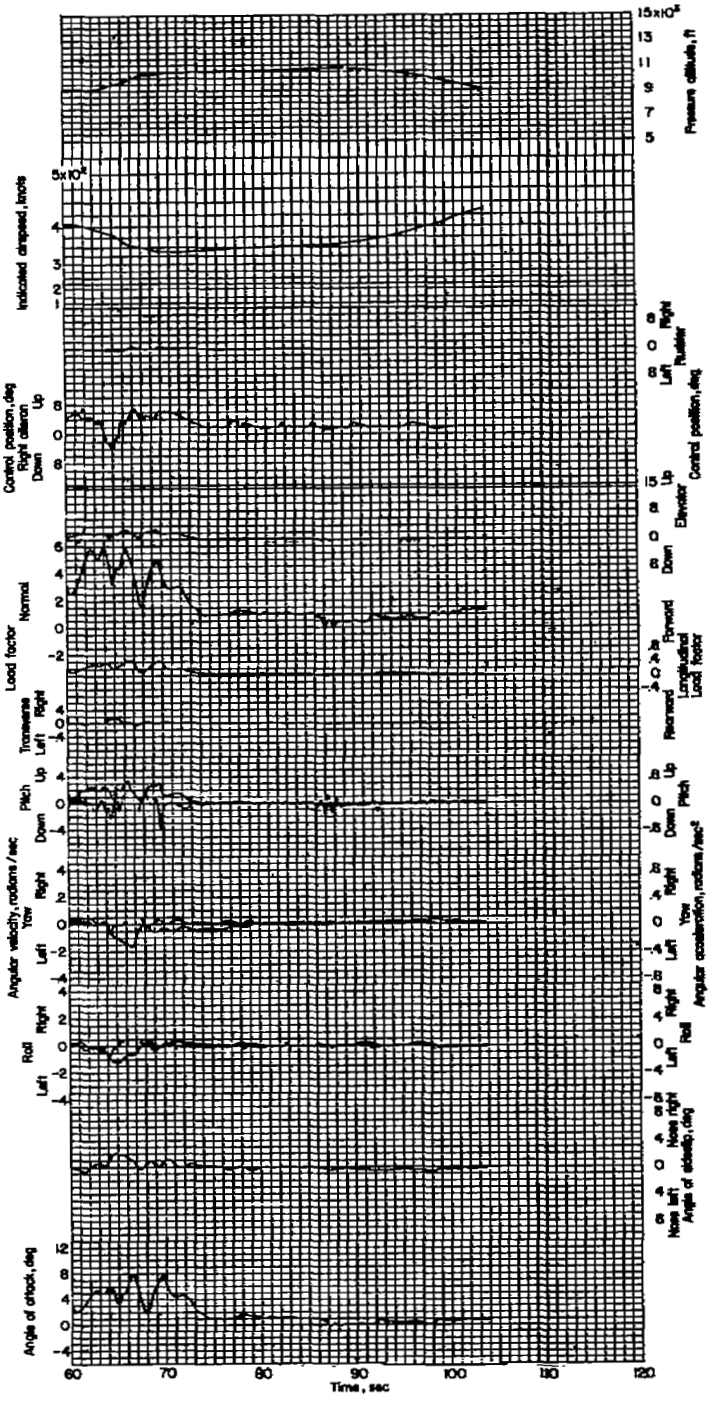
(b)

Figure 141.- Concluded.



(a)

Figure 142.- Pull-up into climbing right aileron roll followed by left aileron roll into dive and rolling pull-out. Airplane weight, 17,740 pounds; center of gravity at 25.0 percent M.A.C.; flight 4.



(b)

Figure 142.- Concluded.

[redacted]

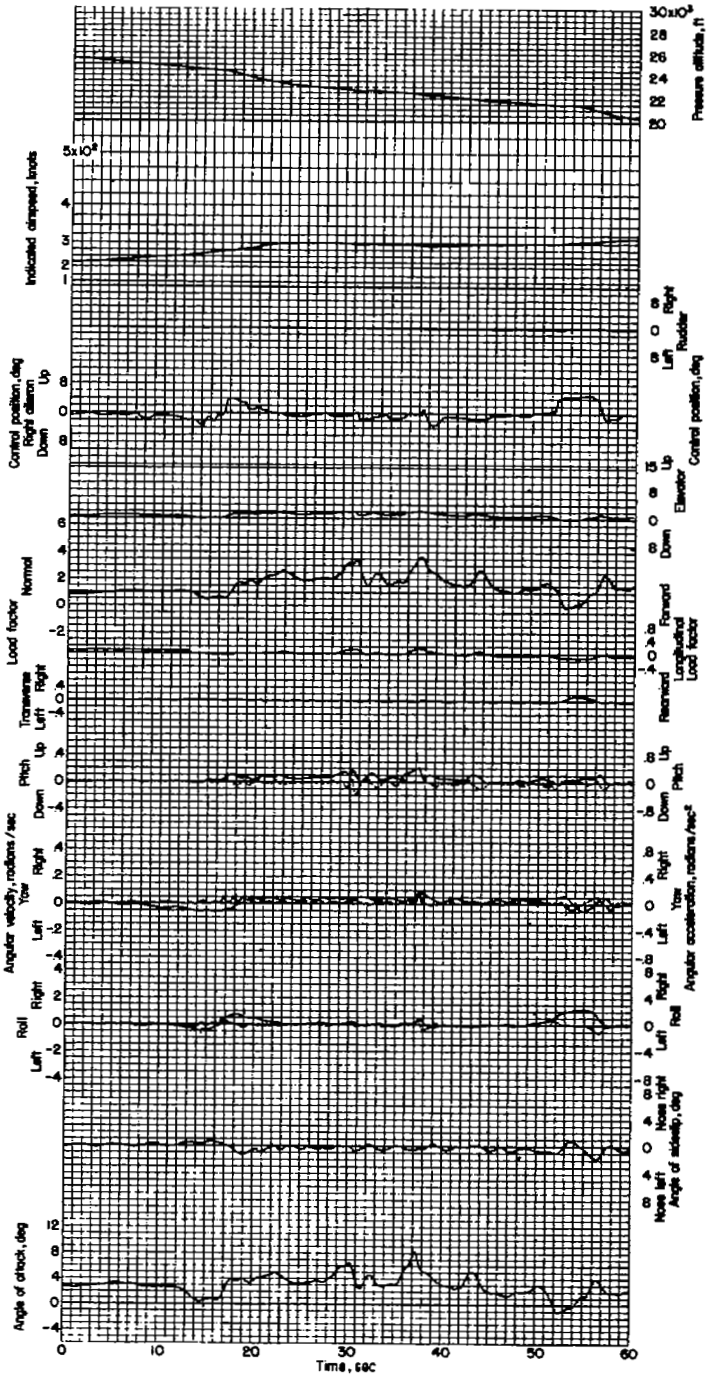


Figure 143.- Left and right turn followed by right aileron roll. Airplane weight, 17,610 pounds; center of gravity at 25.0 percent M.A.C.; flight 5.

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[redacted]

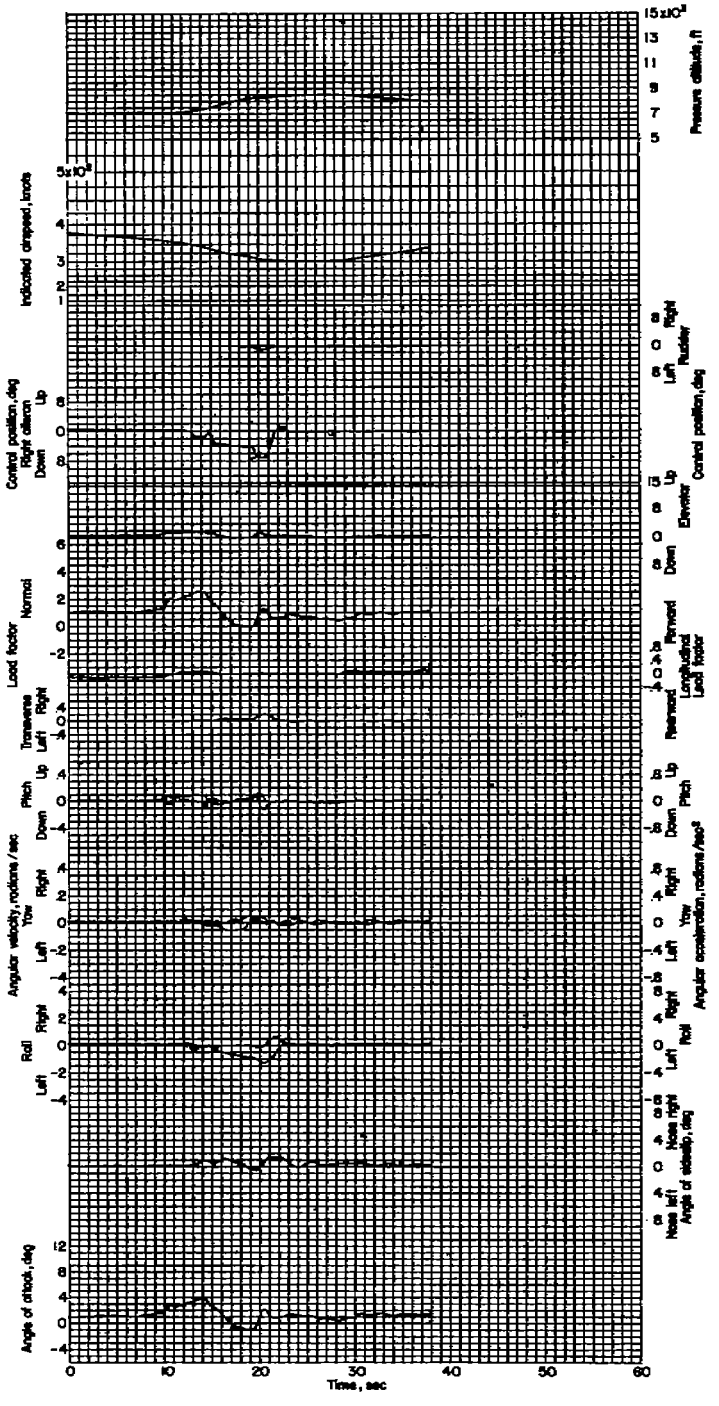


Figure 144.- Left aileron roll. Airplane weight, 17,360 pounds; center of gravity at 24.8 percent M.A.C.; flight 5.

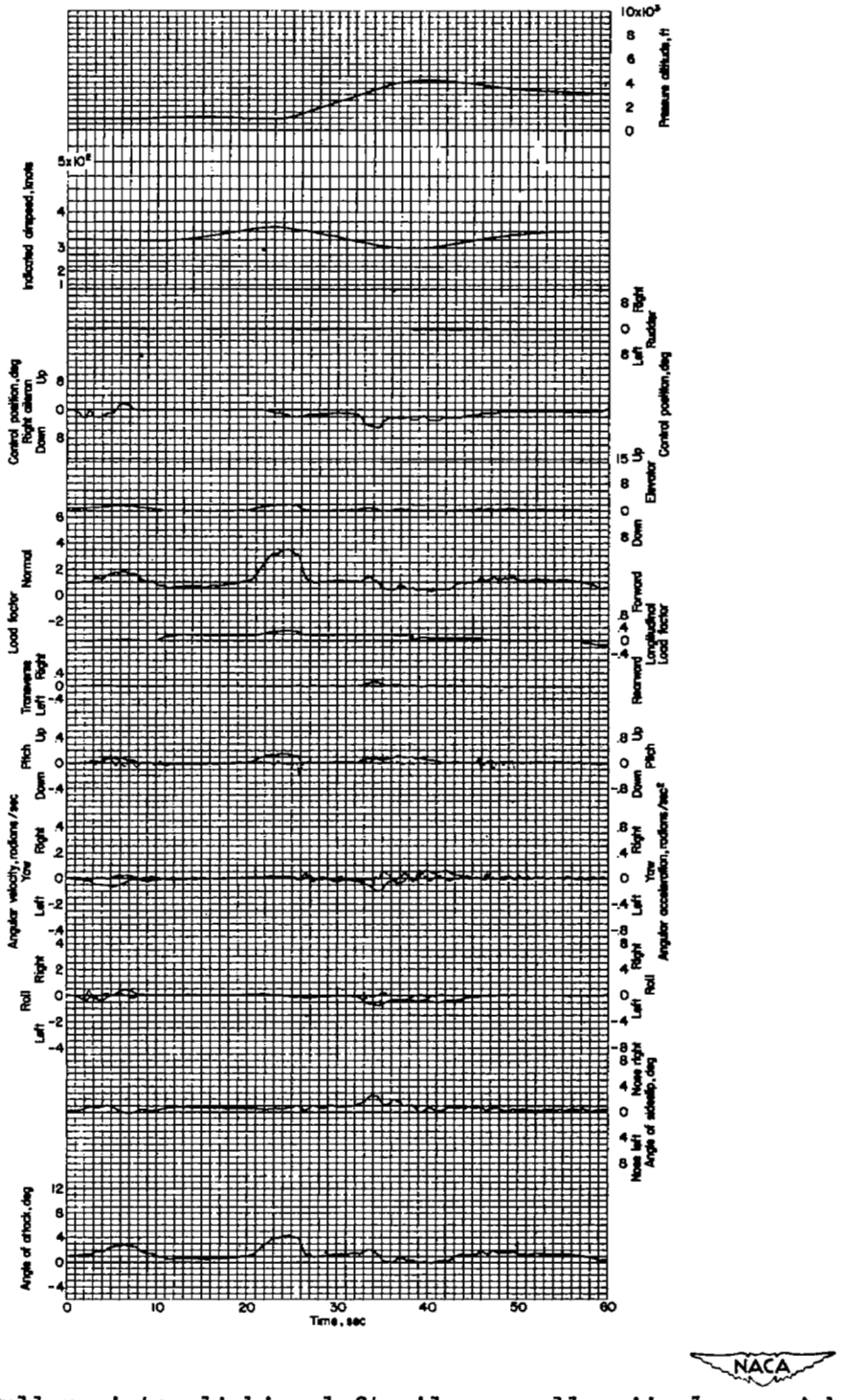


Figure 145.- Pull-up into climbing left aileron roll. Airplane weight, 16,330 pounds; center of gravity at 24.3 percent M.A.C.; flight 5.

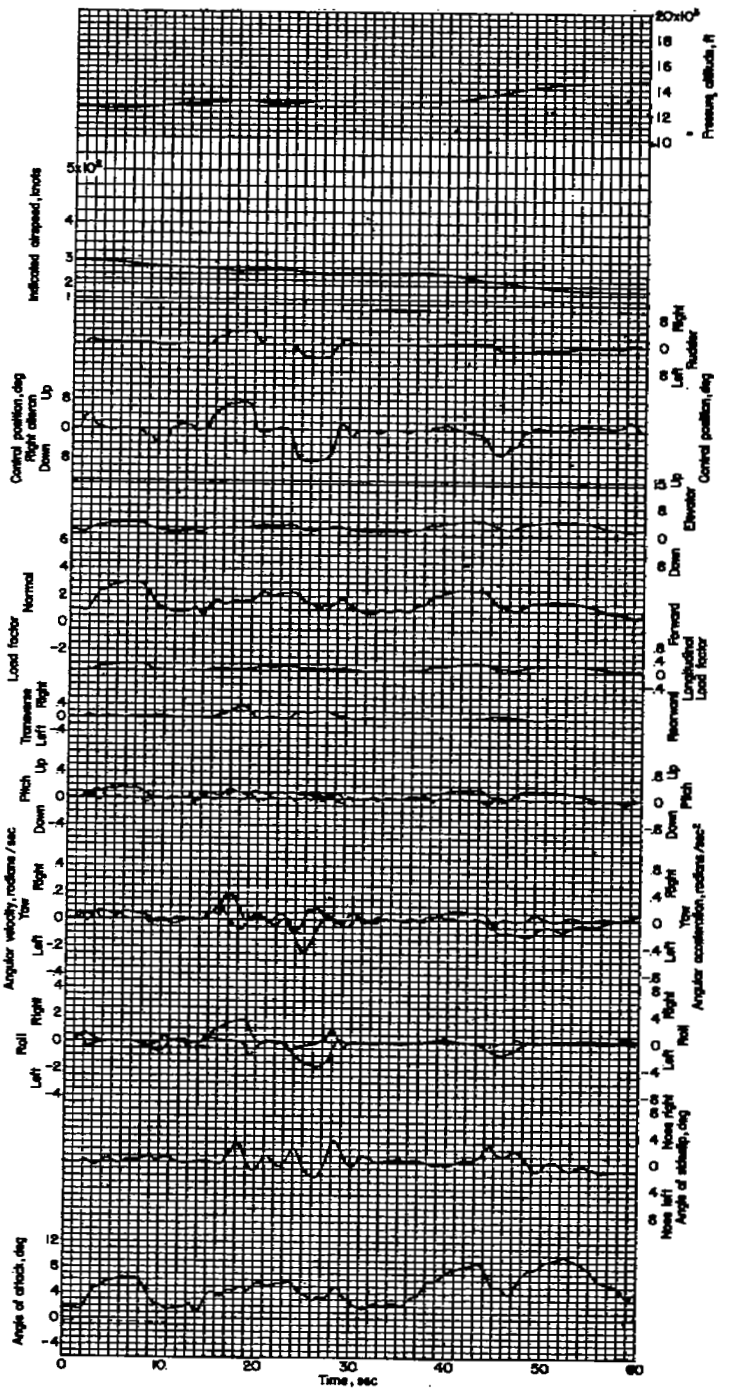


Figure 146.- Right and left aileron roll followed by chandelle. Airplane weight, 16,560 pounds; center of gravity at 24.4 percent M.A.C.; flight 6.

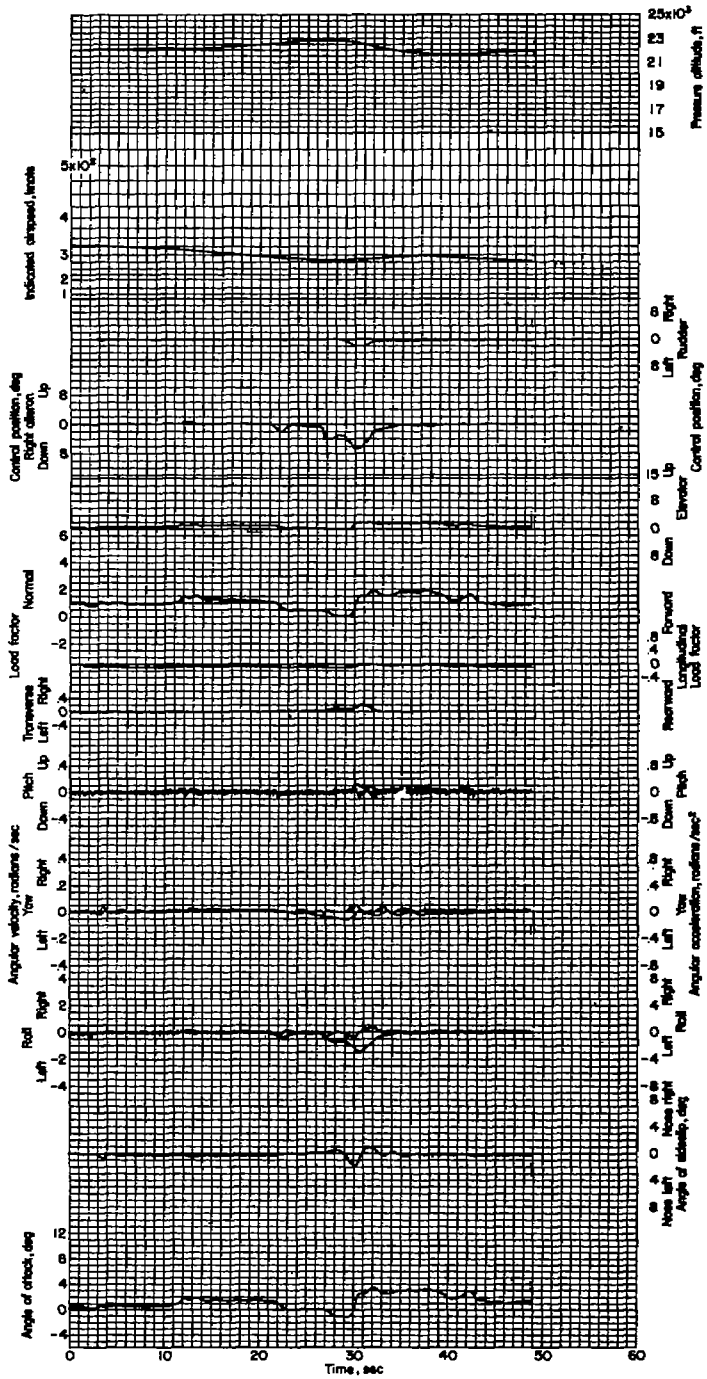
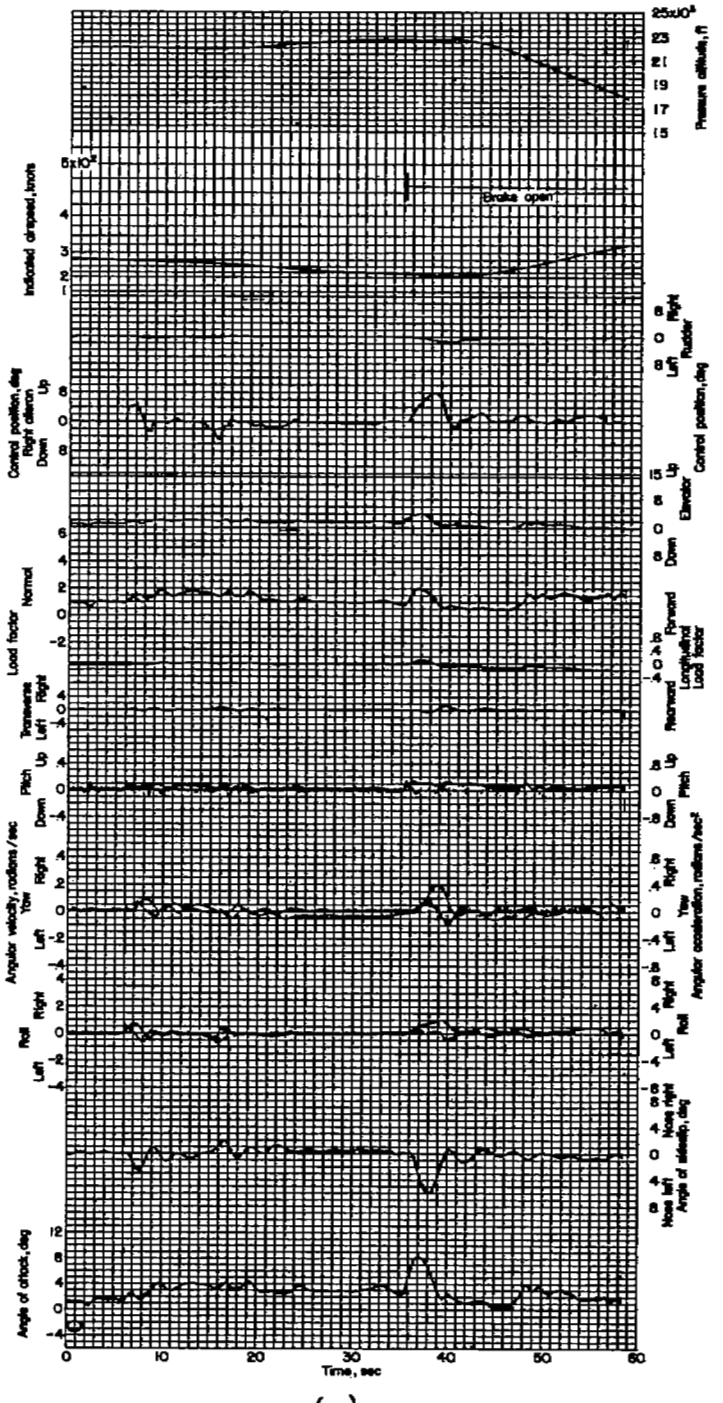


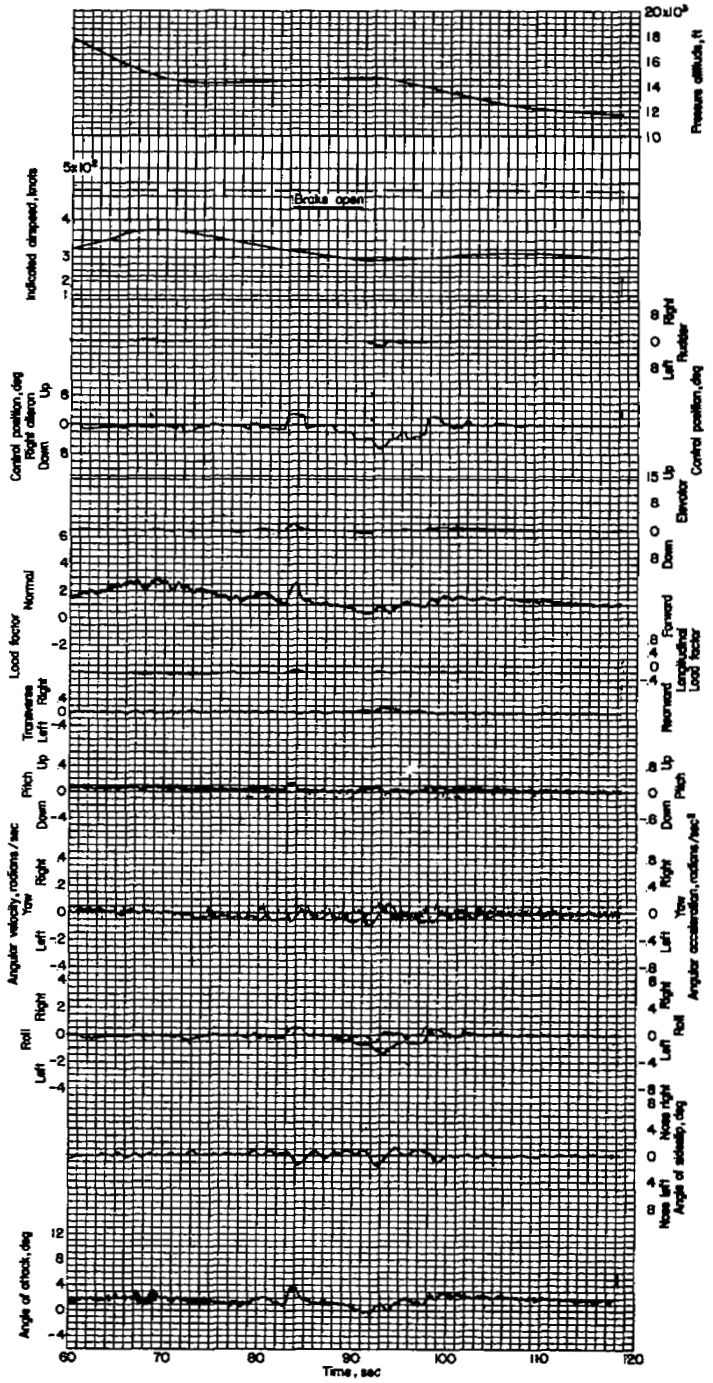
Figure 147.- Left aileron roll. Airplane weight, 16,230 pounds; center of gravity at 24.3 percent M.A.C.; flight 7.



(a)

NACA

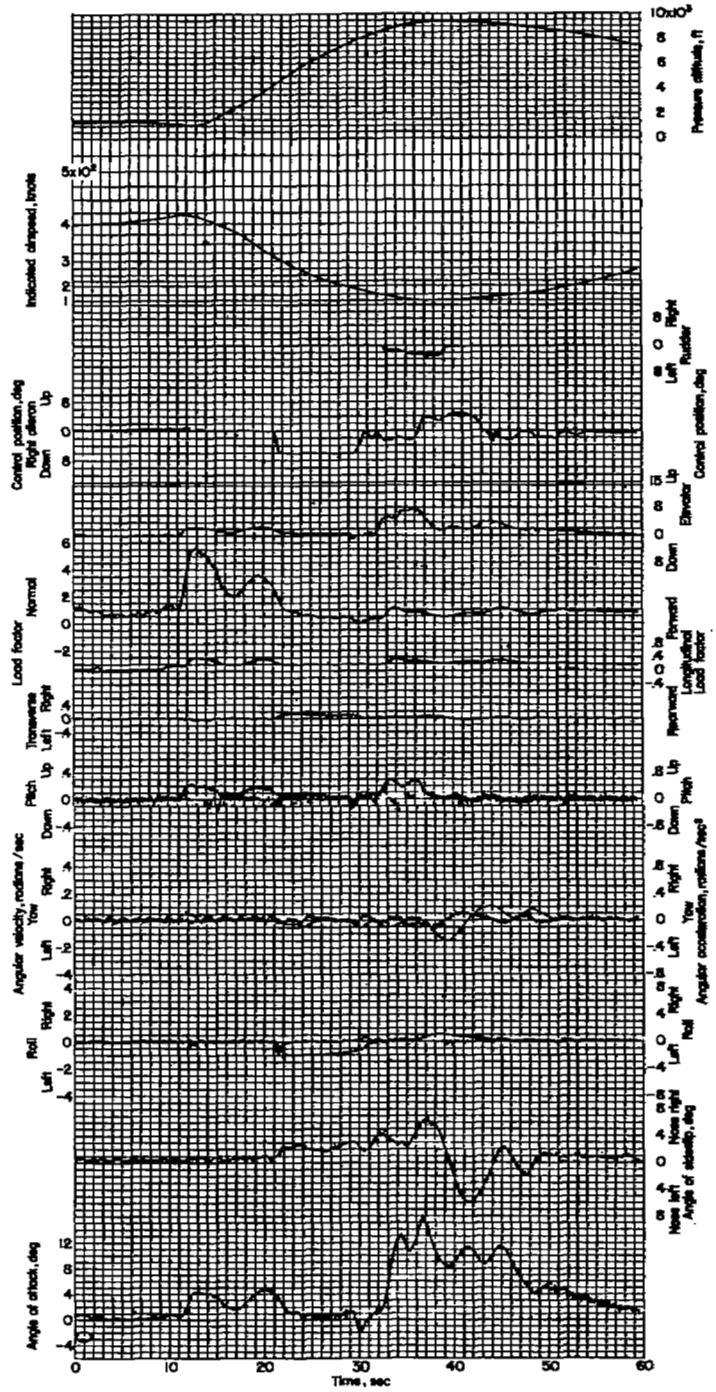
Figure 148.- Right and left turn and diving right aileron roll followed by pull-out and left aileron roll. Airplane weight, 16,150 pounds; center of gravity at 24.2 percent M.A.C.; flight 7.



(b)

Figure 148.- Concluded.

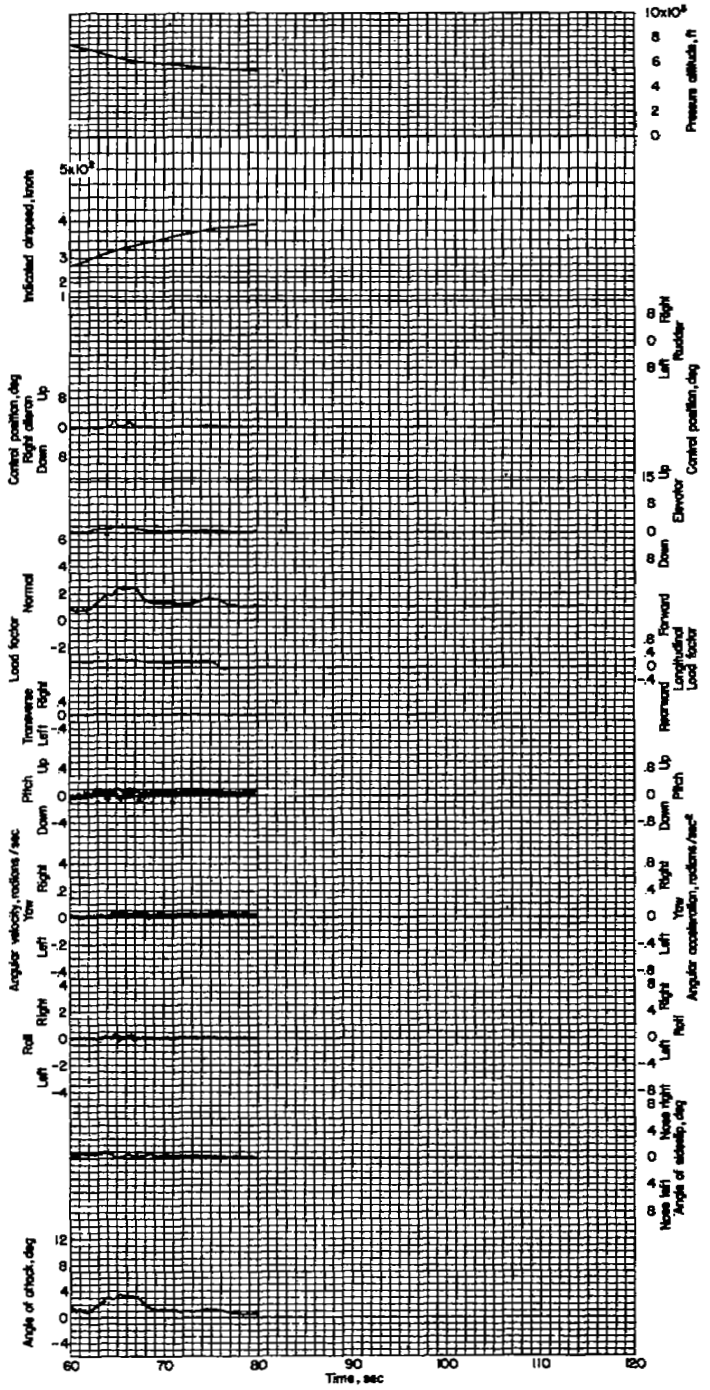
[redacted]



(a)

Figure 149.- Pull-up into steep climb with one and one-half left aileron rolls and roll out to the right. Airplane weight, 15,850 pounds; center of gravity at 24.0 percent M.A.C.; flight 7.

[redacted]



(b)

Figure 149.- Concluded.

[redacted]

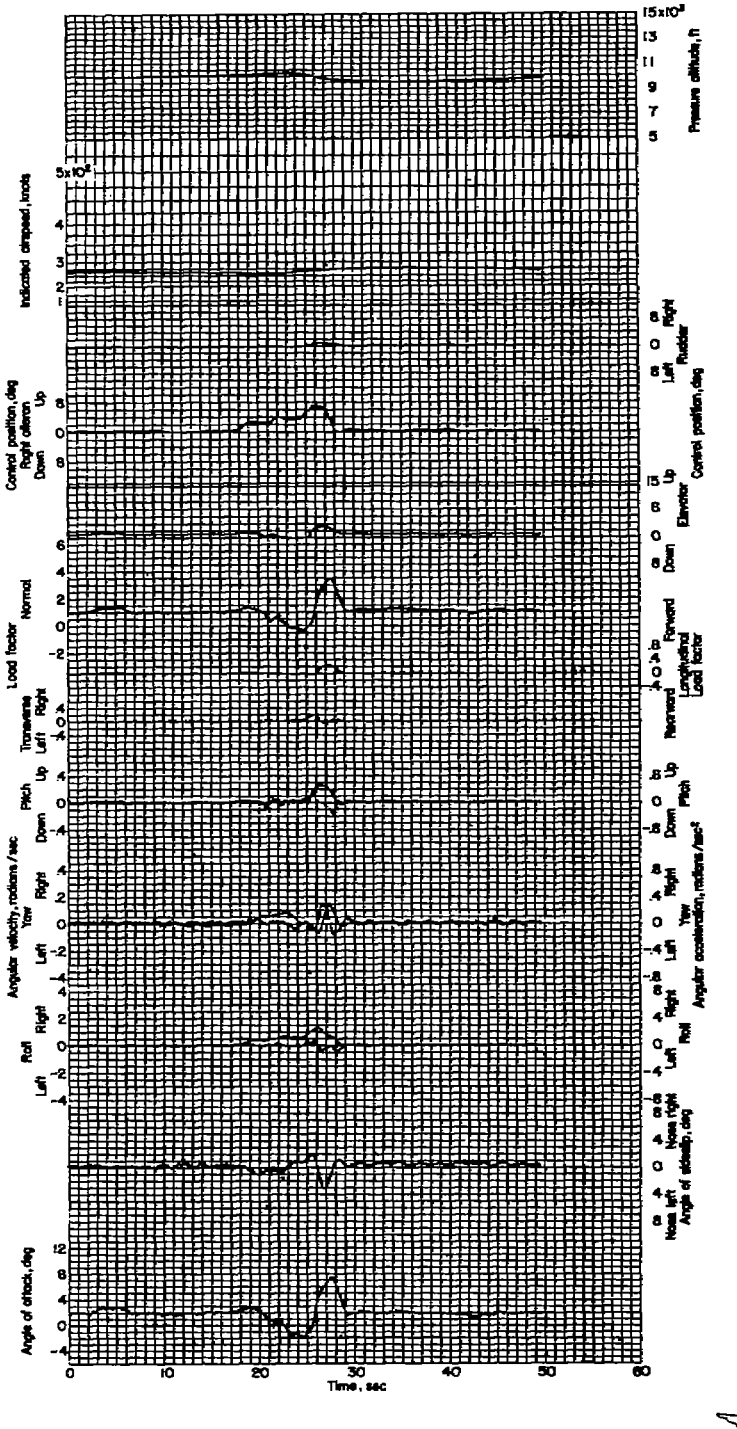


Figure 150.- Right aileron roll. Airplane weight, 14,560 pounds; center of gravity at 24.9 percent M.A.C.; flight 8.

[redacted]

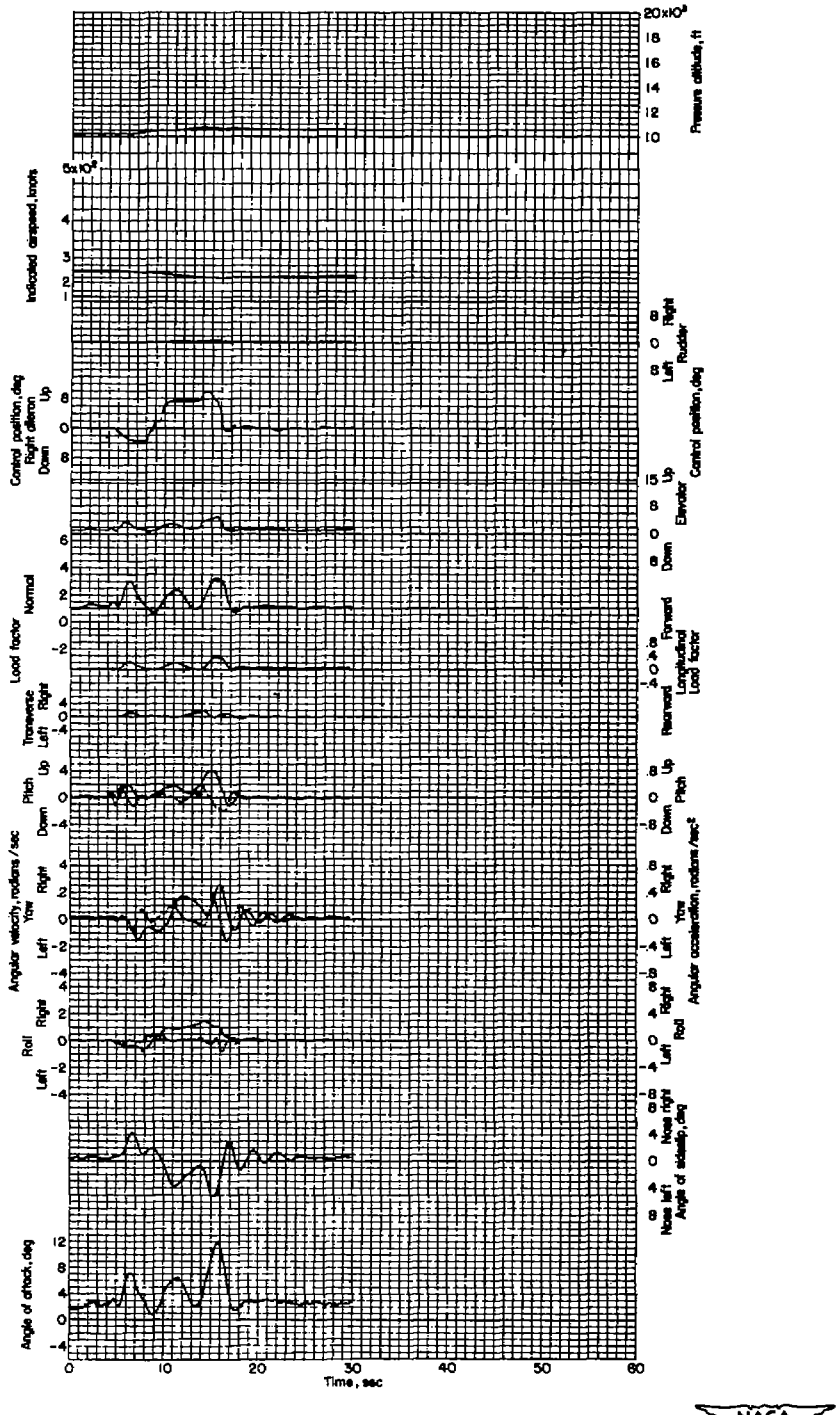
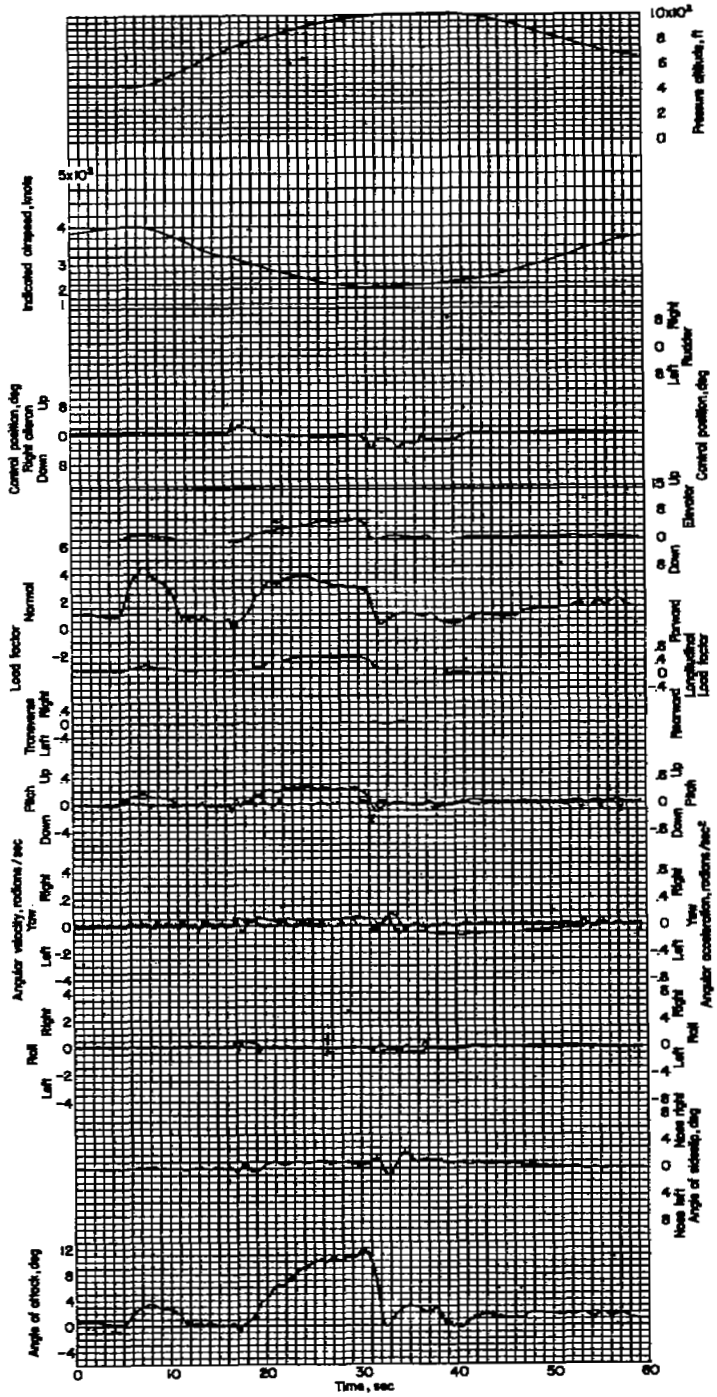


Figure 151.- Right aileron roll. Airplane weight, 14,510 pounds; center of gravity at 25.0 percent M.A.C.; flight 8.

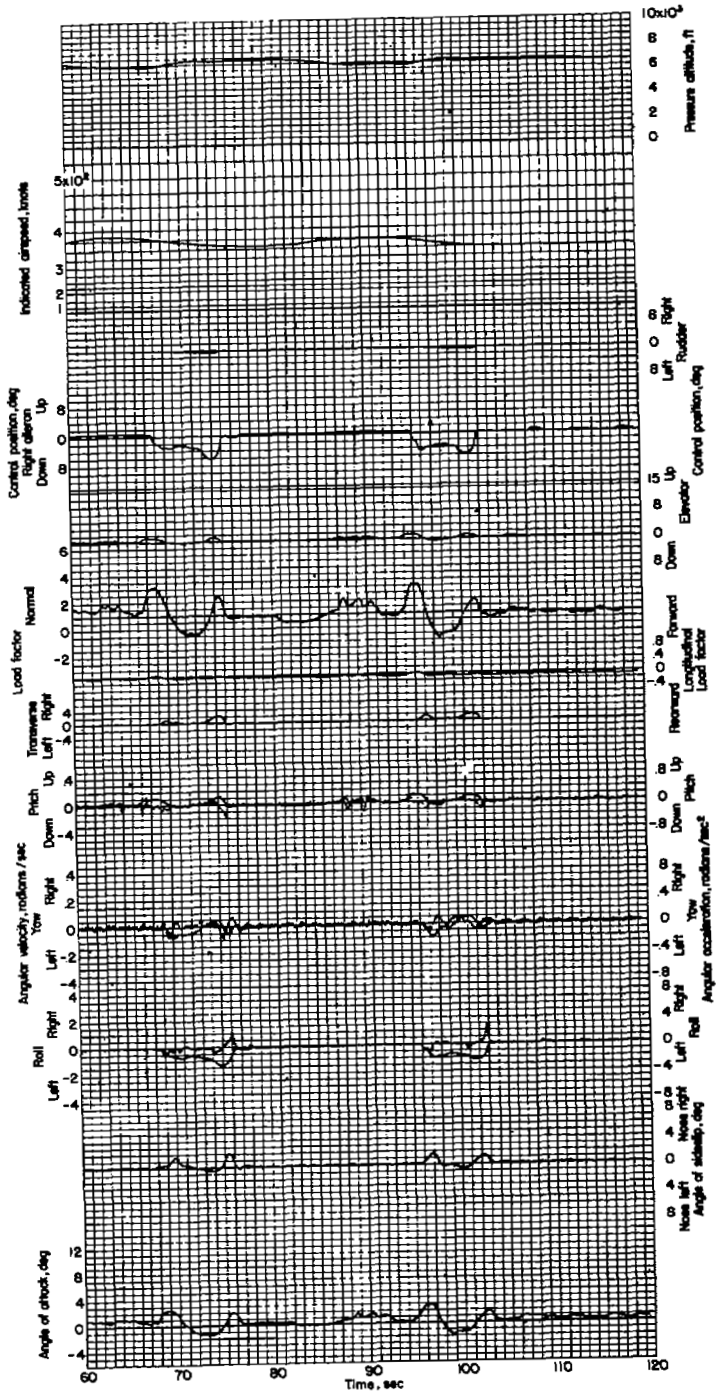
C[redacted]



(a)

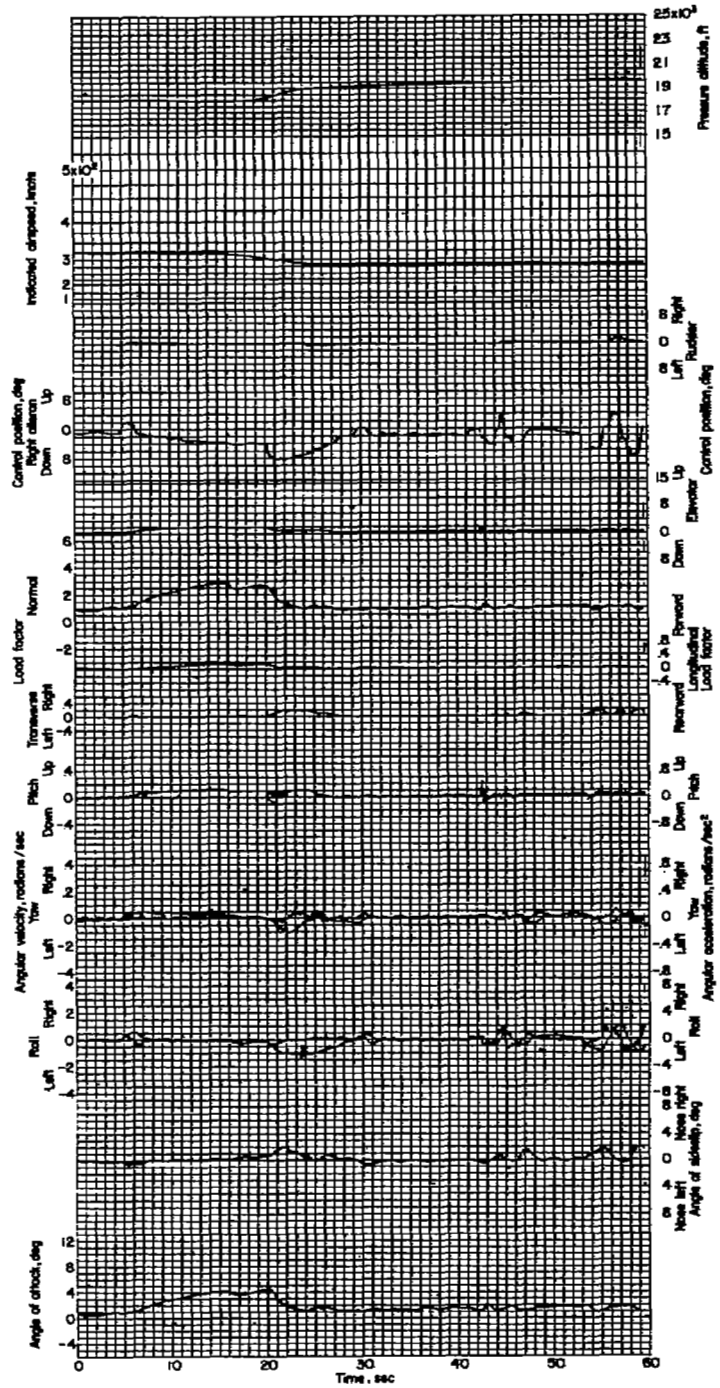
NACA

Figure 152.- Pull-up into chandelle followed by two left aileron rolls. Airplane weight, 14,260 pounds; center of gravity at 25.4 percent M.A.C.; flight 8.



(b)

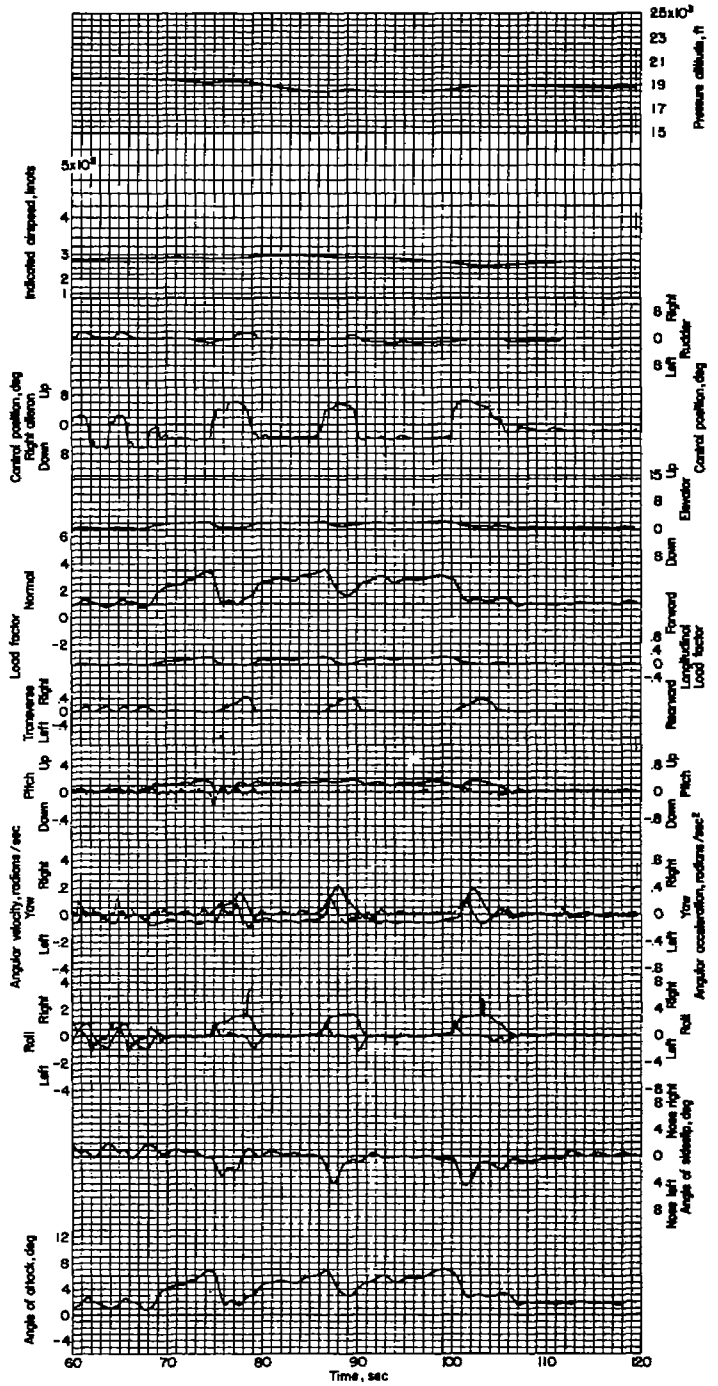
Figure 152.- Concluded.



(a)

NACA

Figure 153.- Right turn and left aileron roll followed by series of banks and three right aileron rolls. Airplane weight, 16,290 pounds; center of gravity at 24.3 percent M.A.C.; flight 9.



(b)

Figure 153.- Concluded.

[redacted]

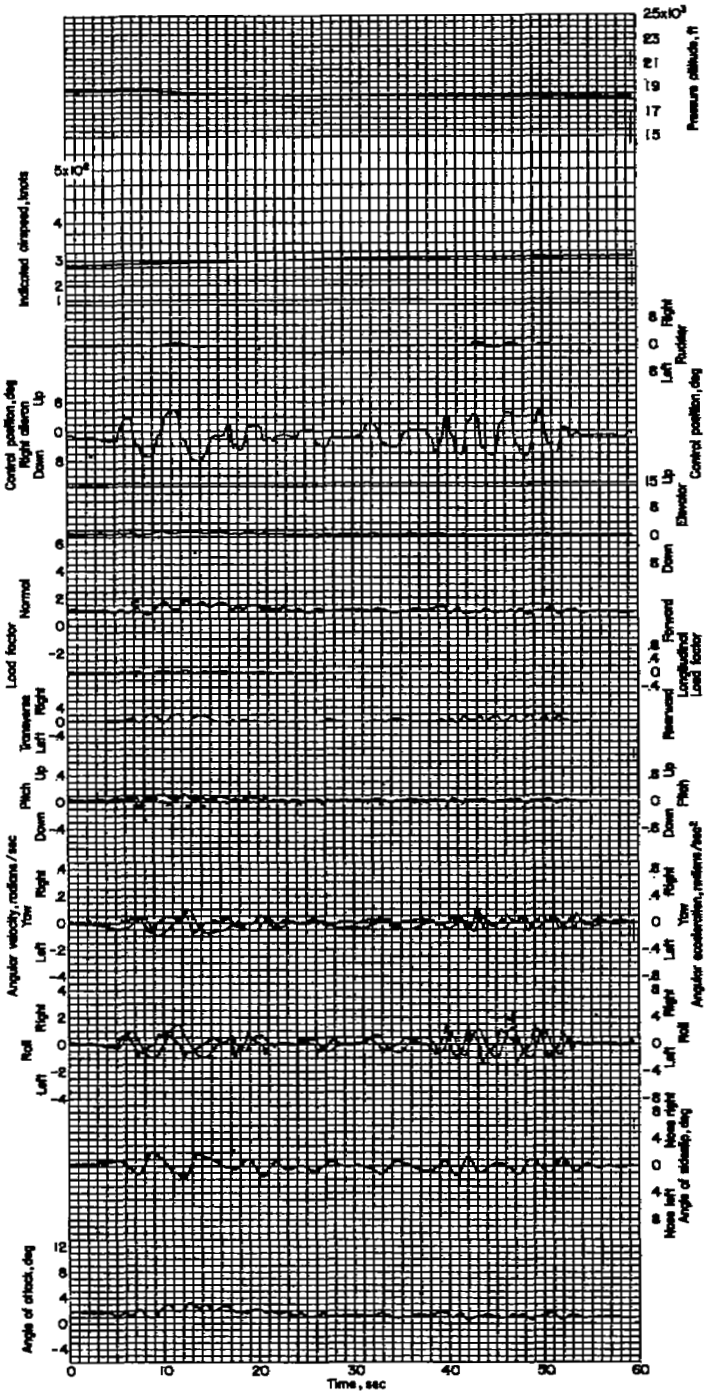


Figure 154.- Series of banks. Airplane weight, 16,230 pounds; center of gravity at 24.3 percent M.A.C.; flight 9.

[redacted]

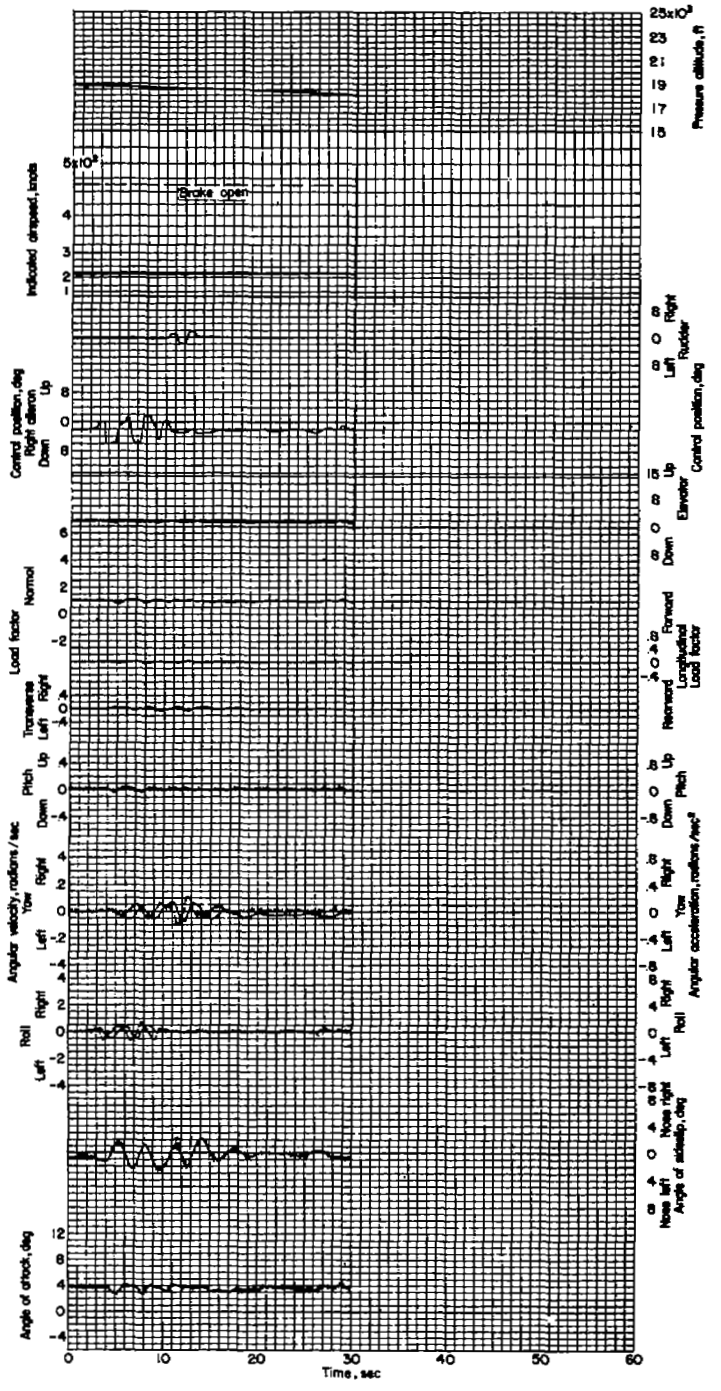


Figure 155.- Series of banks. Airplane weight, 15,480 pounds; center of gravity at 25.2 percent M.A.C.; flight 9.

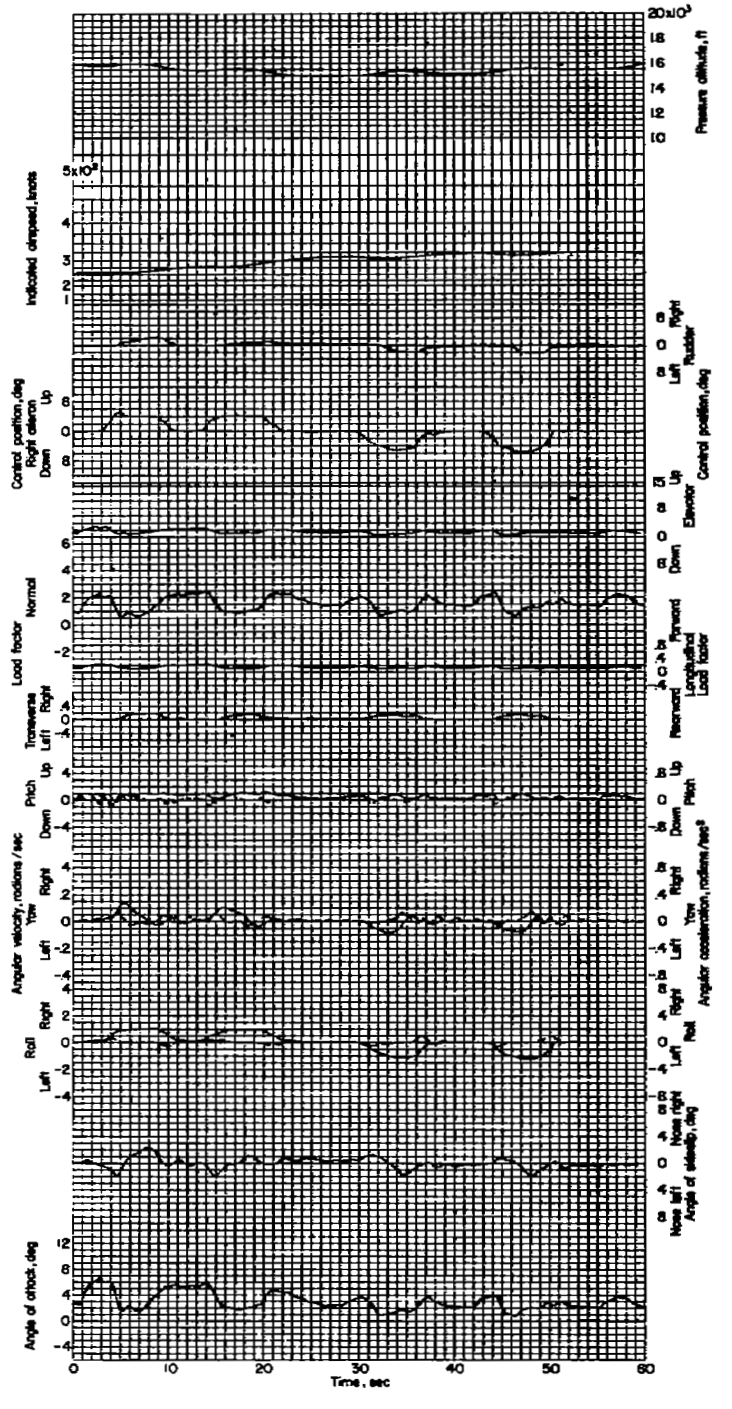


Figure 156.- Two right aileron rolls followed by two left aileron rolls. Airplane weight, 16,130 pounds; center of gravity at 24.2 percent M.A.C.; flight 10.

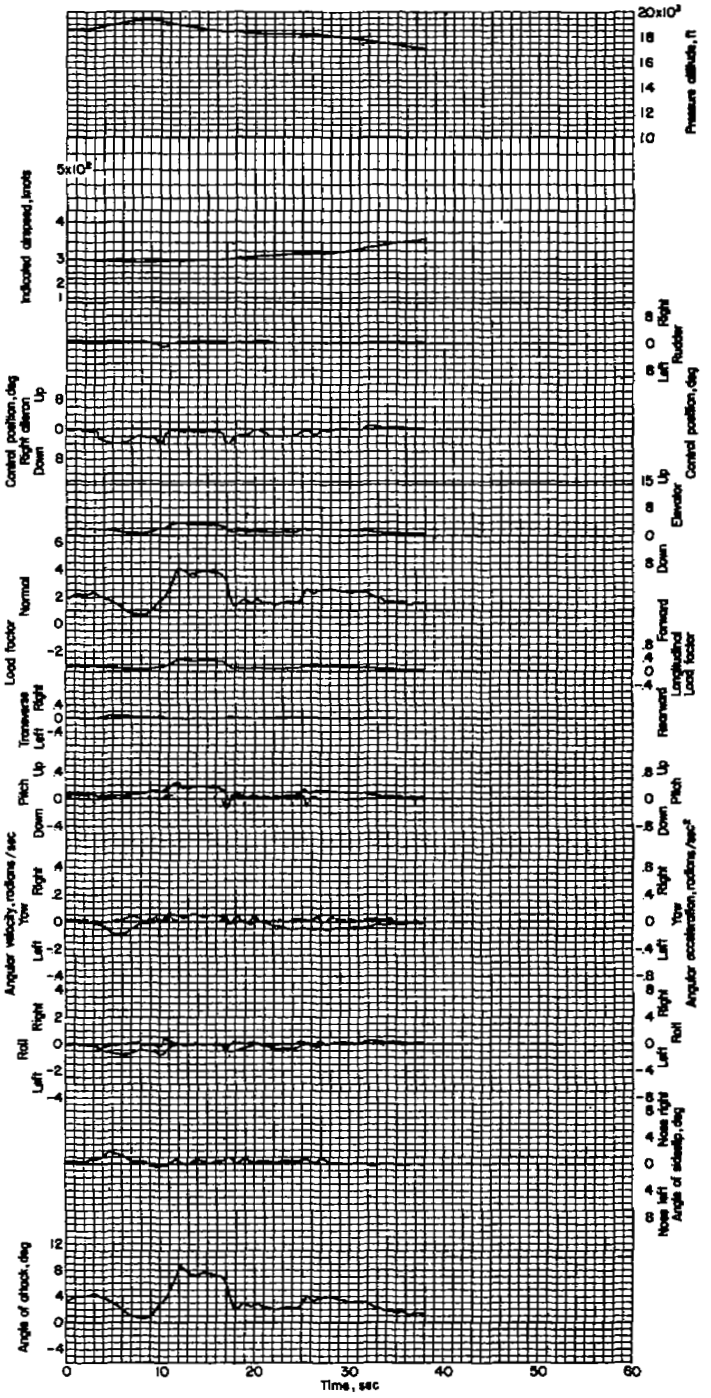


Figure 157.- Left aileron roll and left turn. Airplane weight, 15,810 pounds; center of gravity at 24.0 percent M.A.C.; flight 14.

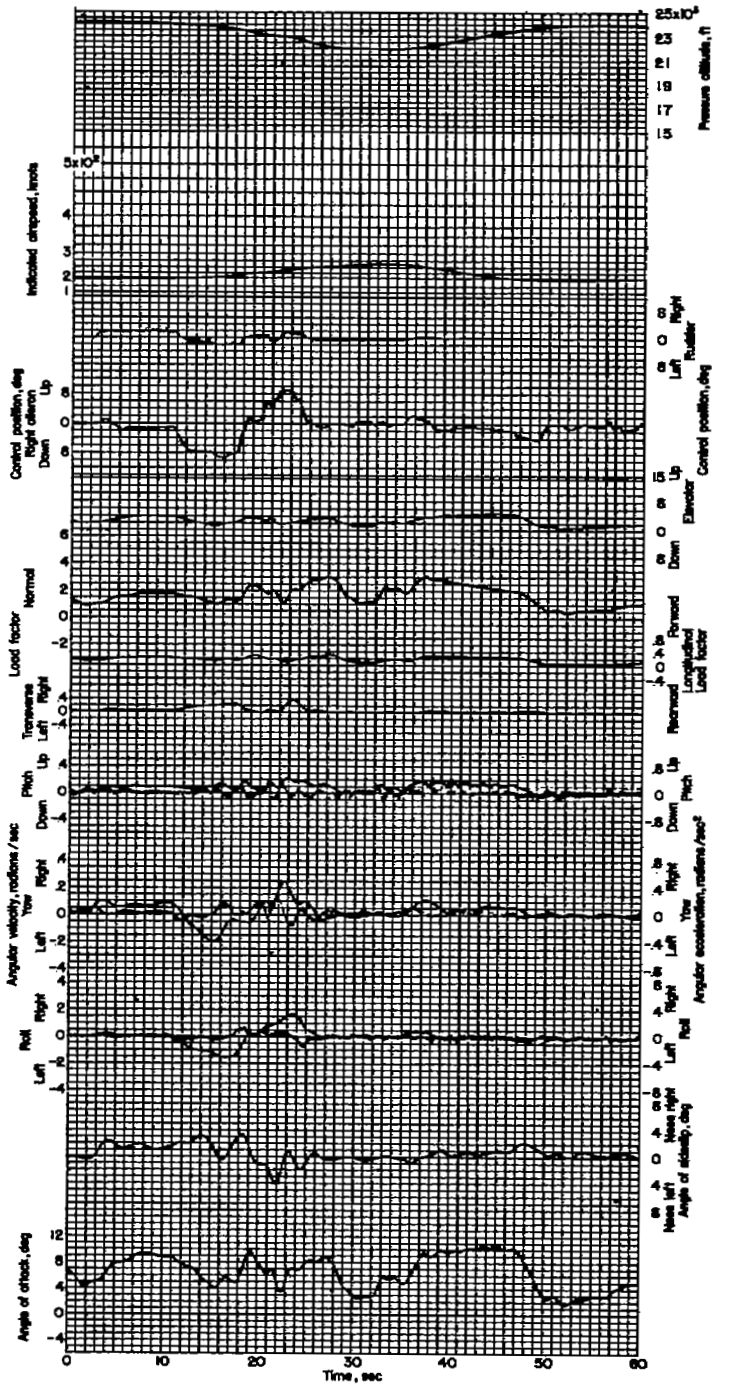
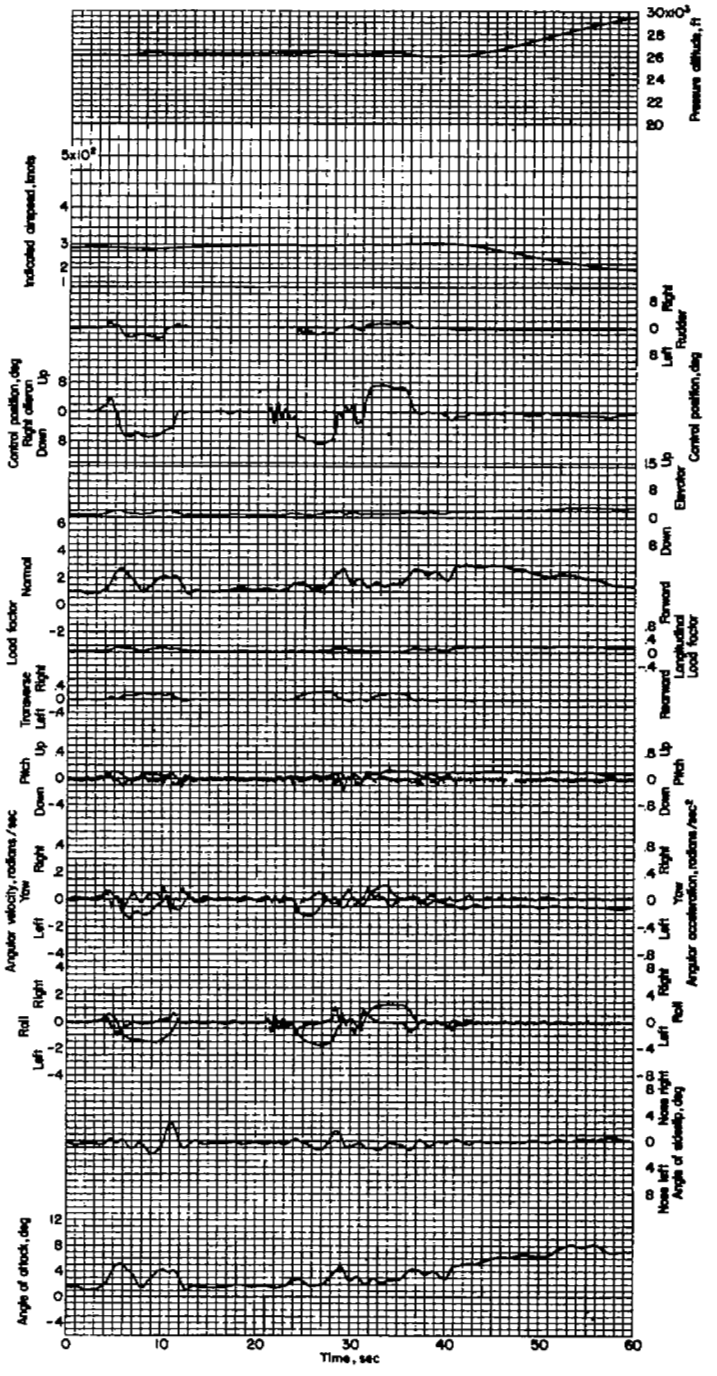


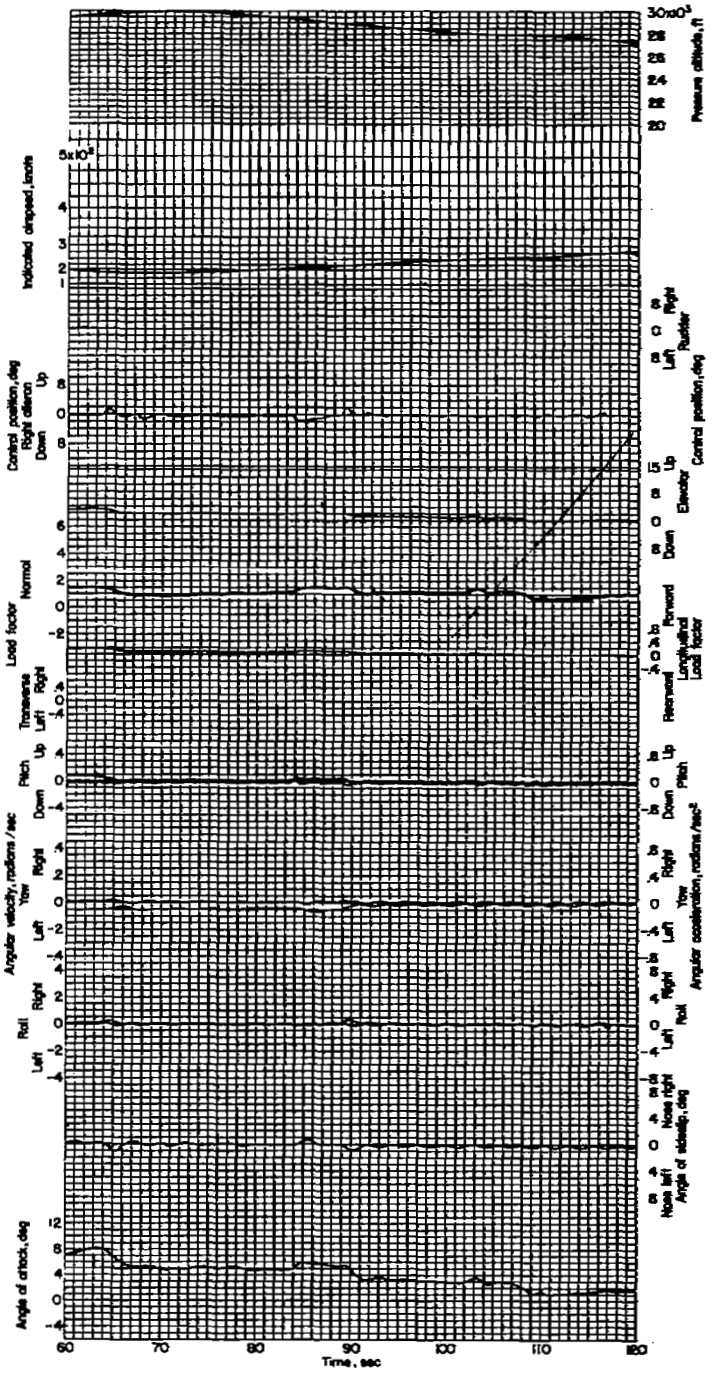
Figure 158.- Right turn into left and right aileron roll followed by chandelle. Airplane weight, 16,290 pounds; center of gravity at 24.3 percent M.A.C.; flight 15.

[redacted]



(a)

Figure 159.- Two left aileron rolls and right aileron roll followed by left turn. Airplane weight, 16,020 pounds; center of gravity at 24.1 percent M.A.C.; flight 15.



(b)

NACA

Figure 159.- Concluded.

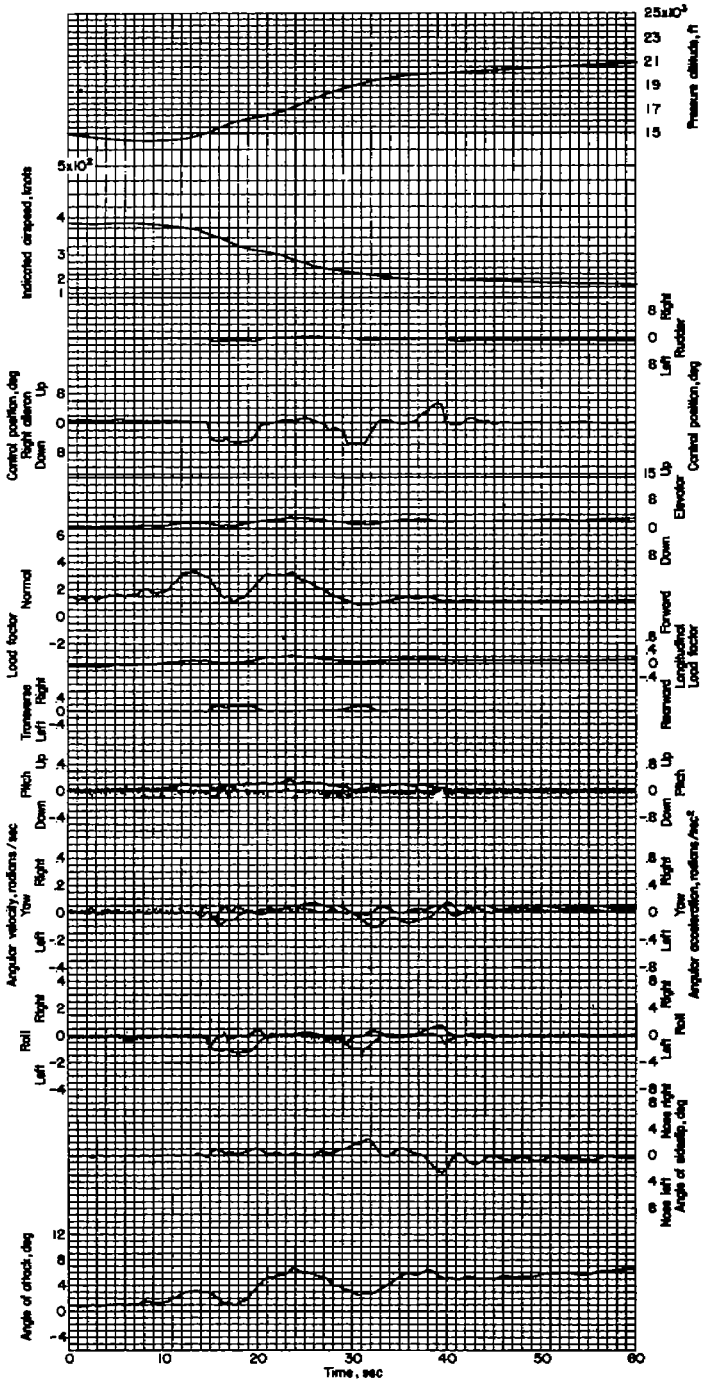


Figure 160.- Left aileron roll followed by series of climbing turns. Airplane weight, 15,580 pounds; center of gravity at 23.9 percent M.A.C.; flight 15.

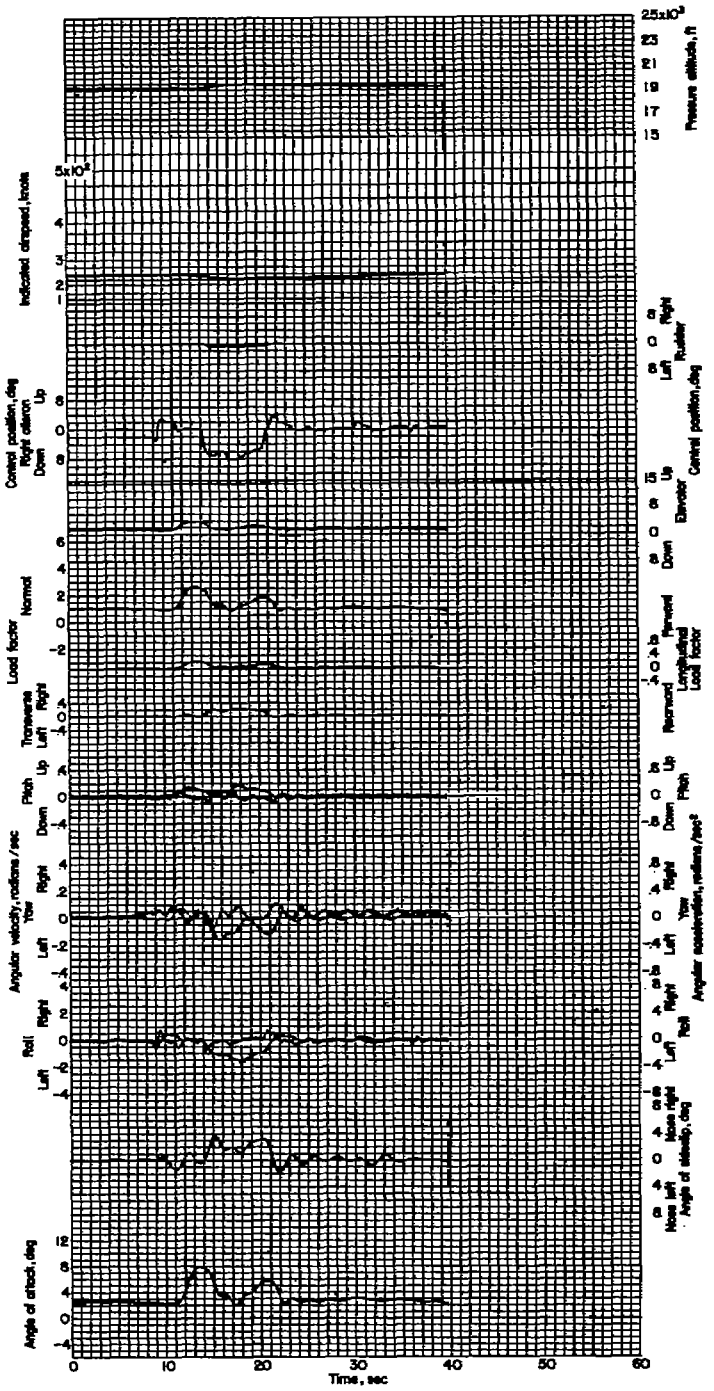
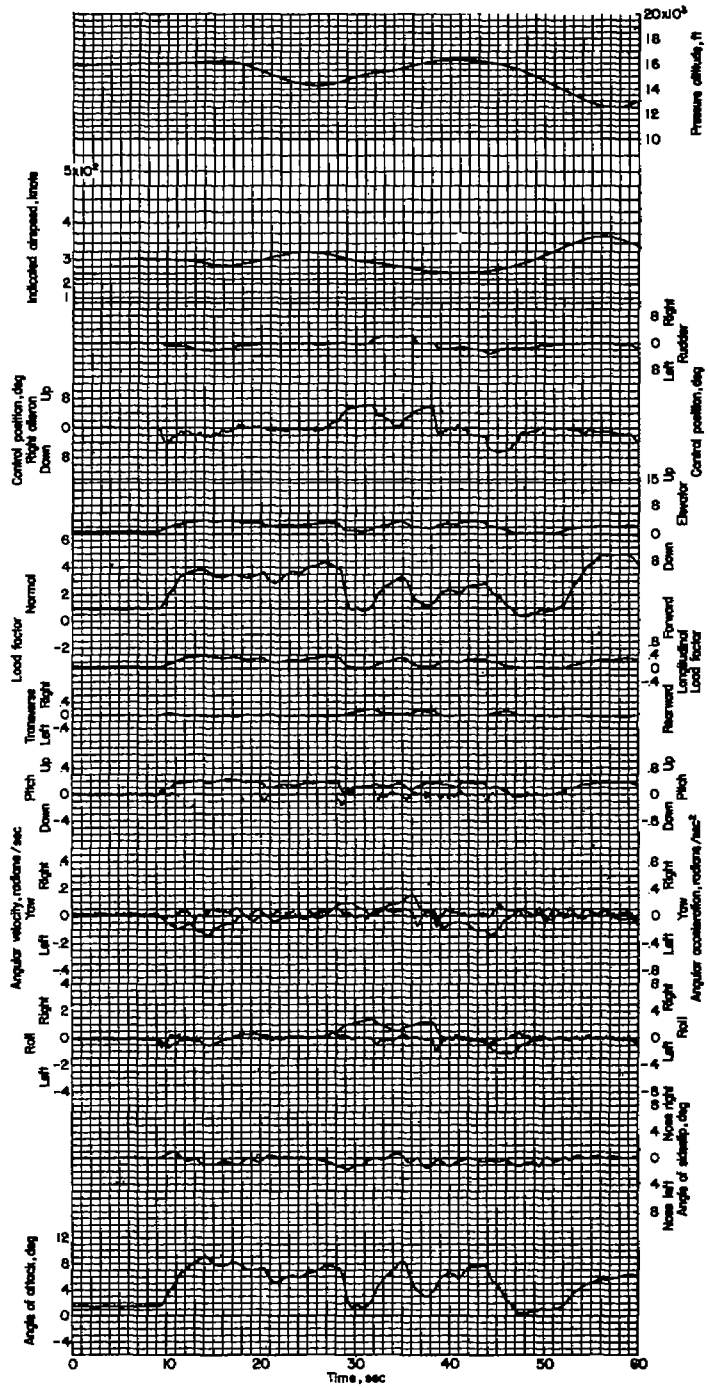


Figure 161.- Left aileron roll. Airplane weight, 15,370 pounds; center of gravity at 23.9 percent M.A.C.; flight 15.

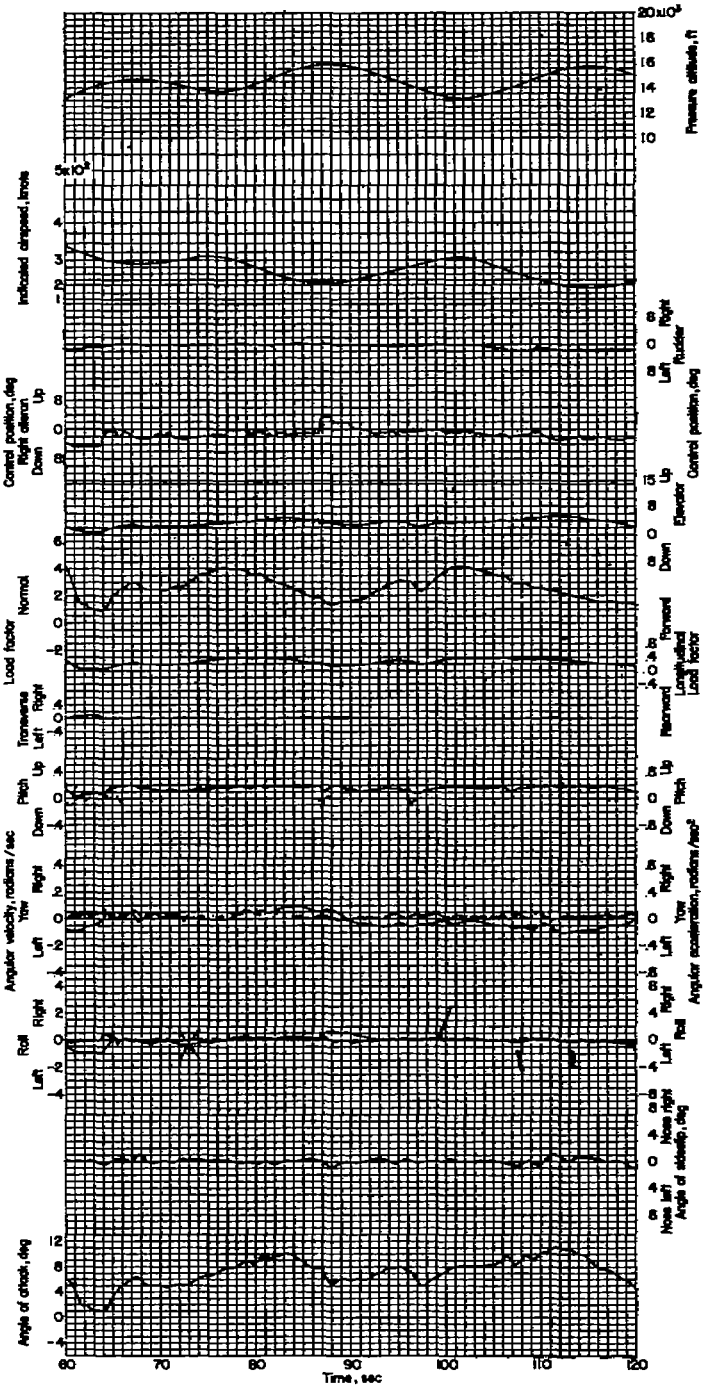
[redacted]



(a)

Figure 162.- Peel-off into series of diving and climbing turns and partial rolls including two consecutive right barrel rolls. Airplane weight, 16,160 pounds; center of gravity at 24.2 percent M.A.C.; flight 17.

[redacted]



(b)

Figure 162.- Concluded.

[redacted]

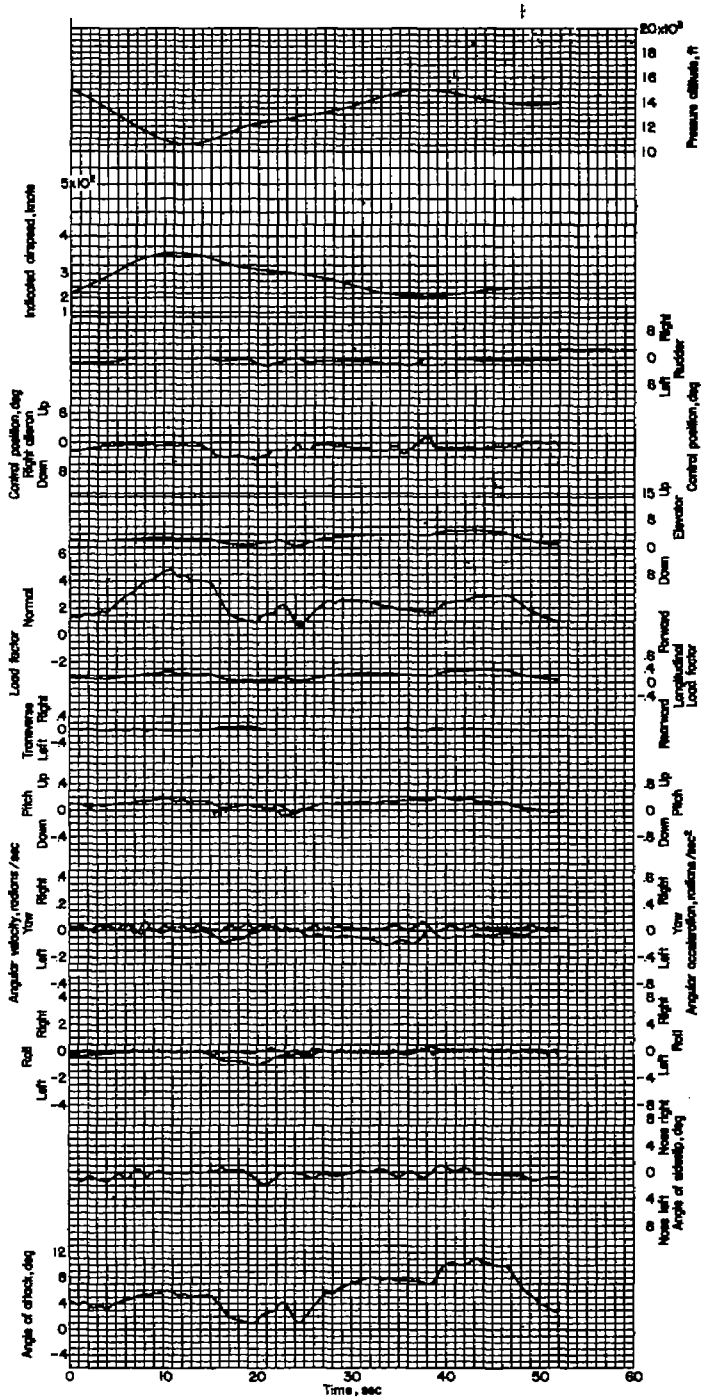
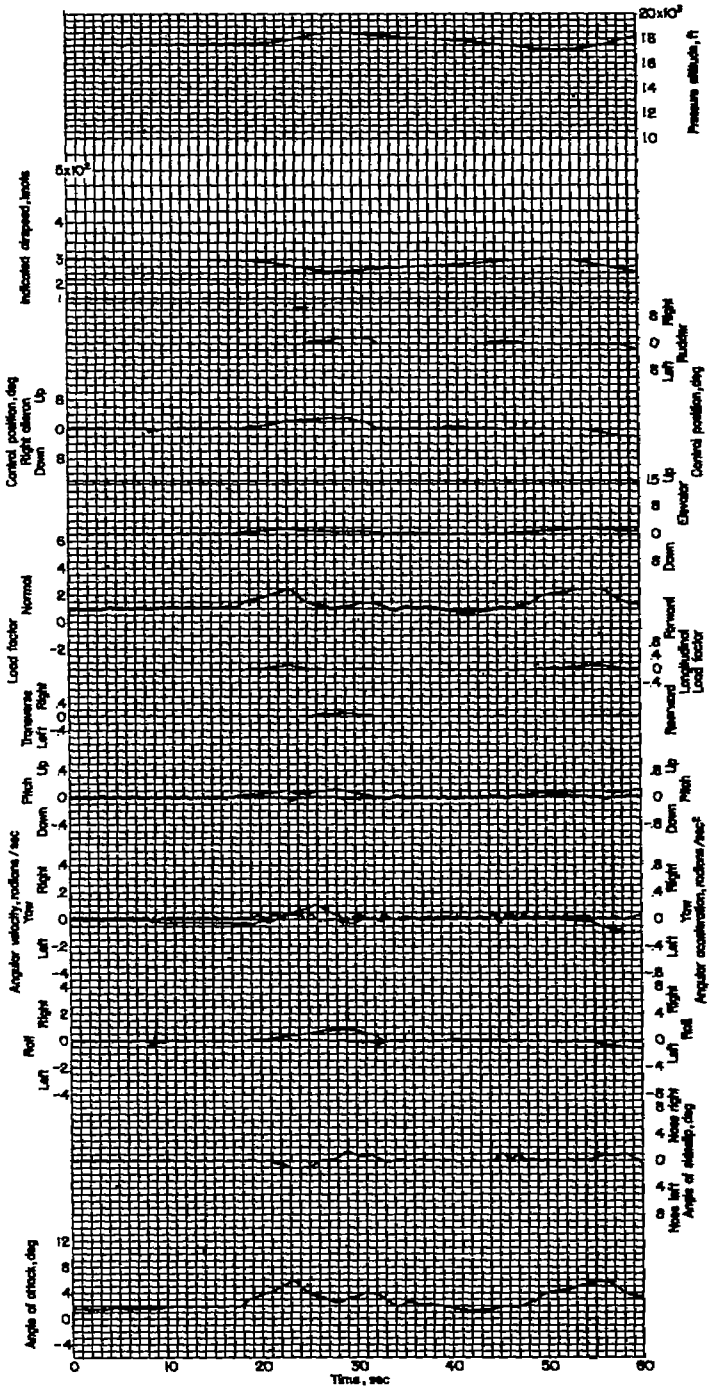


Figure 163.- Dive and pull-up into left aileron roll and left turn. Airplane weight, 16,100 pounds; center of gravity at 24.2 percent M.A.C.; flight 17.

NACA

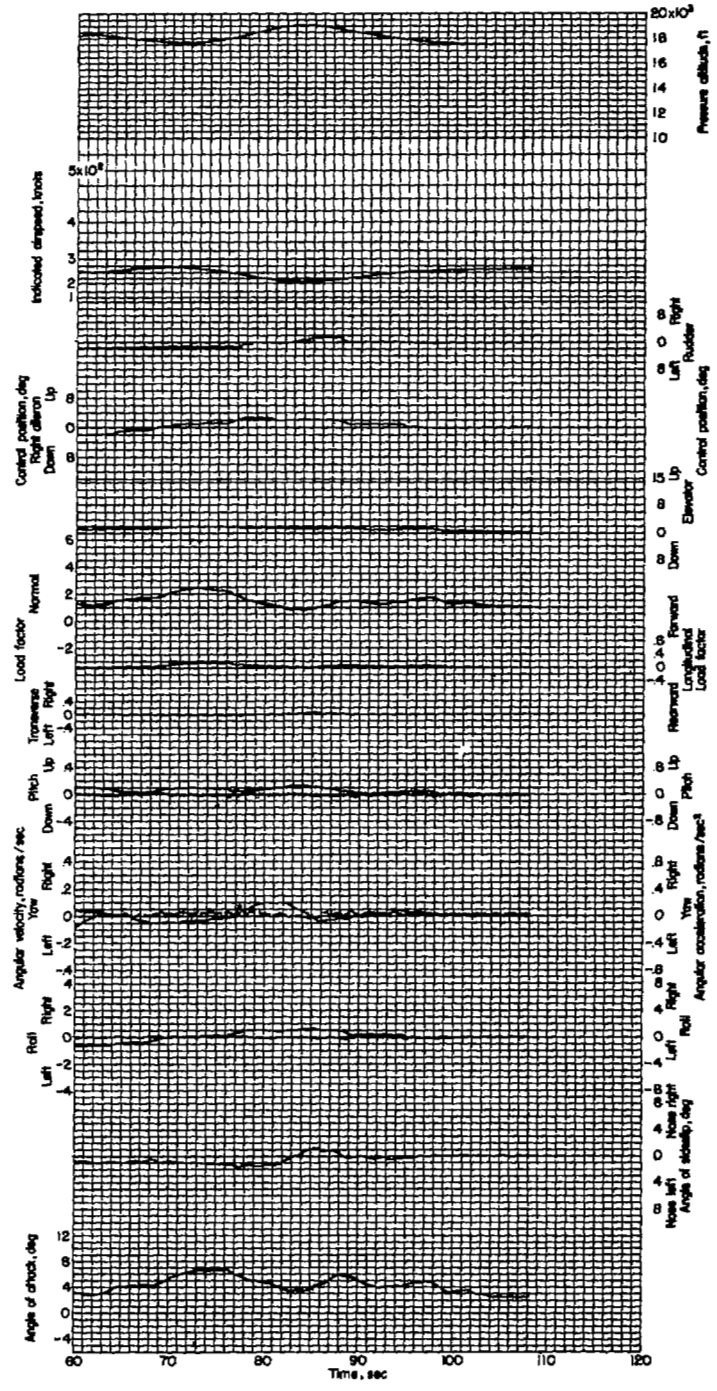


(a)

NACA

Figure 164.- Right aileron roll followed by left and right aileron roll. Airplane weight, 14,670 pounds; center of gravity at 23.9 percent M.A.C.; flight 19.

[redacted]



(b)

Figure 164.- Concluded.

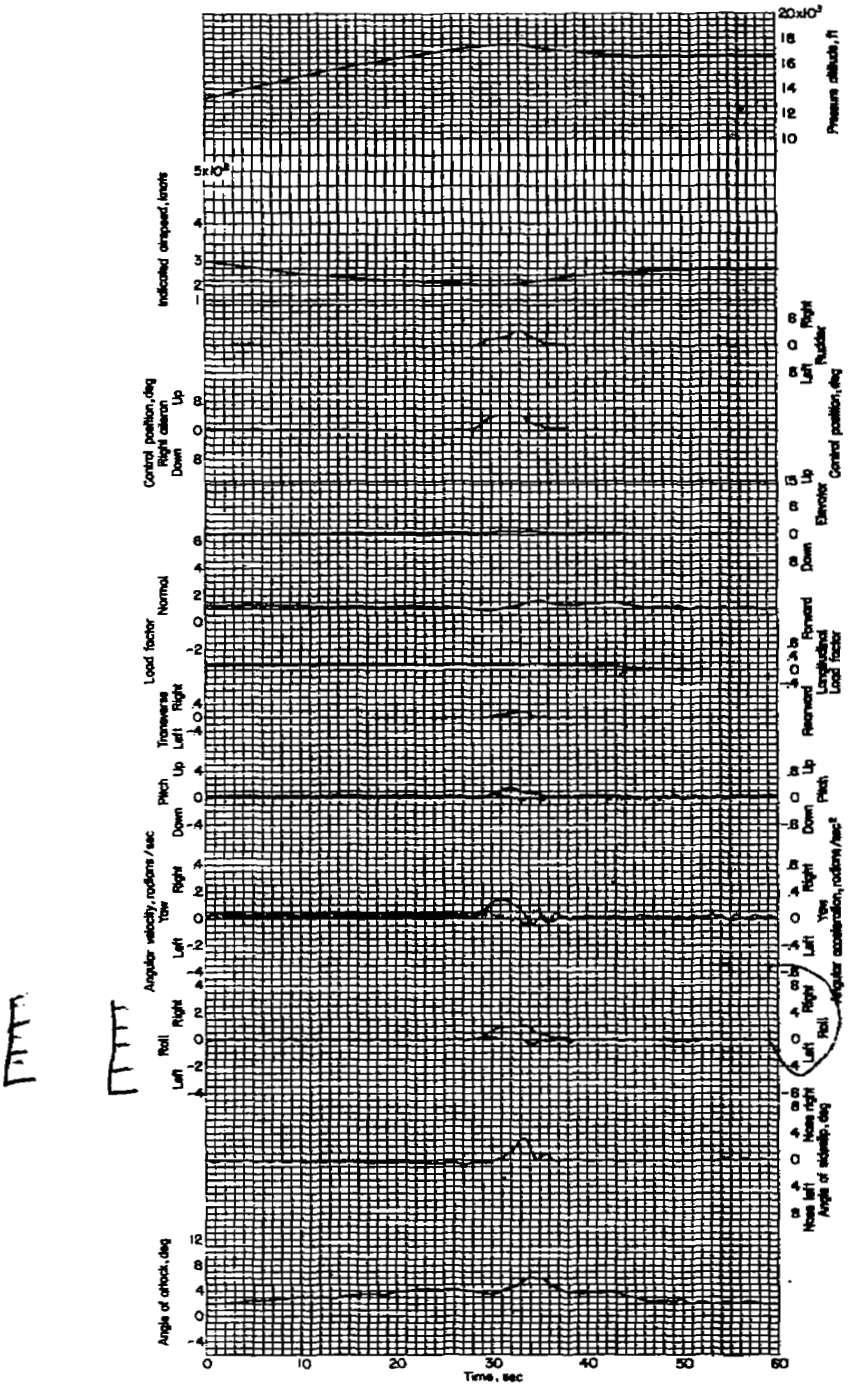
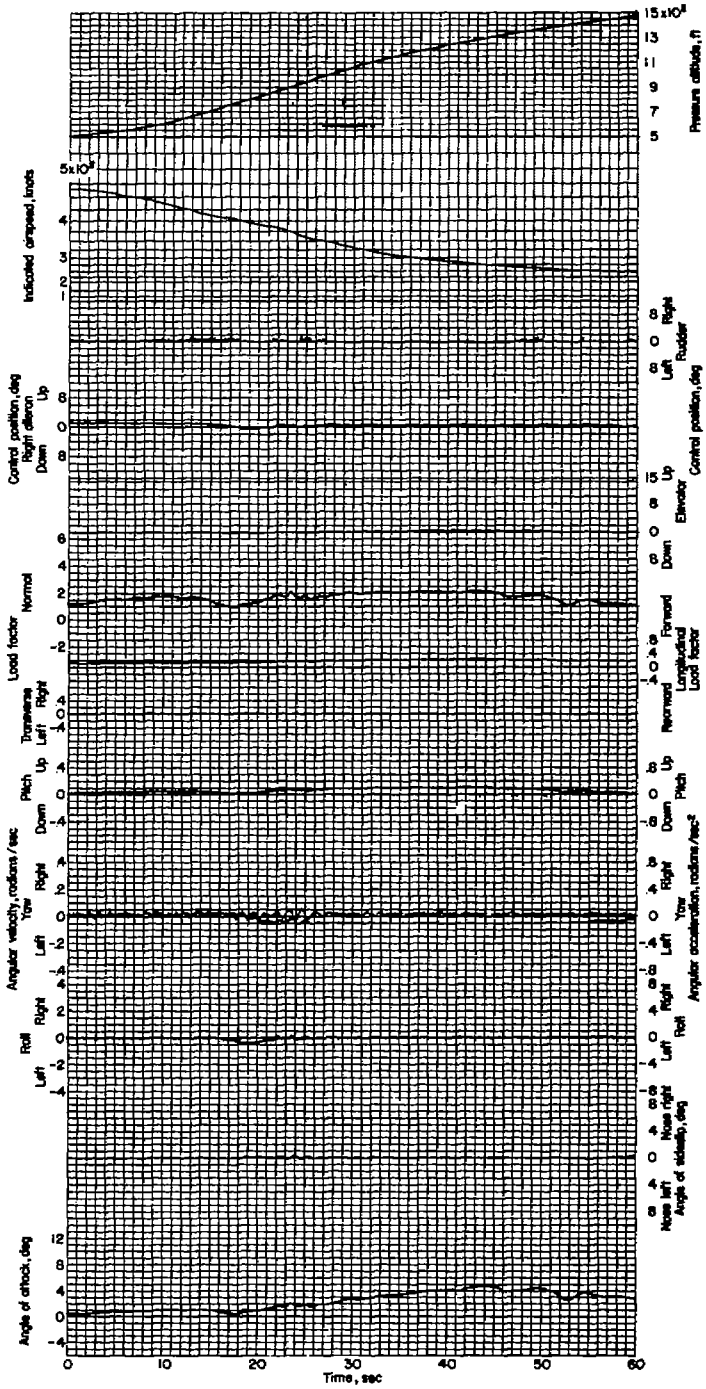


Figure 165.- Climbing right turn into right aileron roll. Airplane weight, 14,090 pounds; center of gravity at 24.7 percent M.A.C.; flight 19.

NACA

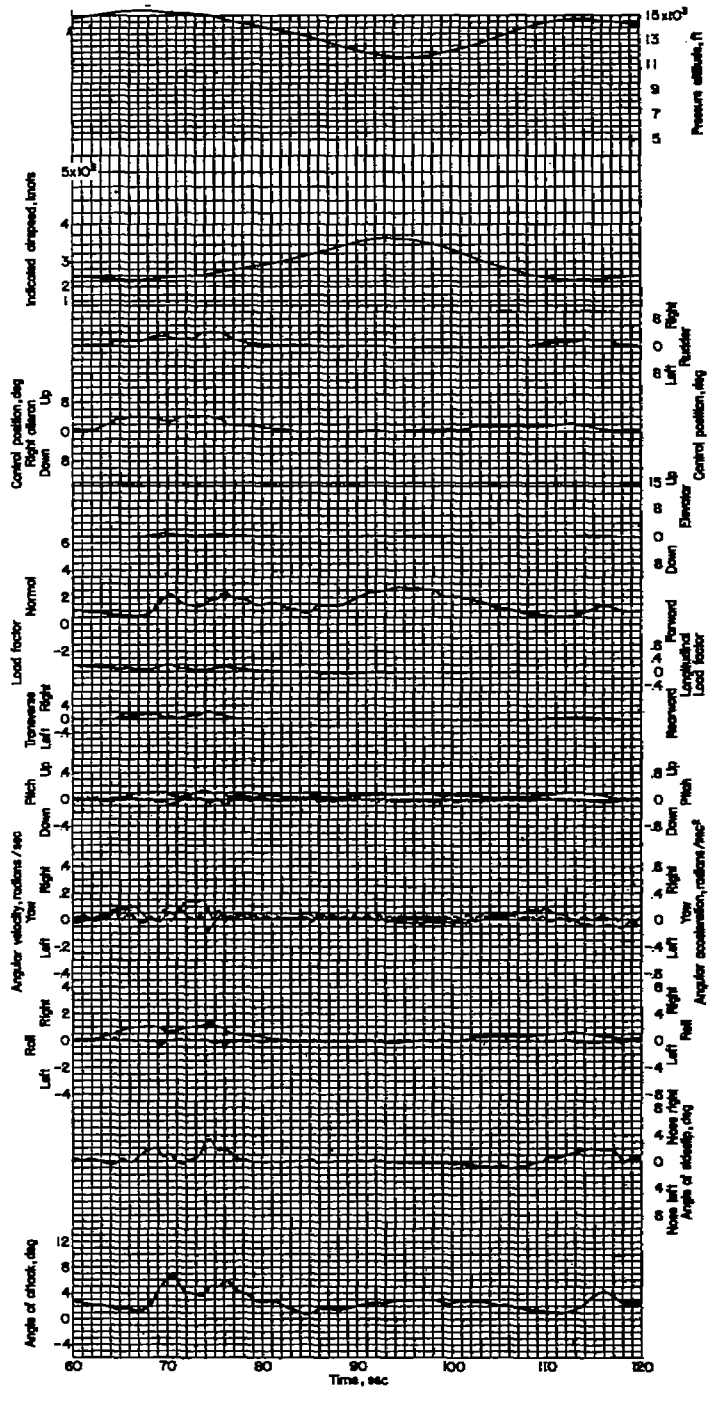


(a)

NACA

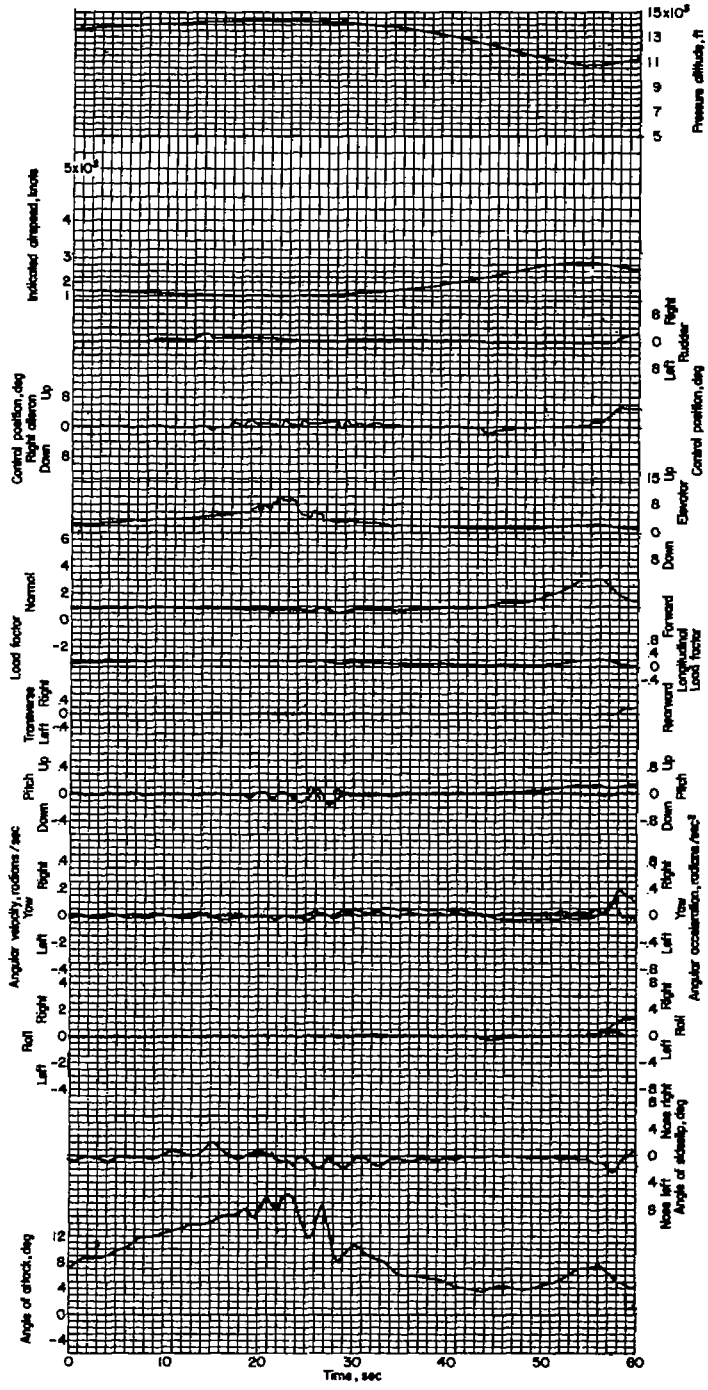
Figure 166.- Climbing left turn into two consecutive right aileron rolls followed by right aileron roll. Airplane weight, 13,550 pounds; center of gravity at 25.5 percent M.A.C.; flight 19.

[redacted]



(b)

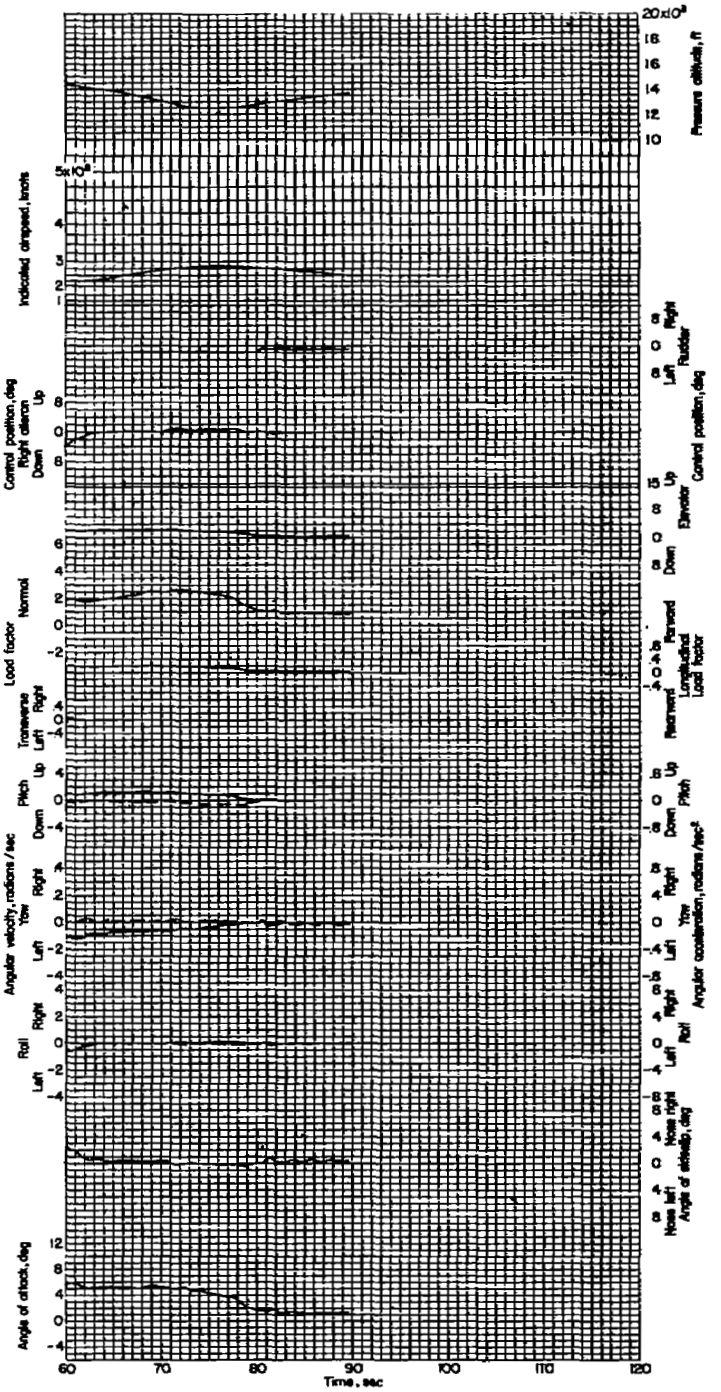
Figure 166.- Concluded.



(a)

NACA

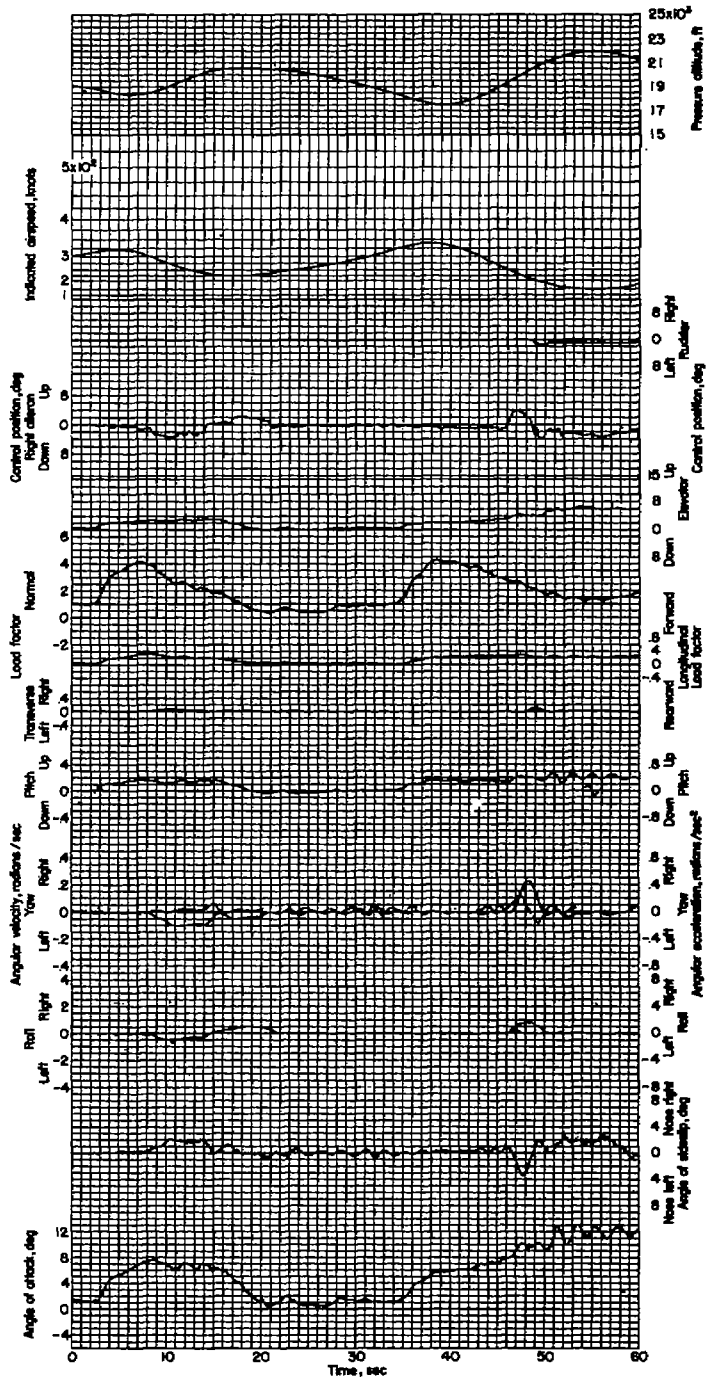
Figure 167.- Stall followed by right barrel roll into wing-over and right aileron roll. Airplane weight, 14,680 pounds; center of gravity at 23.9 percent M.A.C.; flight 20.



(b)

Figure 169.- Concluded.

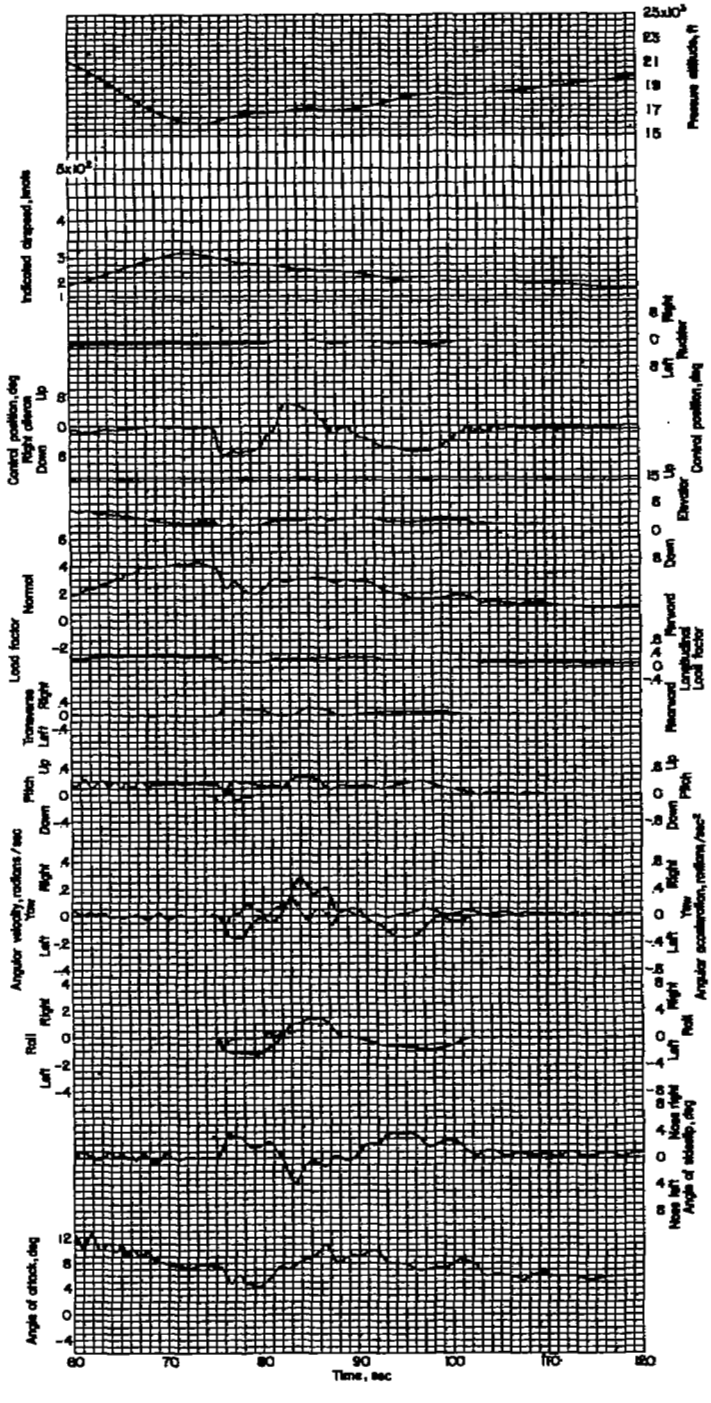
[redacted]



(a)

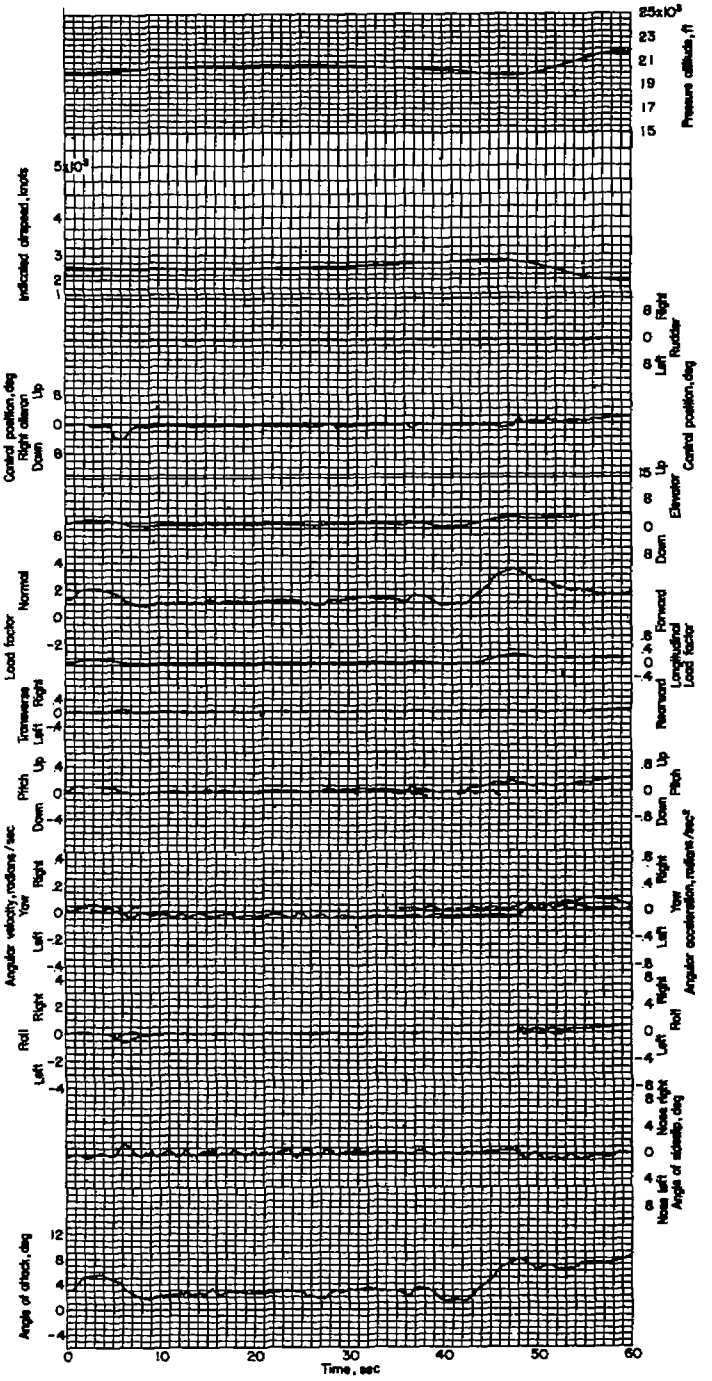
Figure 170.- Chandelle followed by push-down and climbing partial right-roll entry into half-loop followed by series of barrel rolls. Airplane weight, 16,310 pounds; center of gravity at 24.3 percent M.A.C.; flight 3.

[redacted]



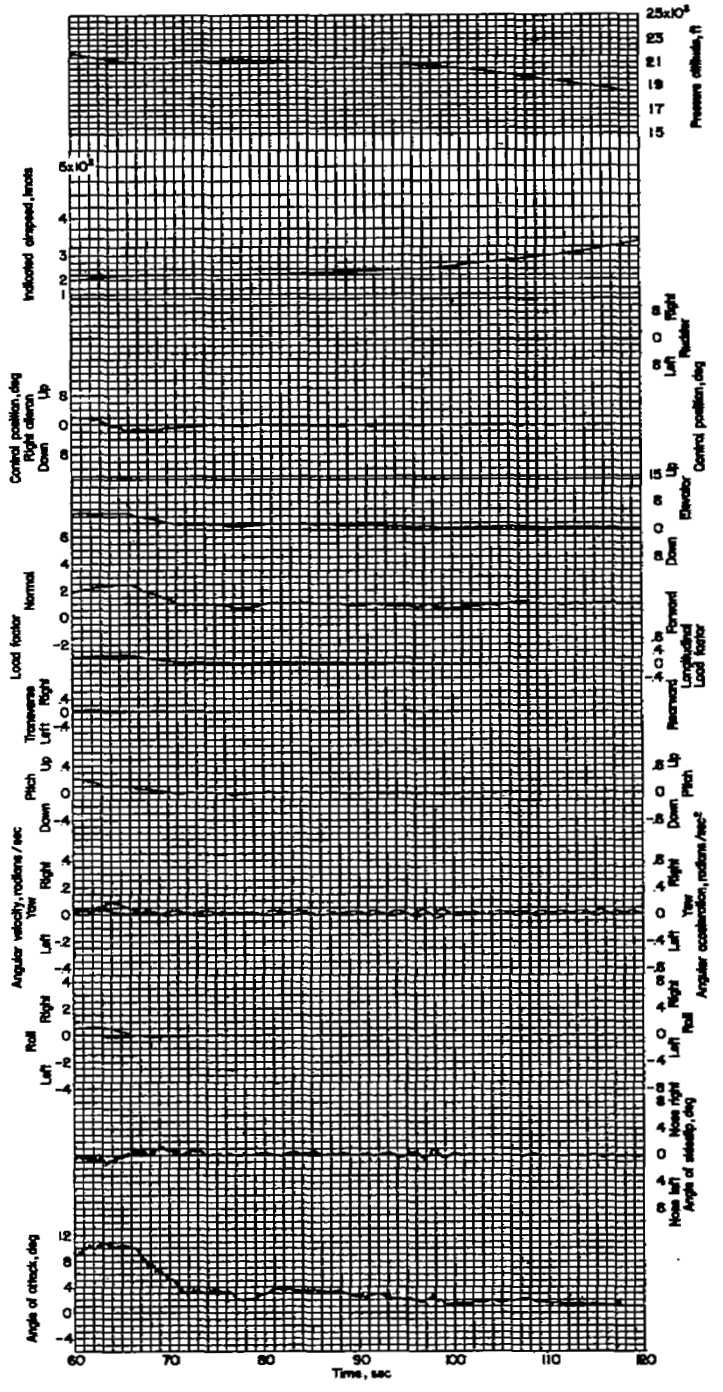
(b)

Figure 170. Concluded.



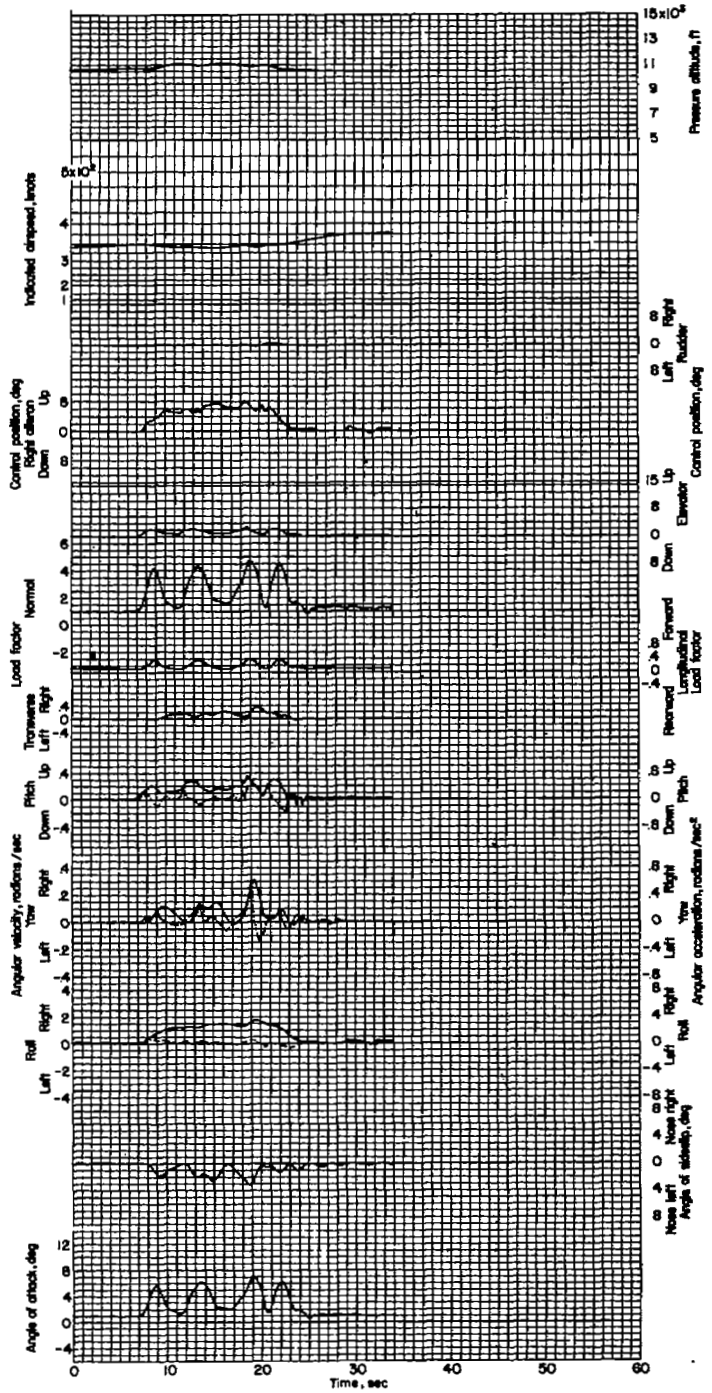
(a)

Figure 171.- Left turn followed by right barrel roll. Airplane weight, 15,980 pounds; center of gravity at 24.1 percent M.A.C.; flight 3.



(b)

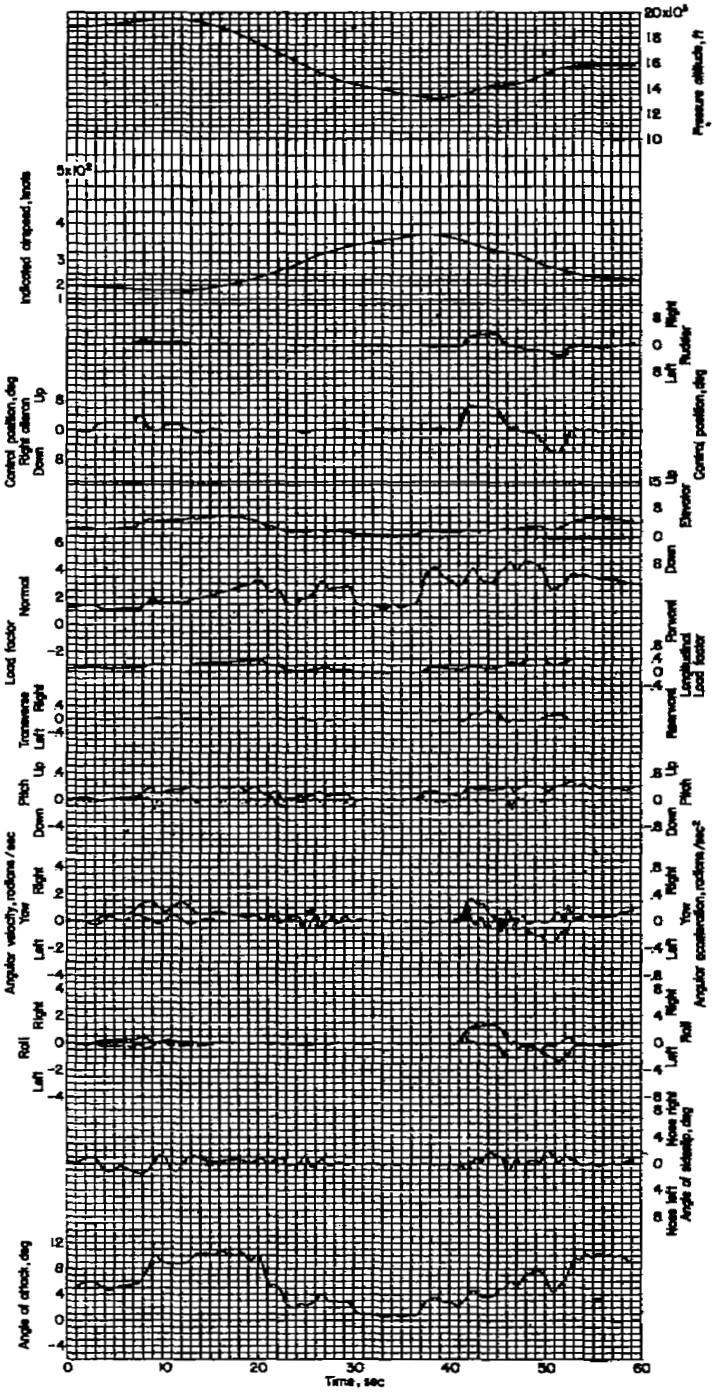
Figure 171.- Concluded.



NACA

Figure 172.- Three consecutive right barrel rolls. Airplane weight, 17,180 pounds; center of gravity at 24.8 percent M.A.C.; flight 5.

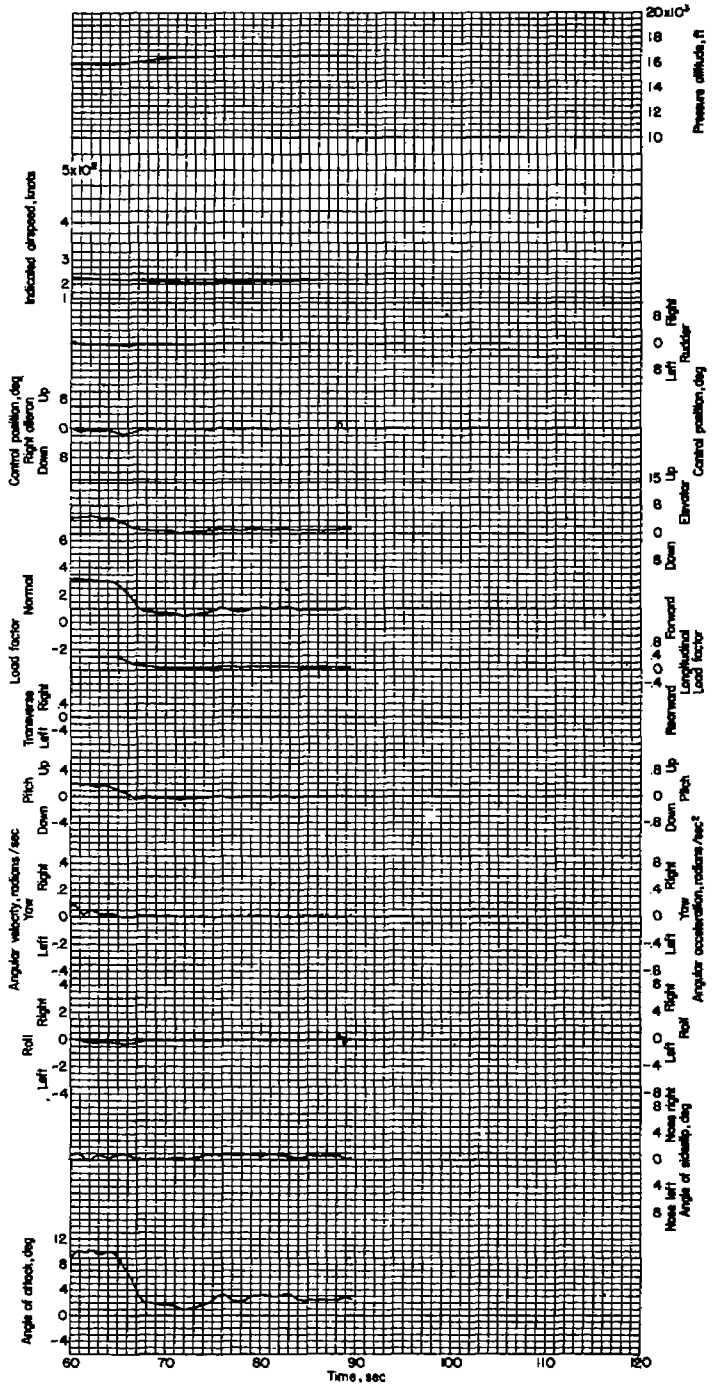
[redacted]



(a)

Figure 173.- Peel-off into dive followed by right and left barrel roll. Airplane weight, 14,590 pounds; center of gravity at 24.9 percent M.A.C.; flight 6.

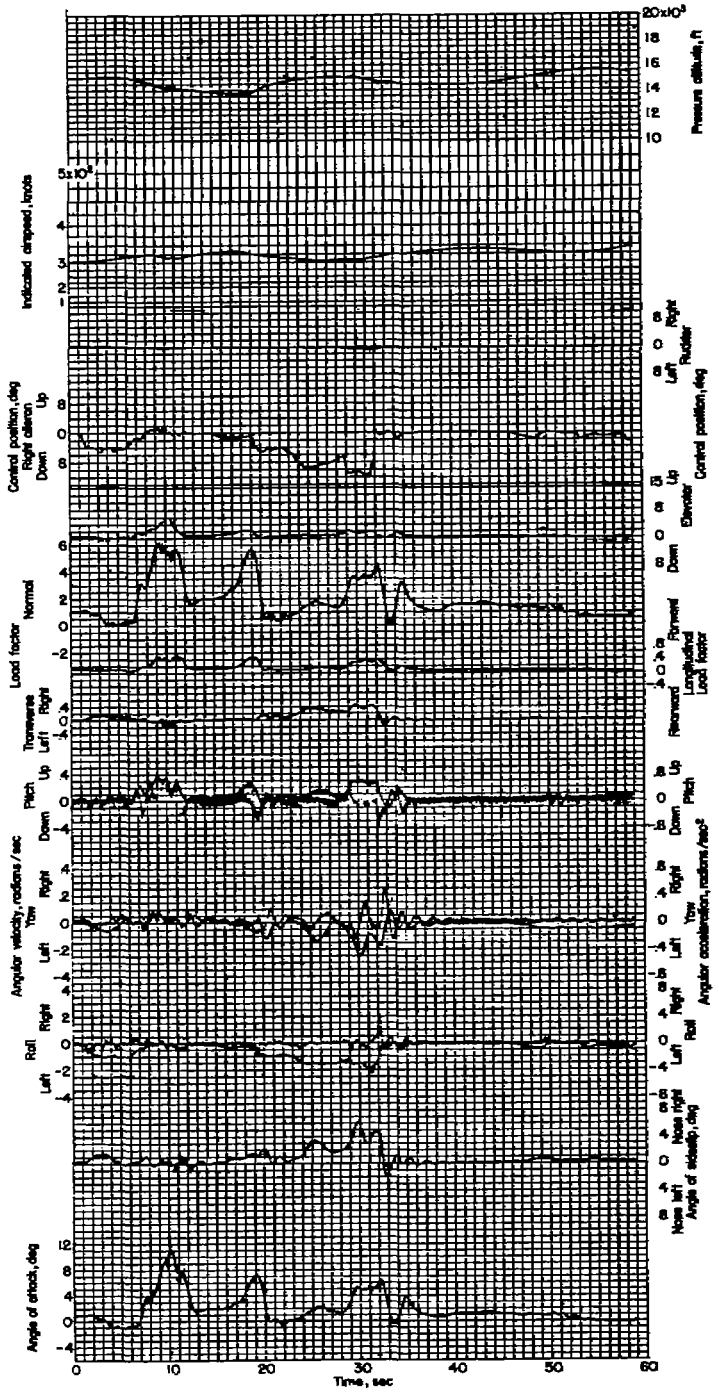
[redacted]



(b)

Figure 173.- Concluded.

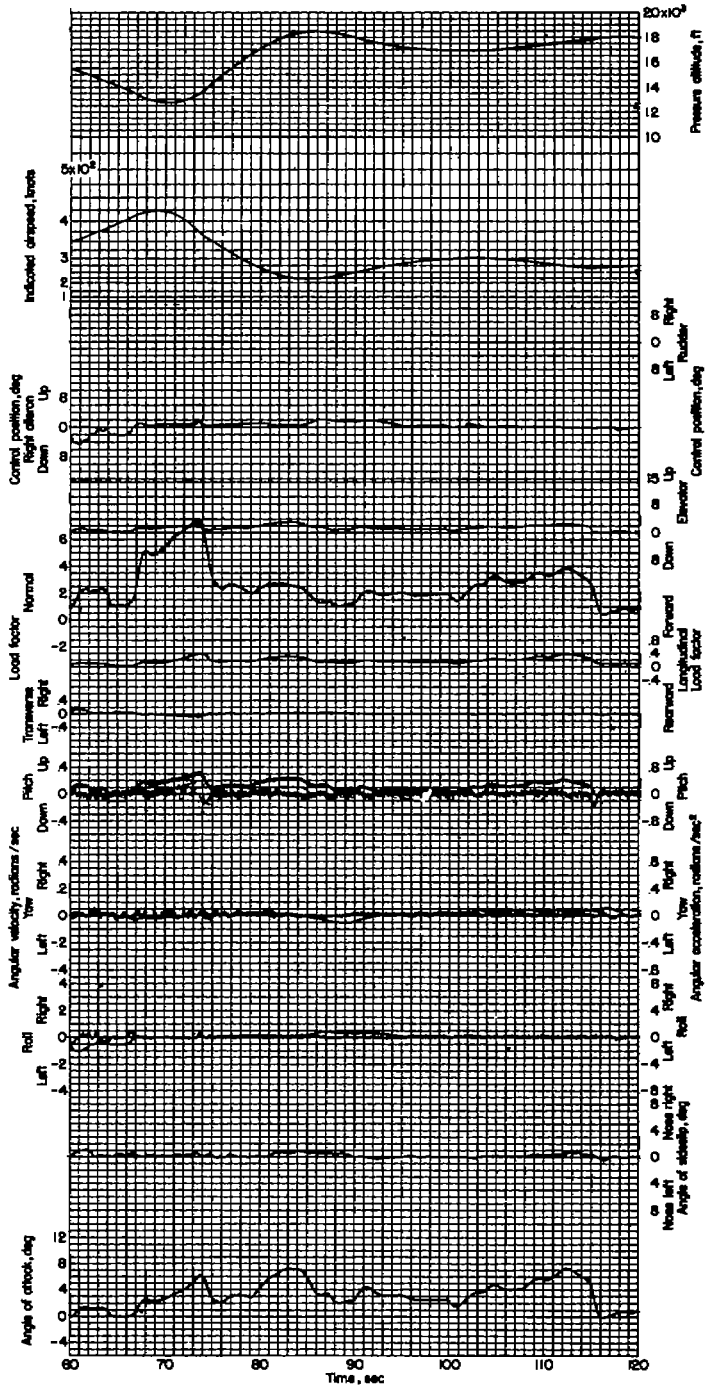
[redacted]



(a)

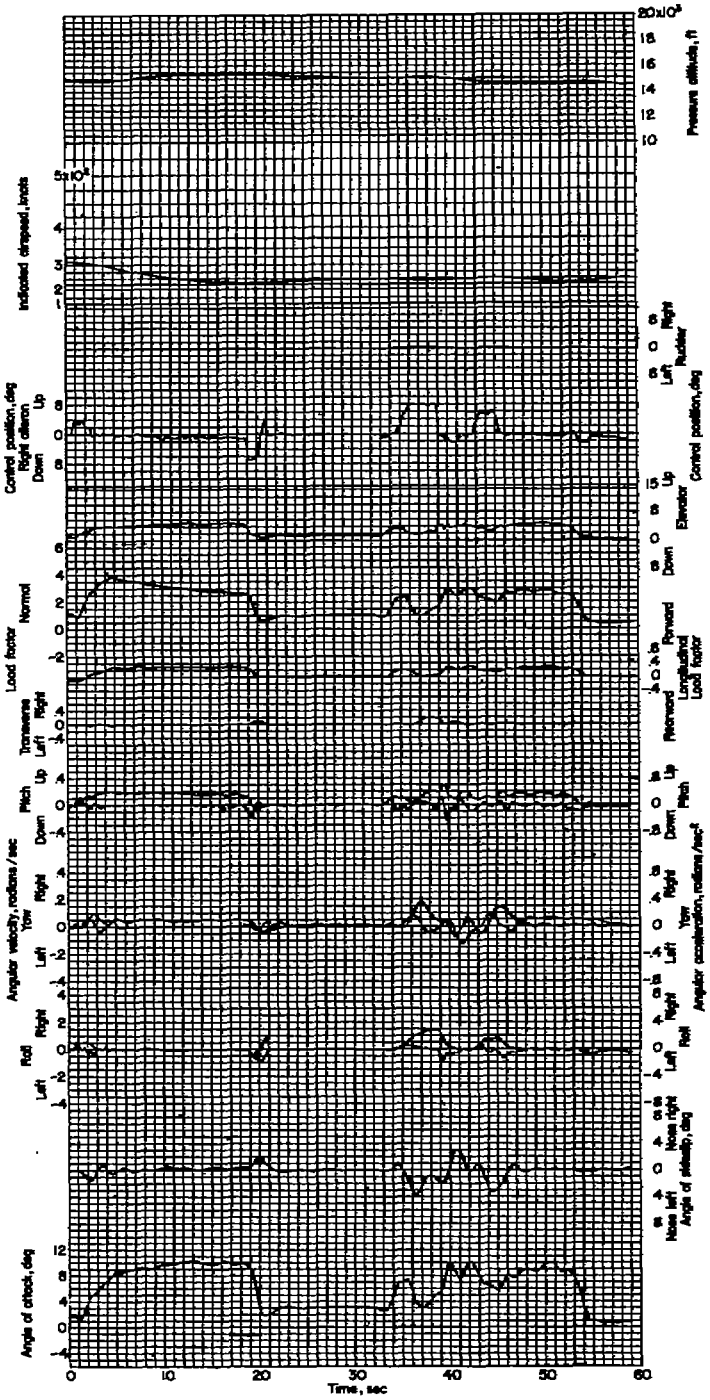
NACA

Figure 174.- Three-quarter left roll into right turn and three consecutive left barrel rolls followed by diving left aileron roll and pull-out into Immelman and right turn. Airplane weight, 14,040 pounds; center of gravity at 25.7 percent M.A.C.; flight 7.



(b)

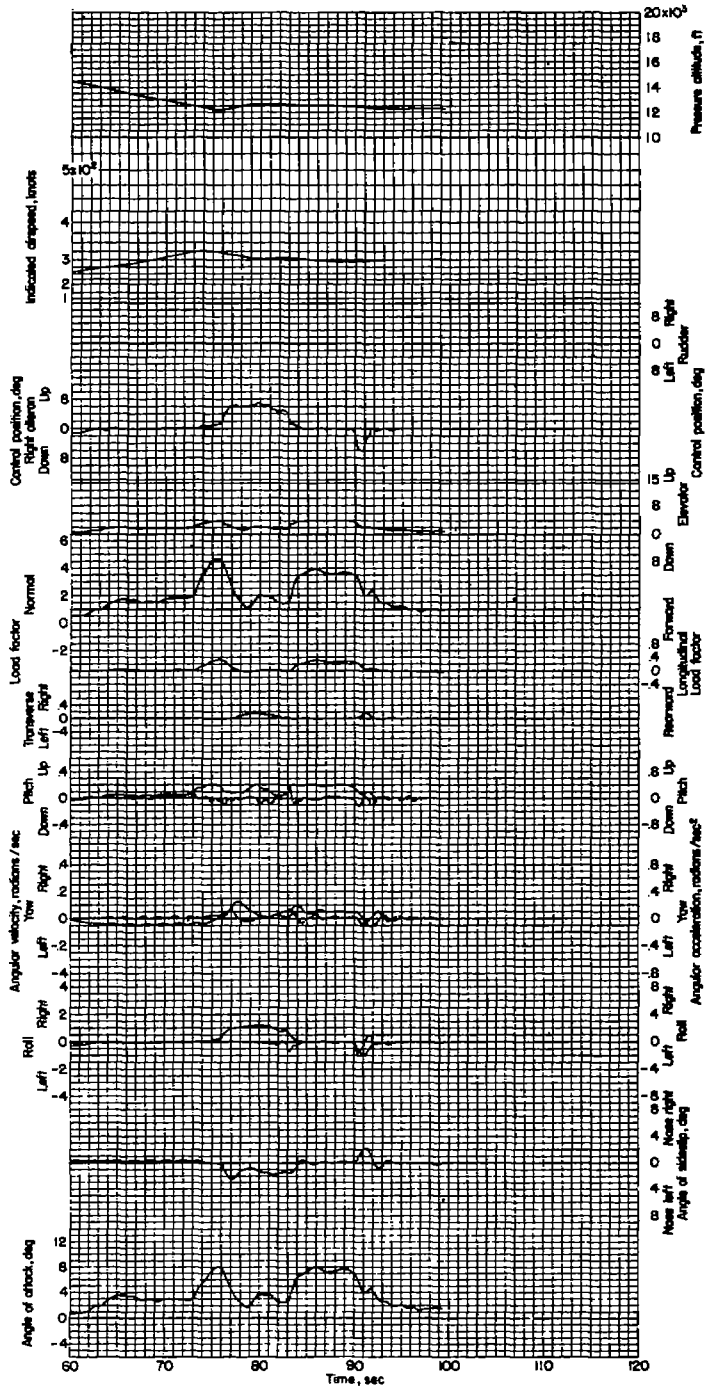
Figure 174.- Concluded.



(a)

Figure 175.- Right turn followed by two right barrel rolls. Airplane weight, 16,110 pounds; center of gravity at 24.2 percent M.A.C.; flight 12.

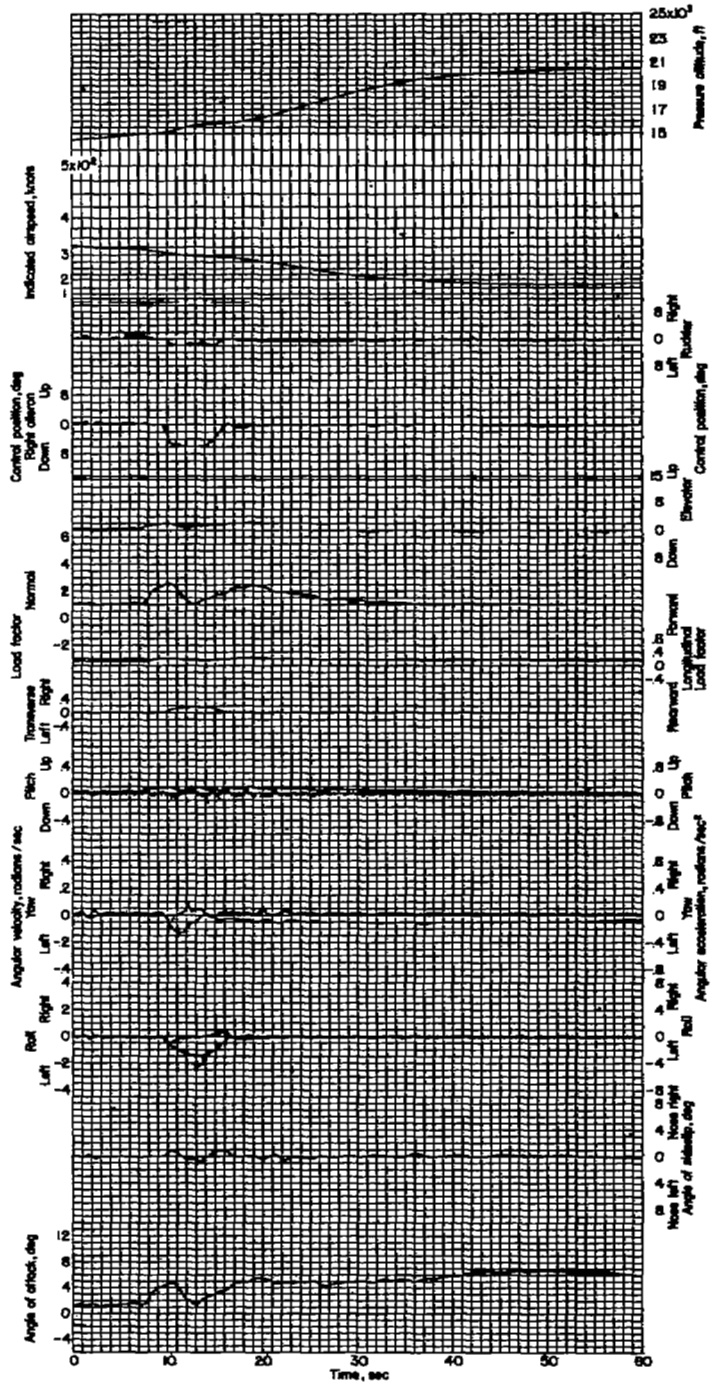
[redacted]



(b)

Figure 175.- Concluded.

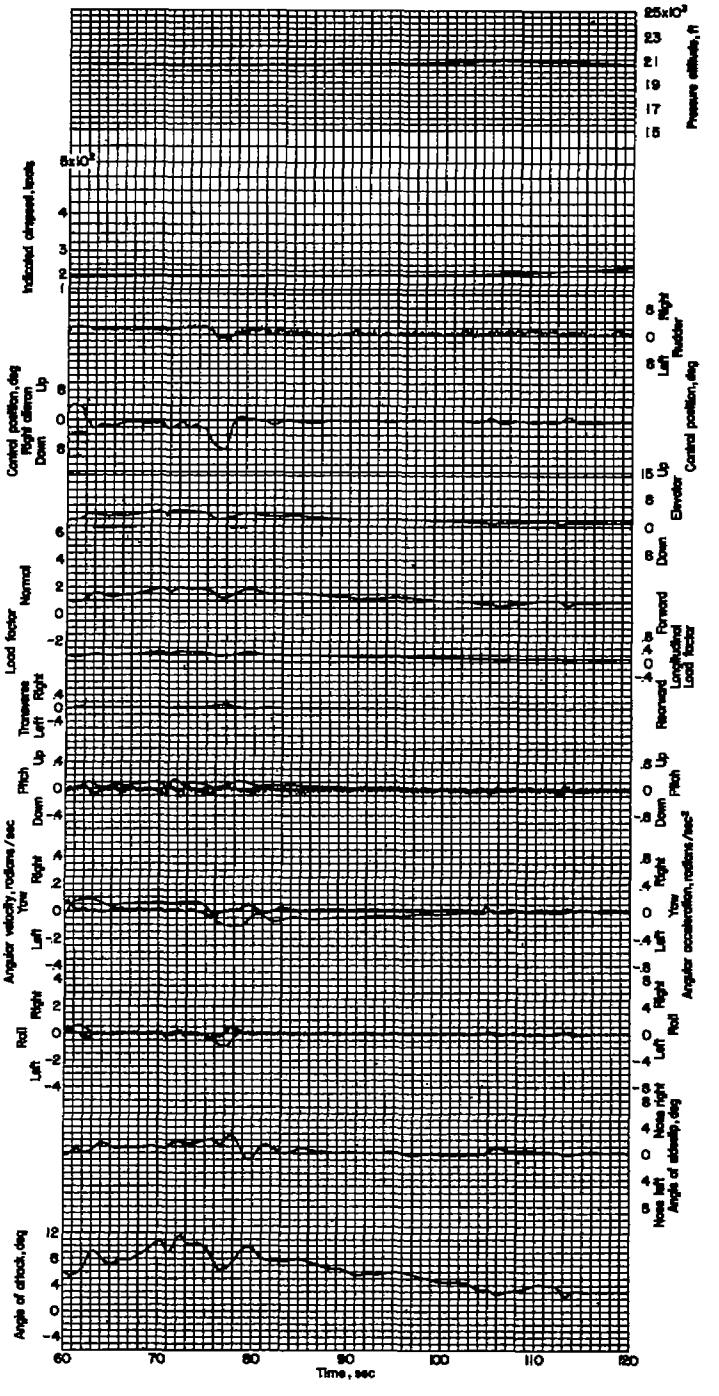
[redacted]



(a)

Figure 176.- Left barrel roll followed by series of turns. Airplane weight, 16,440 pounds; center of gravity at 24.4 percent M.A.C.; flight 15.

[redacted]



(b)

Figure 176.- Concluded.

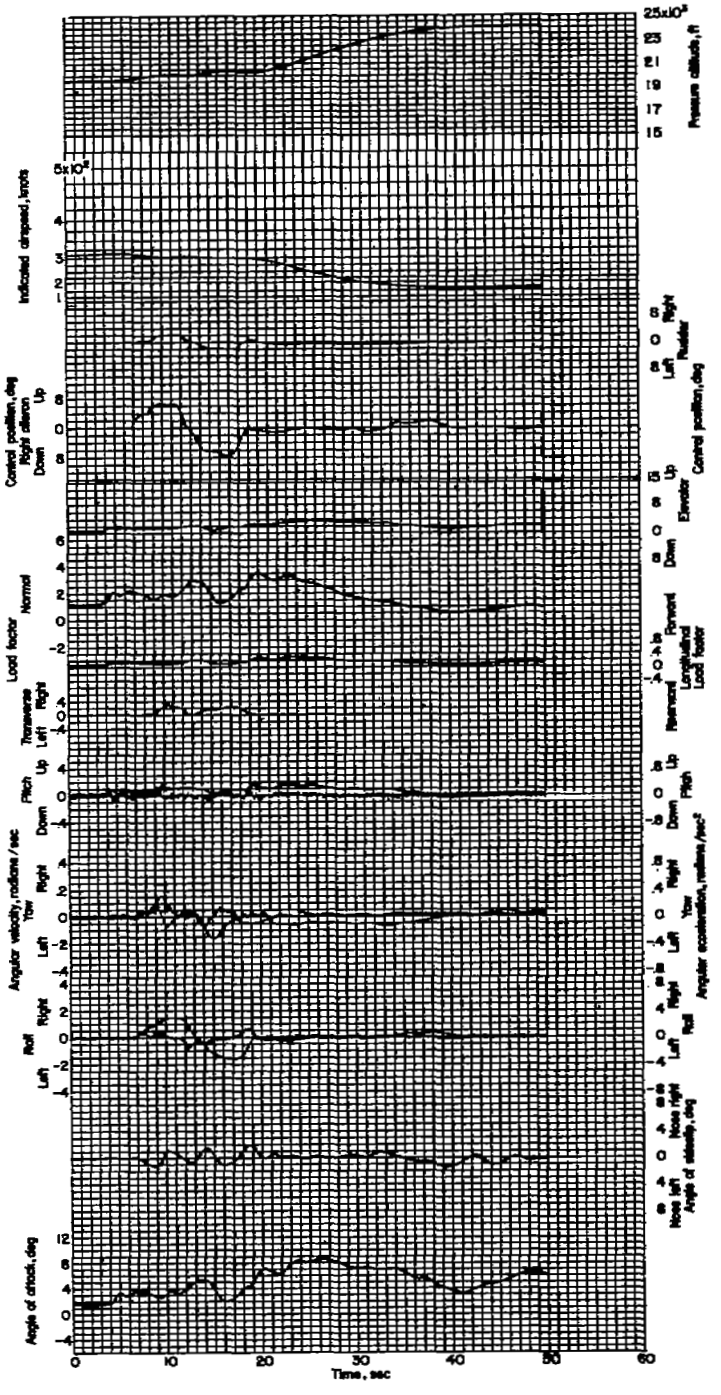
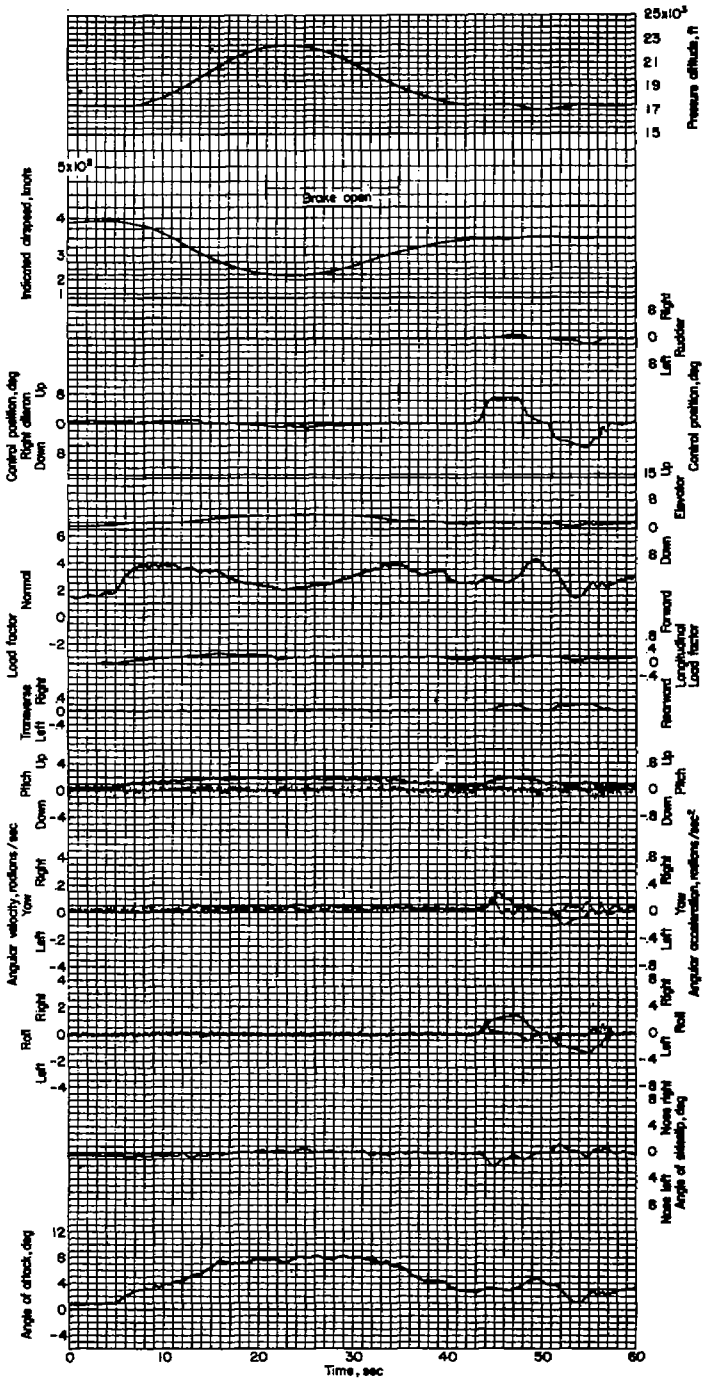


Figure 177.- Right and left barrel roll followed by chandelle. Airplane weight, 16,350 pounds; center of gravity at 24.3 percent M.A.C.; flight 15.

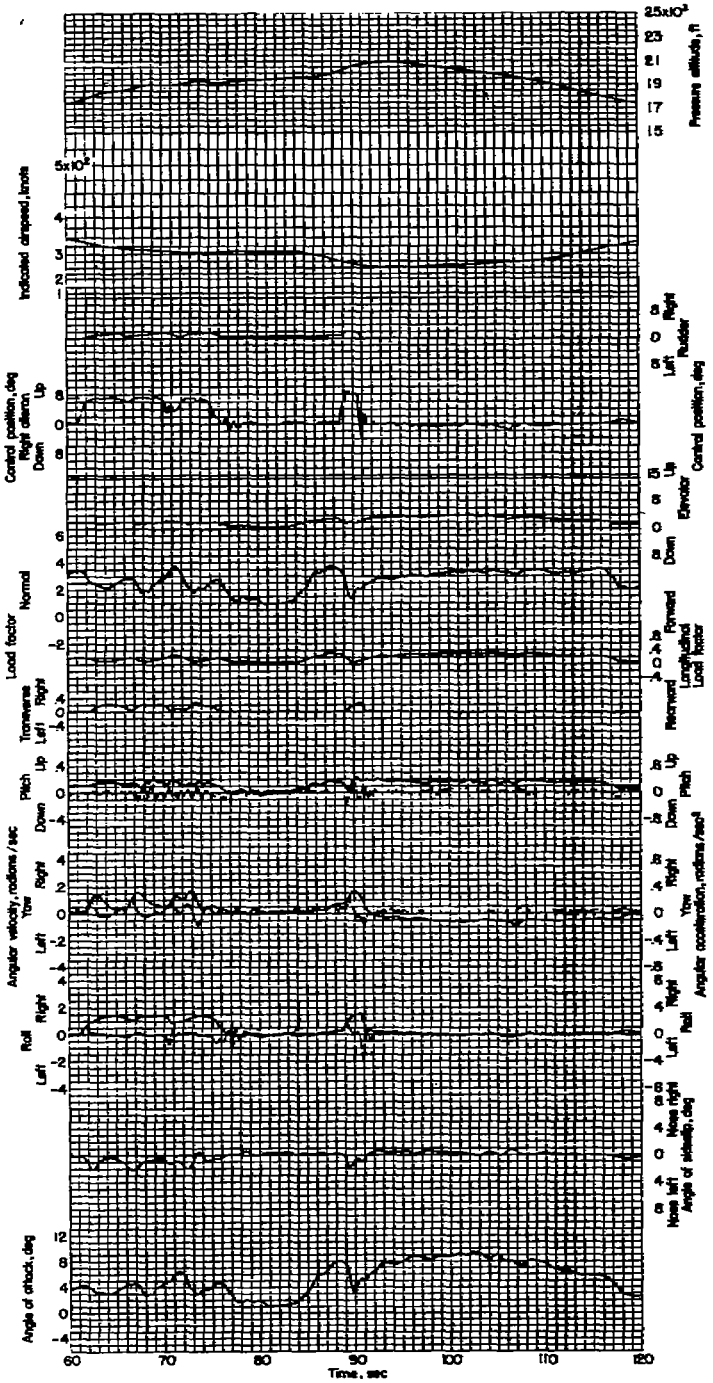
NACA



(a)

Figure 178.- Loop followed by right, left, and three consecutive right barrel rolls and three-quarter right roll into left turn. Airplane weight, 15,770 pounds; center of gravity at 24.0 percent M.A.C.; flight 15.

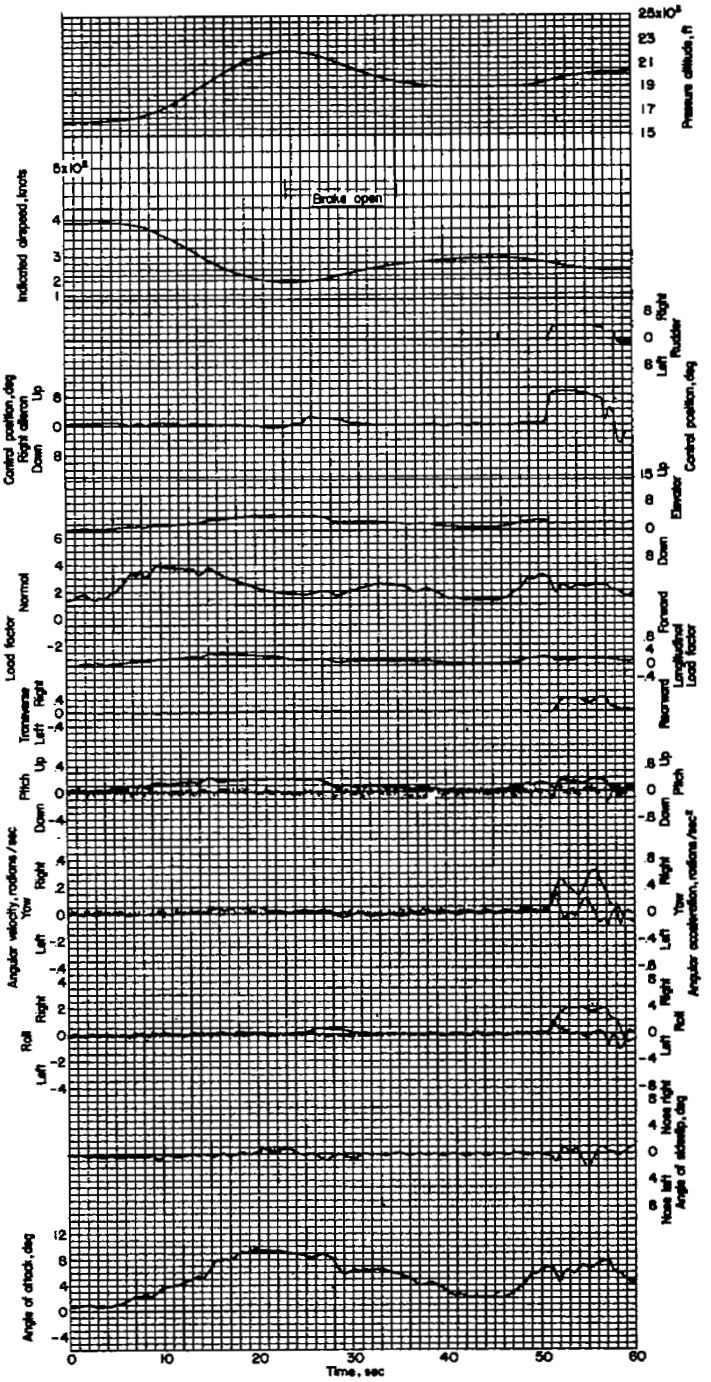
[redacted]



(b)

Figure 178.- Concluded.

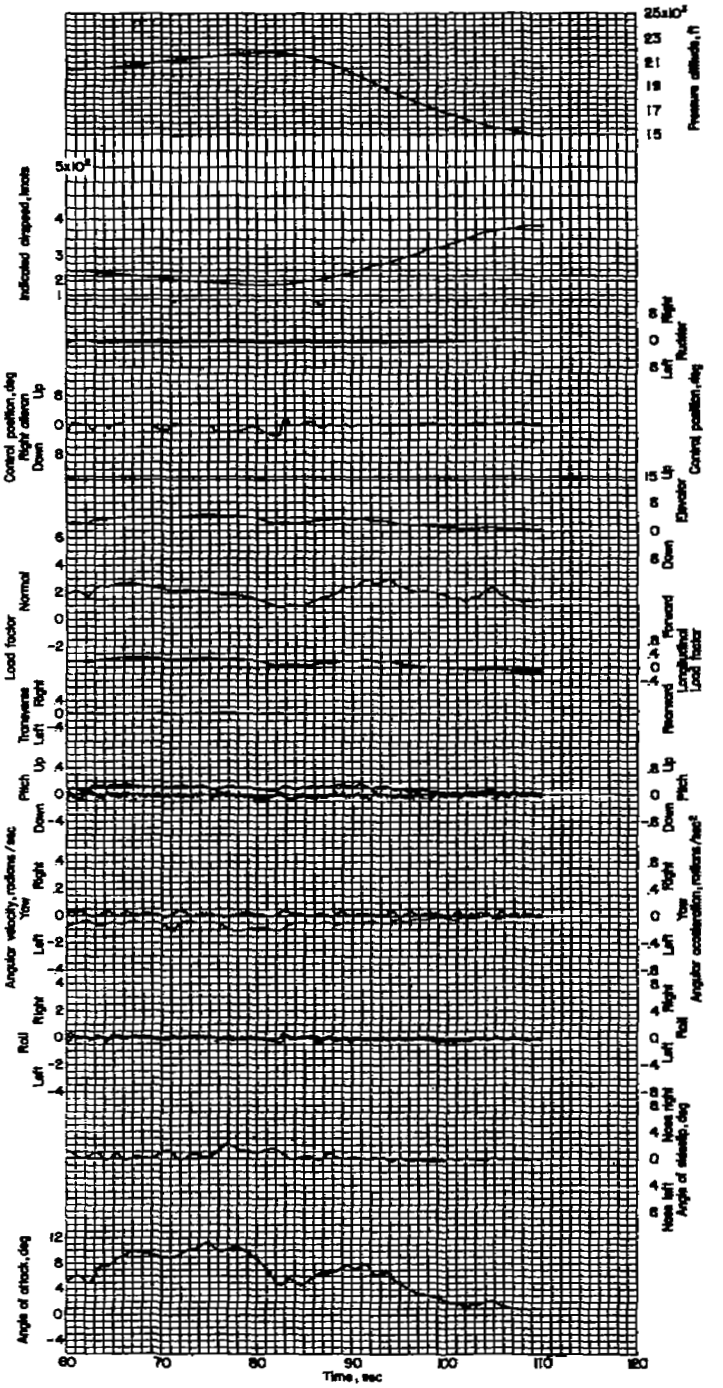
[redacted]



(a)

Figure 179.- Loop with right-quarter-roll recovery followed by two consecutive right barrel rolls and left turn into dive. Airplane weight, 15,640 pounds; center of gravity at 23.9 percent M.A.C.; flight 15.

[redacted]



(b)

Figure 179.- Concluded.

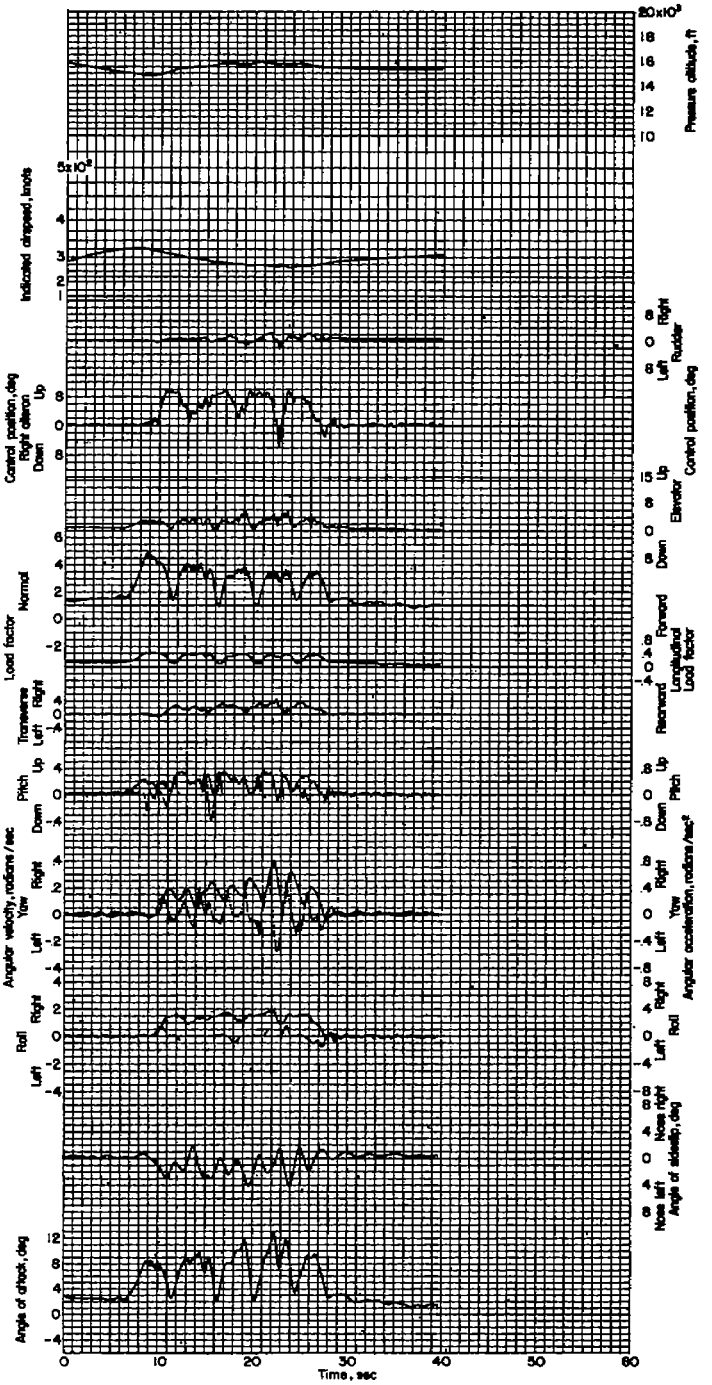
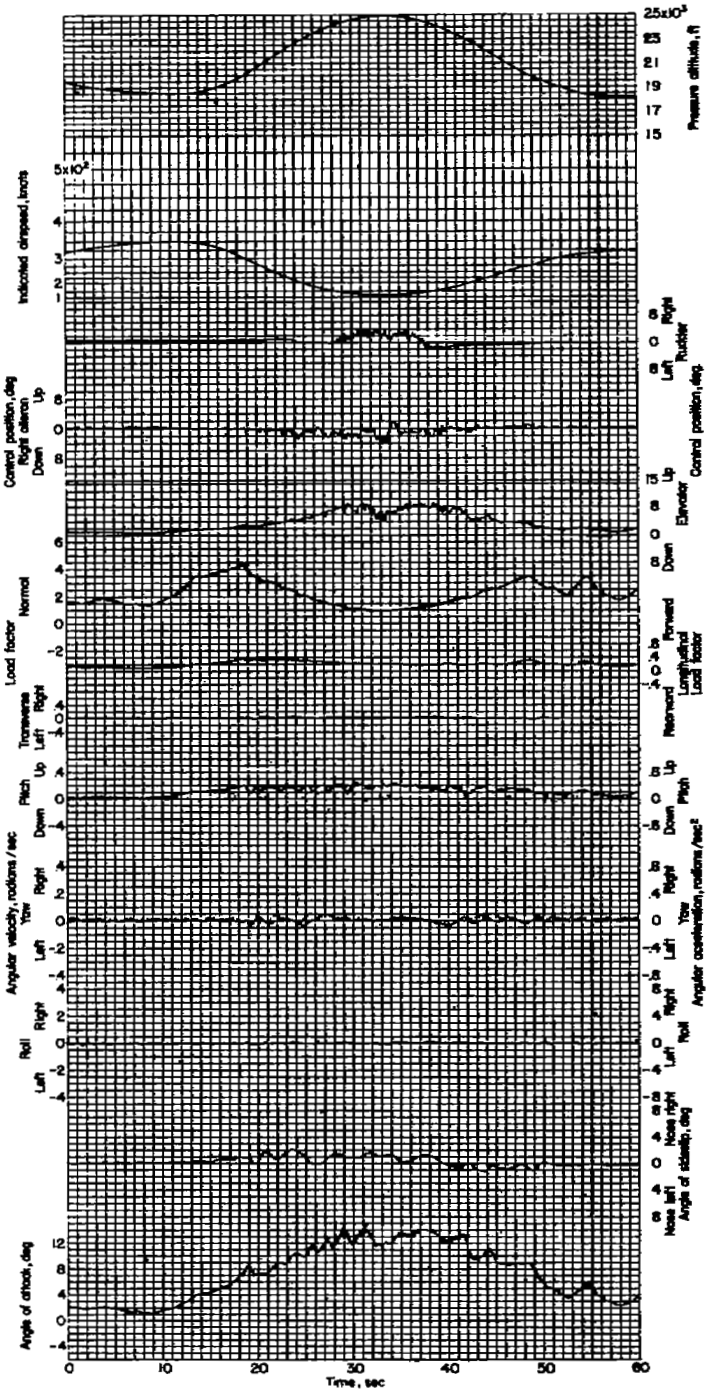


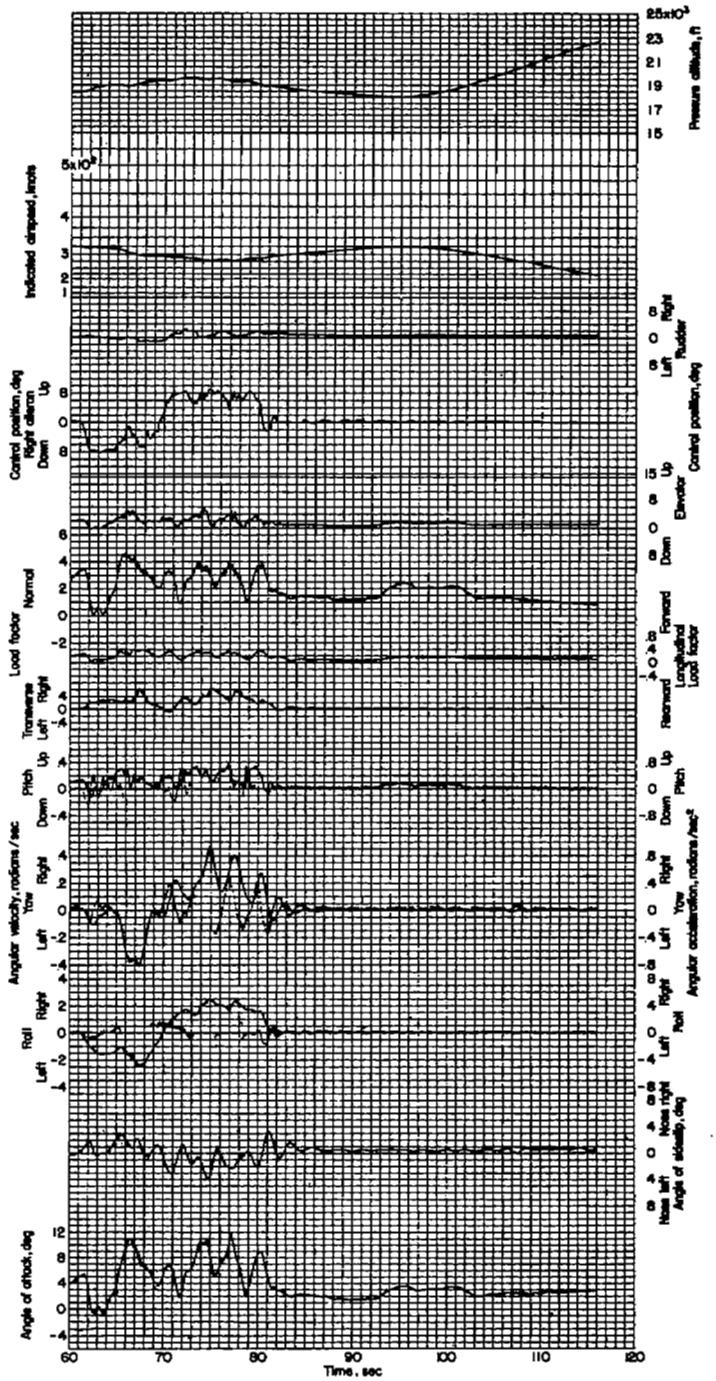
Figure 180.- Four consecutive right barrel rolls. Airplane weight, 16,320 pounds; center of gravity at 24.3 percent M.A.C.; flight 16.

[redacted]



(a)

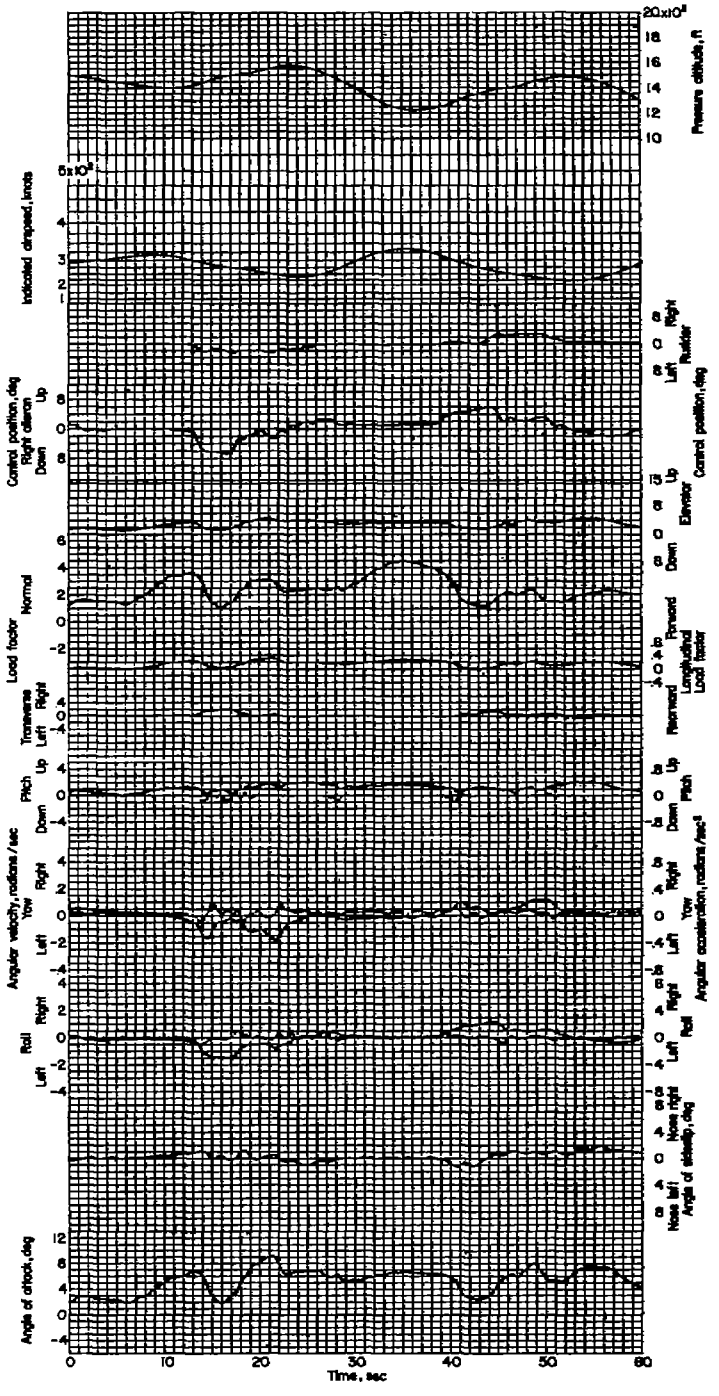
Figure 181.- Loop followed by two consecutive left and three consecutive right barrel rolls. Airplane weight, 16,010 pounds; center of gravity at 24.1 percent M.A.C.; flight 16.



(b)

Figure 181.- Concluded.

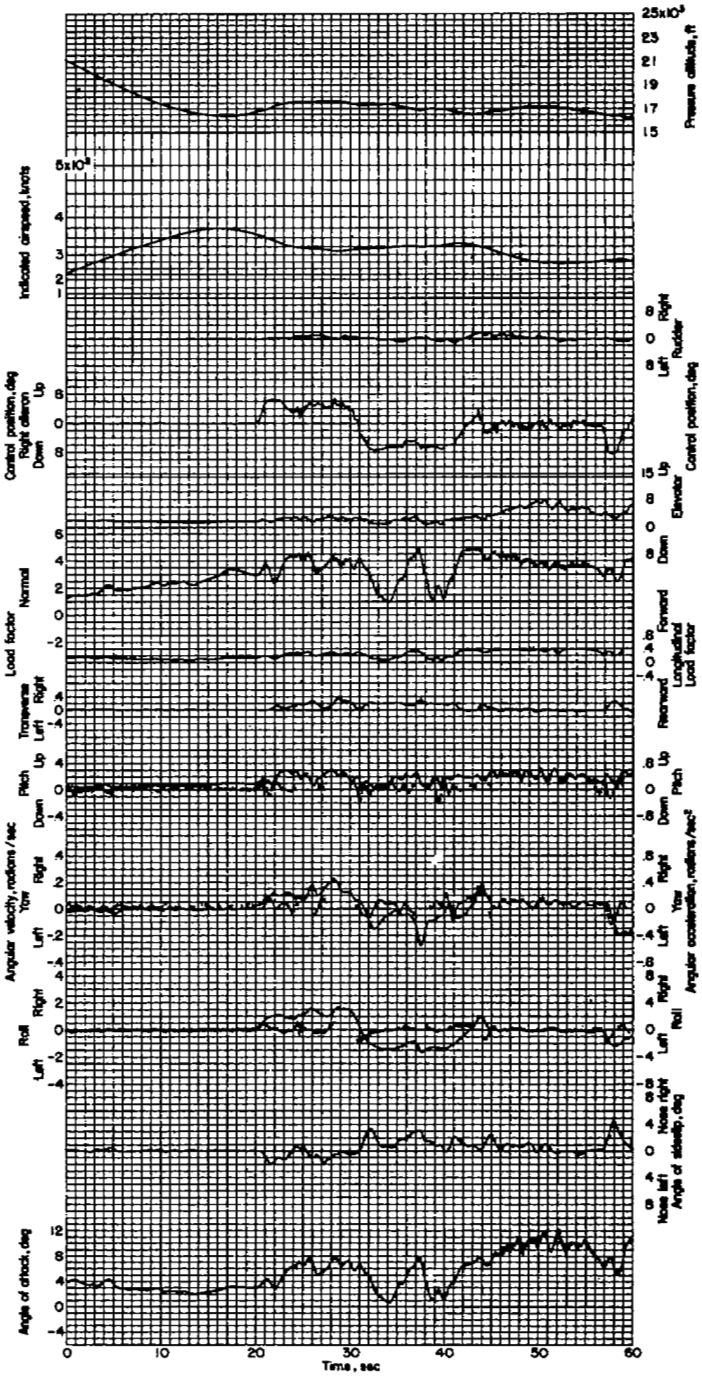
[redacted]



NACA

Figure 182.- Left barrel roll into dive and pull-up followed by right barrel roll. Airplane weight, 15,620 pounds; center of gravity at 23.9 percent M.A.C.; flight 17.

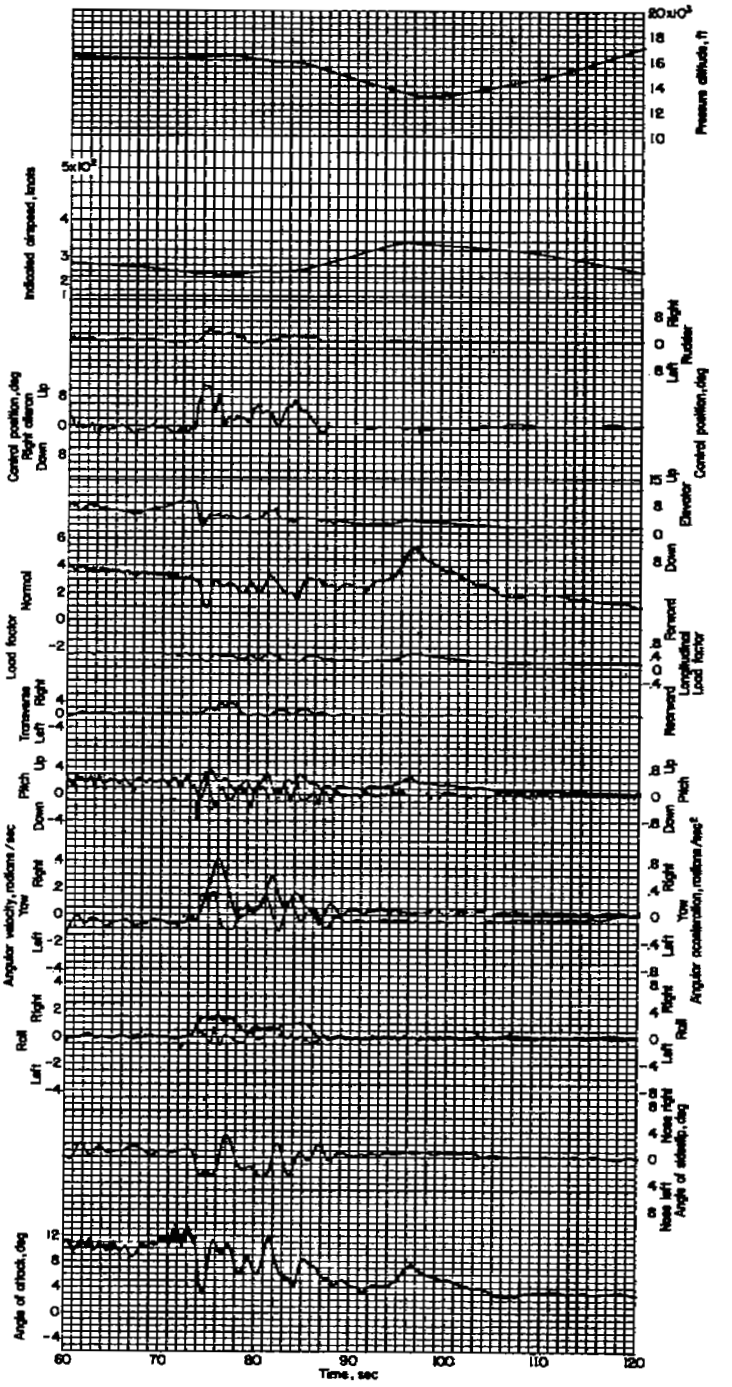
[redacted]



(a)

NACA

Figure 183.- Two consecutive right and two consecutive left barrel rolls into right and left stall turn followed by two consecutive right barrel rolls into left turn. Airplane weight, 15,940 pounds; center of gravity at 24.1 percent M.A.C.; flight 18.



(b)

Figure 183.- Concluded.

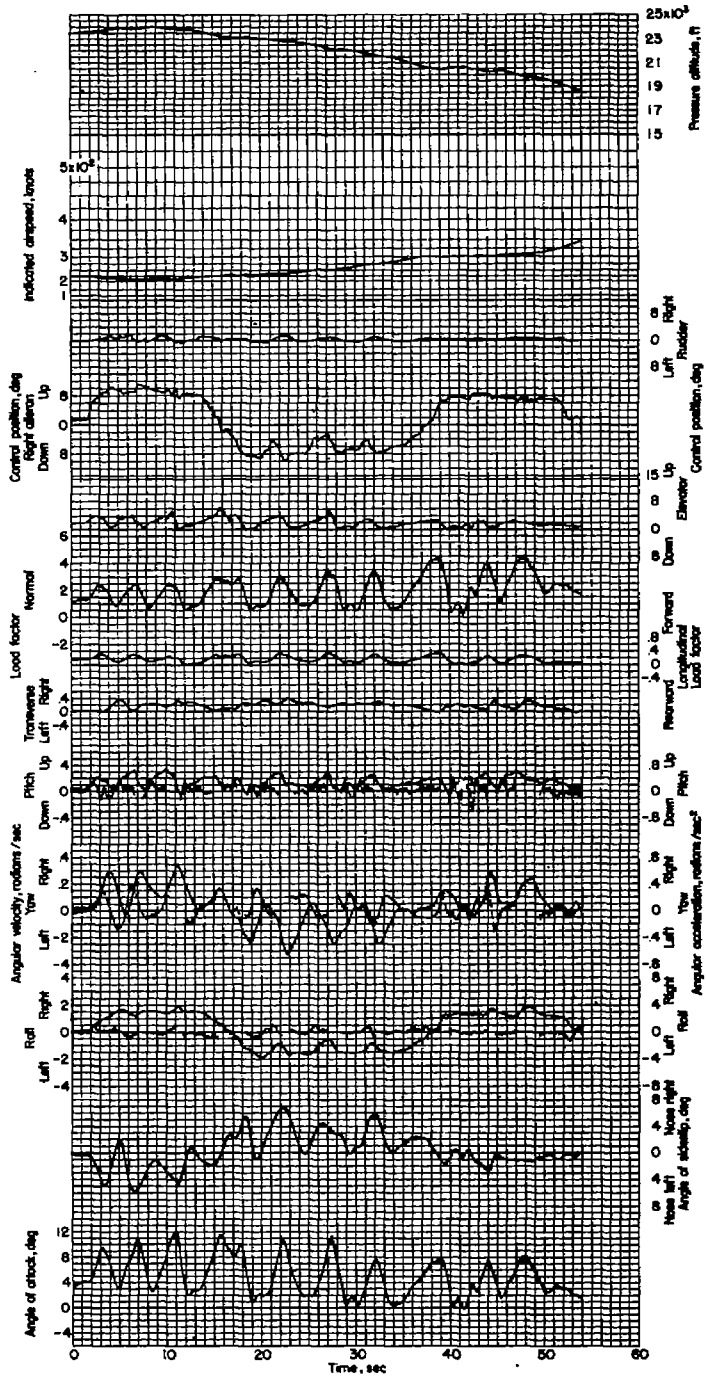
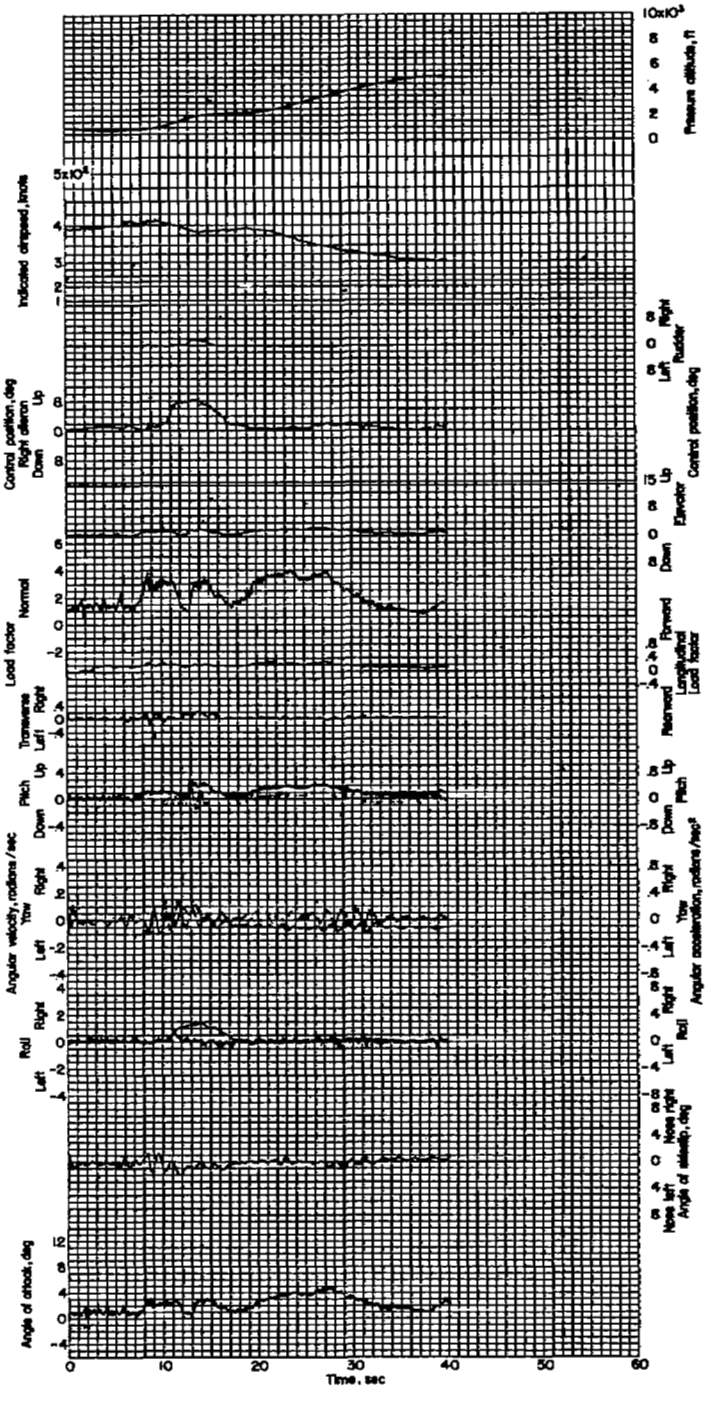
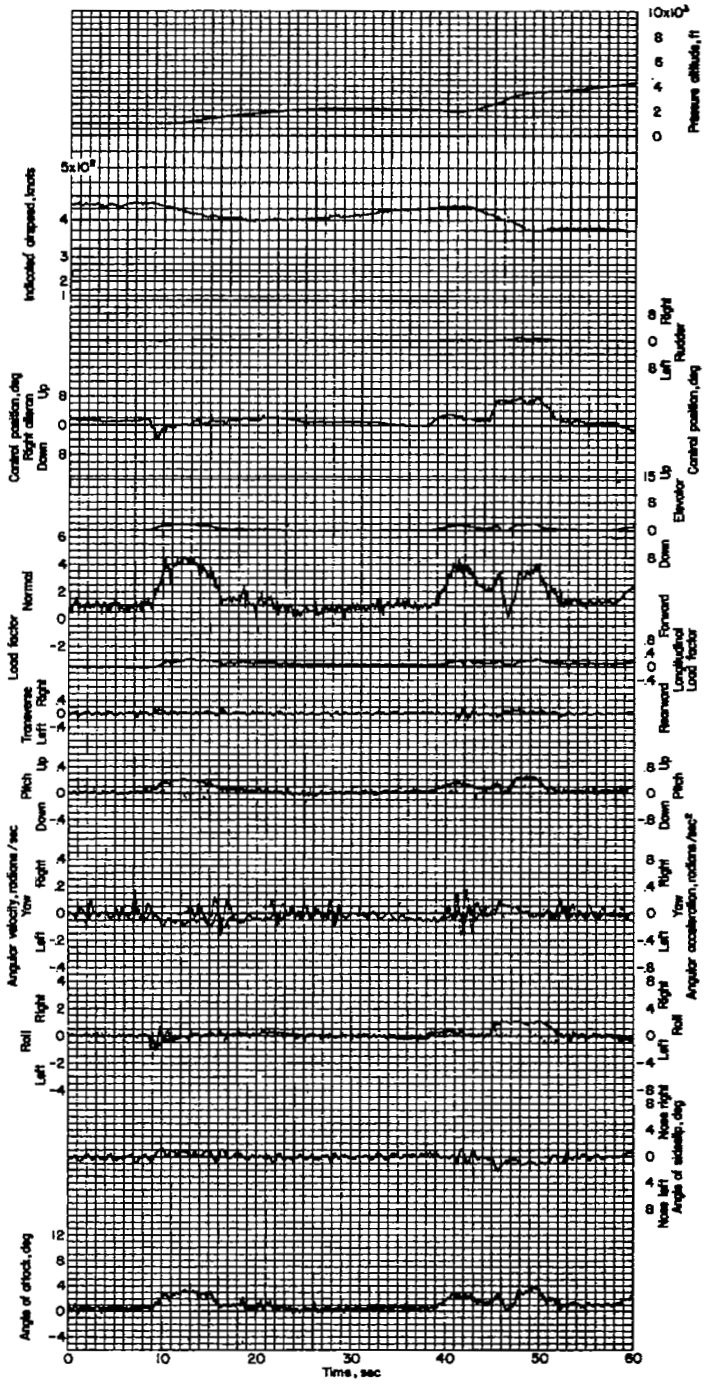


Figure 184.- Three consecutive right, four consecutive left, and three consecutive right barrel rolls. Airplane weight, 15,280 pounds; center of gravity at 23.9 percent M.A.C.; flight 18.



NACA

Figure 185.- Right barrel roll and climbing left turn. Airplane weight, 14,780 pounds; center of gravity at 24.6 percent M.A.C.; flight 18.

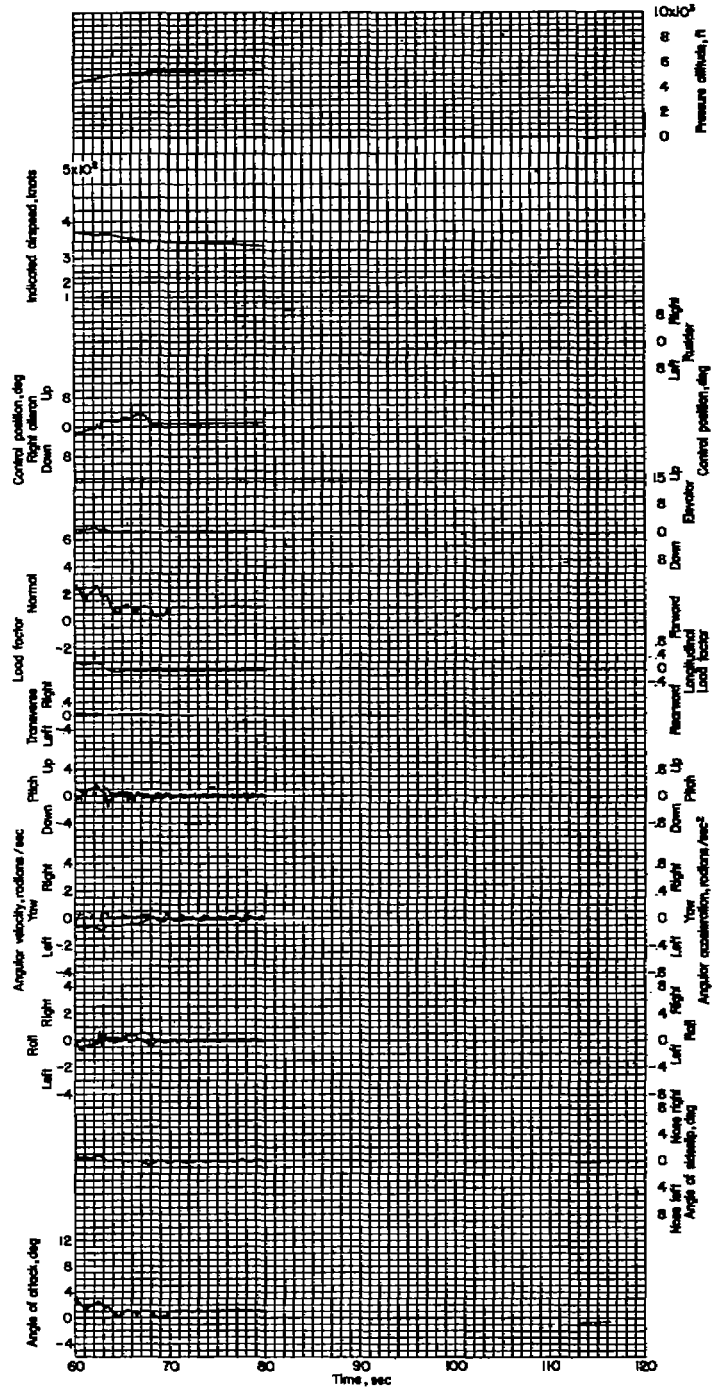


(a)

NACA

Figure 186.- Left turn and right barrel roll followed by climbing left turn. Airplane weight, 14,590 pounds; center of gravity at 24.9 percent M.A.C.; flight 18.

[redacted]



(b)

Figure 186.- Concluded.

[redacted]

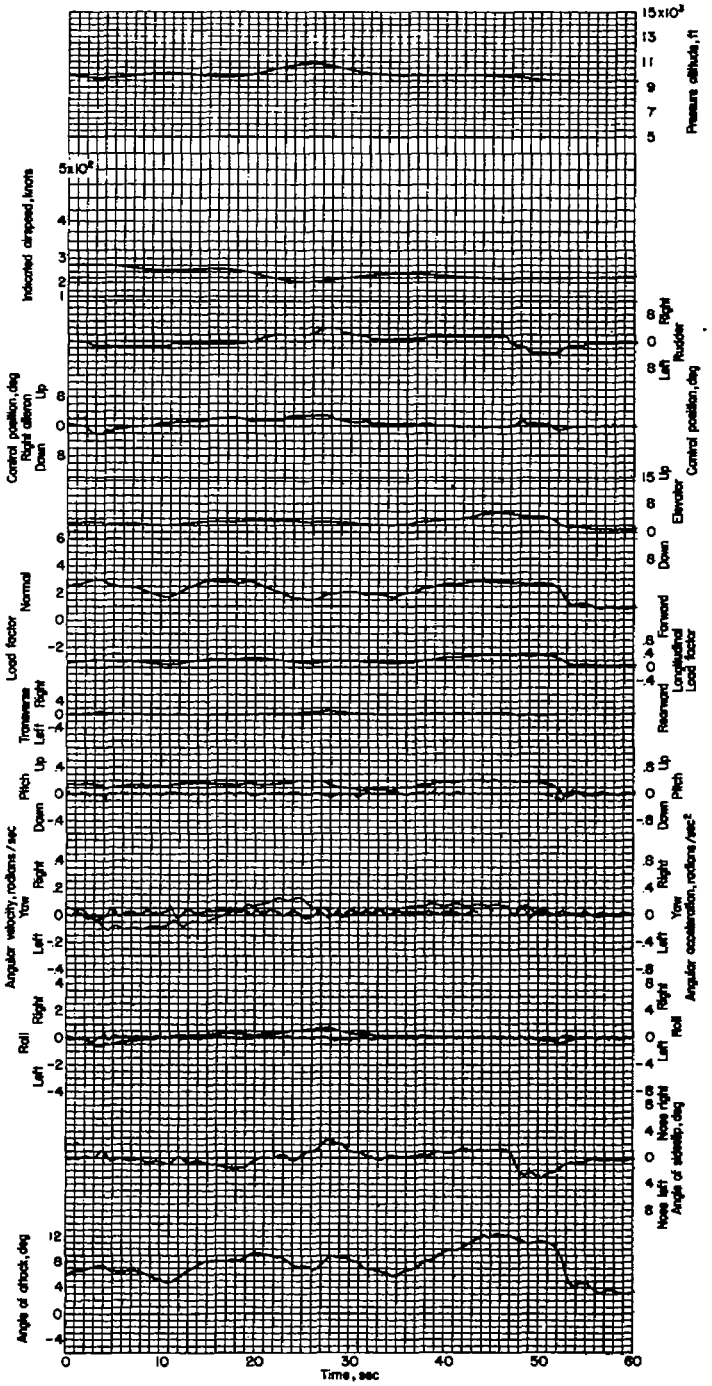


Figure 187.- Left turn into right barrel roll followed by right turn. Airplane weight, 14,640 pounds; center of gravity at 24.0 percent M.A.C.; flight 20.

NACA

[redacted]

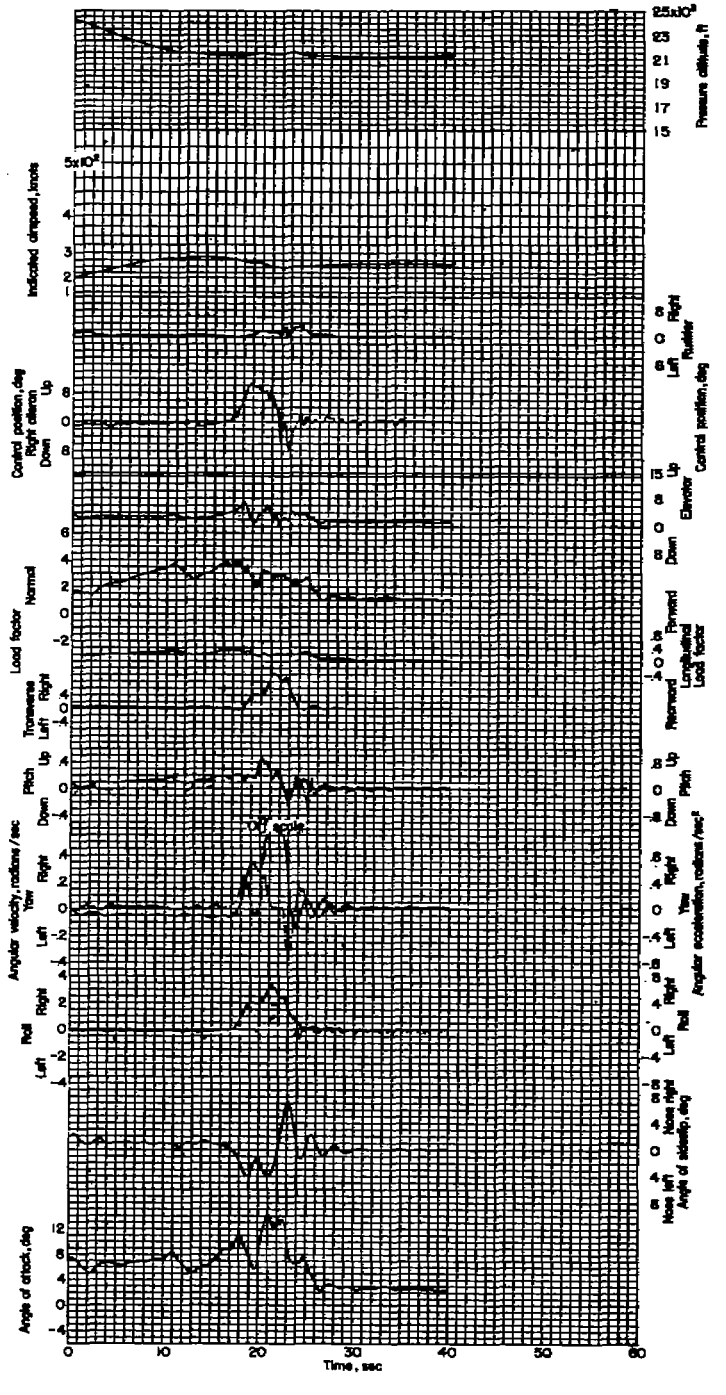
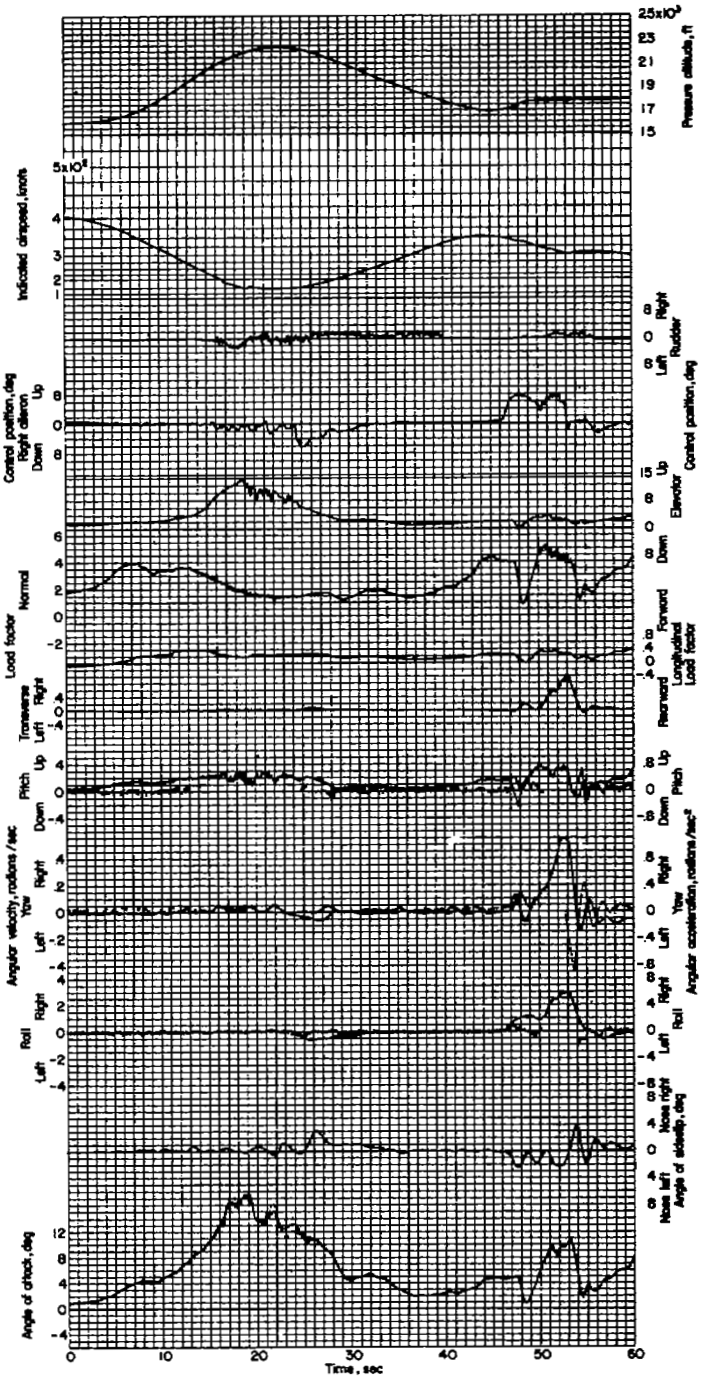


Figure 188.- Two-rotation right snap roll. Airplane weight, 15,730 pounds; center of gravity at 24.0 percent M.A.C.; flight 16.

[redacted]

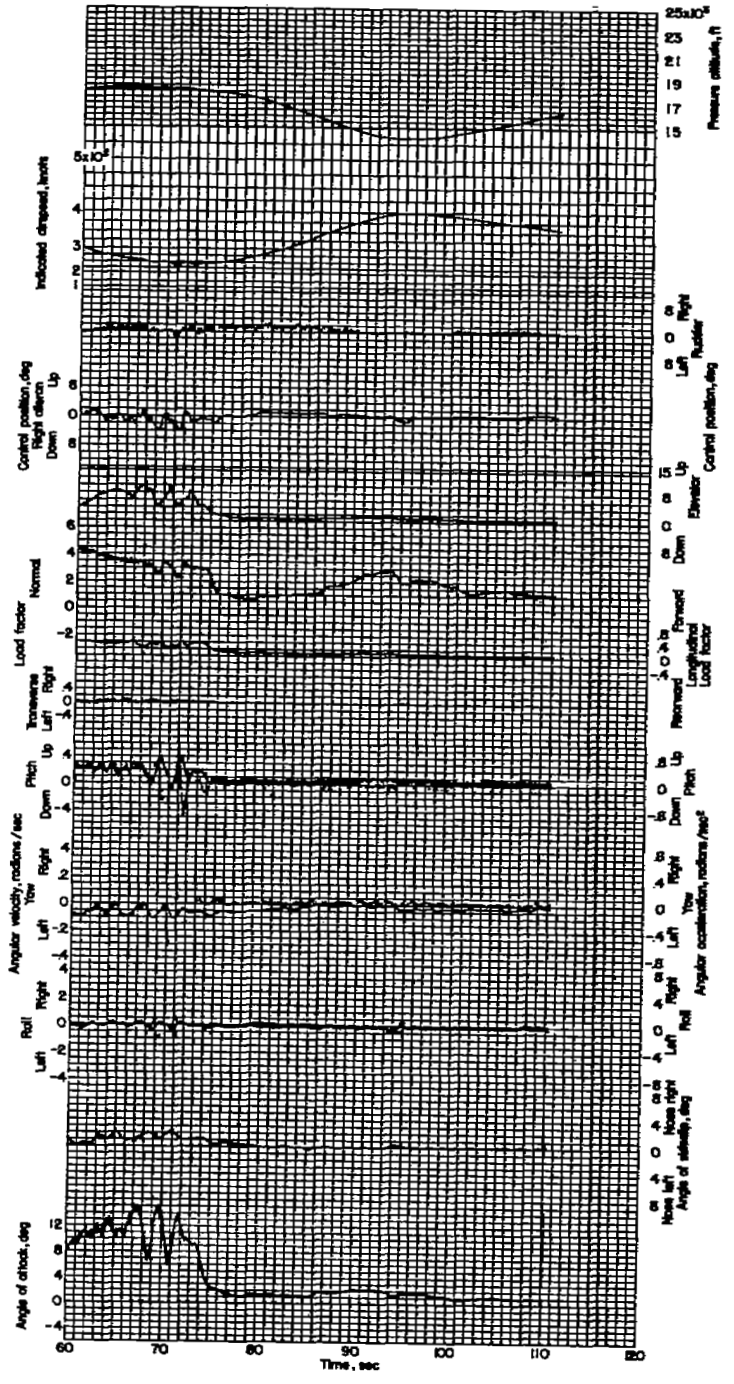


(a)

NACA

Figure 189.- Immelman followed by two-rotation right snap roll into stall left turn. Airplane weight, 15,600 pounds; center of gravity at 23.9 percent M.A.C.; flight 18.

[redacted]

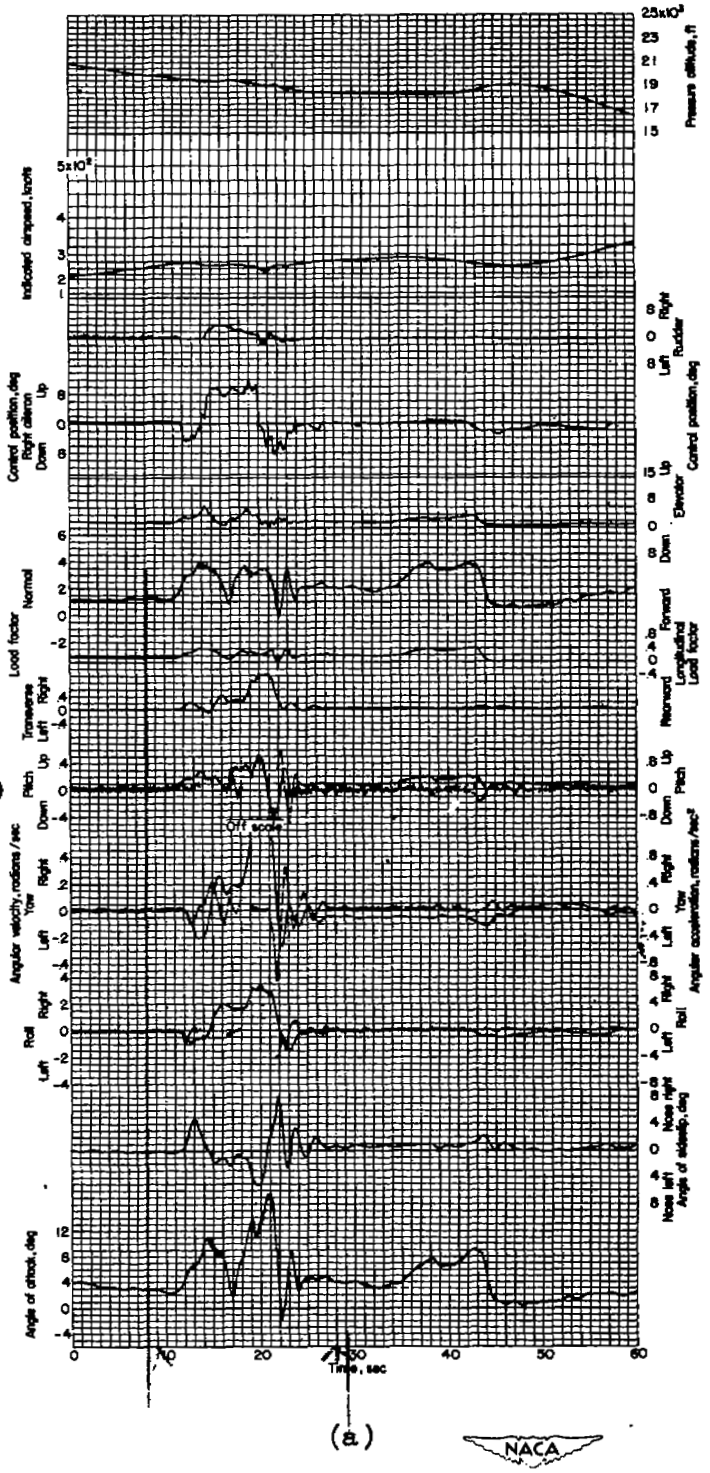


(b)

NACA

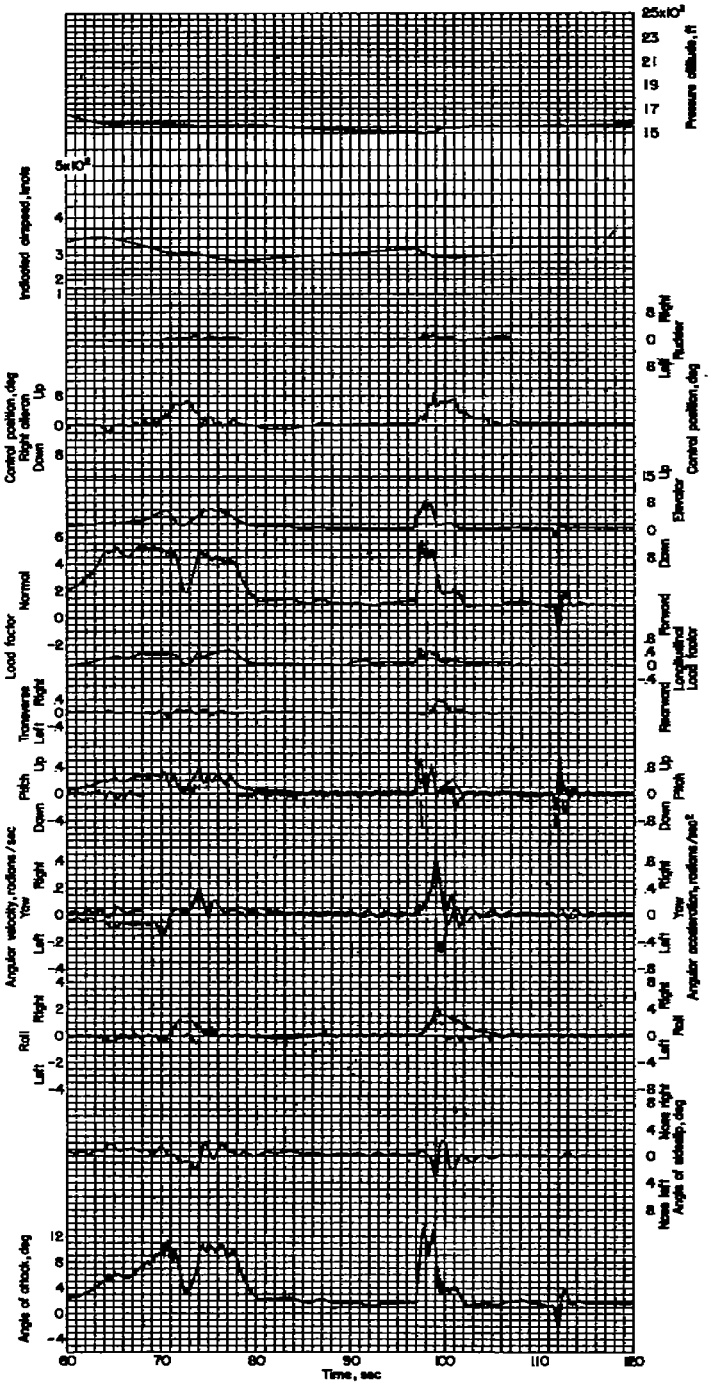
Figure 189.- Concluded.

[redacted]



(a)

Figure 190.- Two-rotation right snap roll into left turn with left-roll entry into diving left turn and right half-roll into right turn followed by abrupt pull-up into right snap roll and push-down — pull-up. Airplane weight, 15,150 pounds; center of gravity at 24.1 percent M.A.C.; flight 18.



(b)

Figure 190.- Concluded.

[redacted]

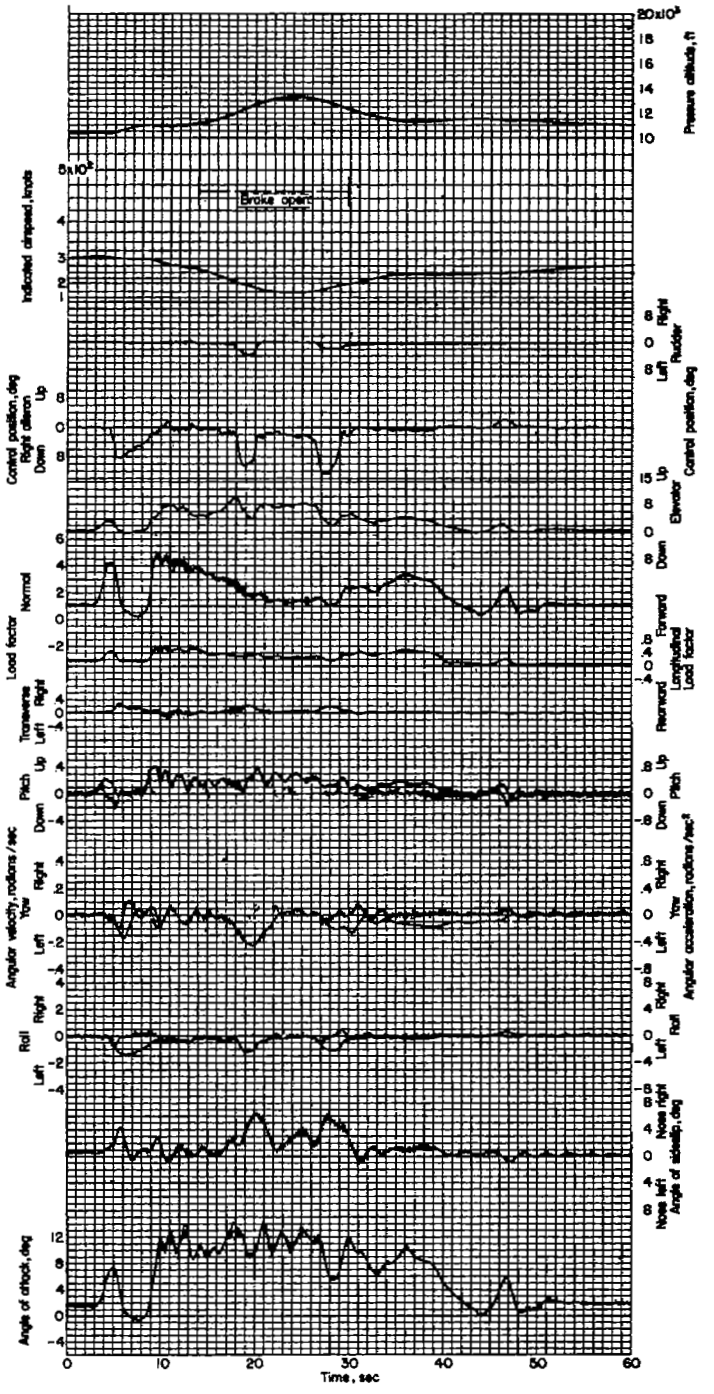


Figure 191.- Left barrel roll followed by vertical recovery and left turn. Airplane weight, 15,310 pounds; center of gravity at 23.9 percent M.A.C.; flight 7.

[redacted]

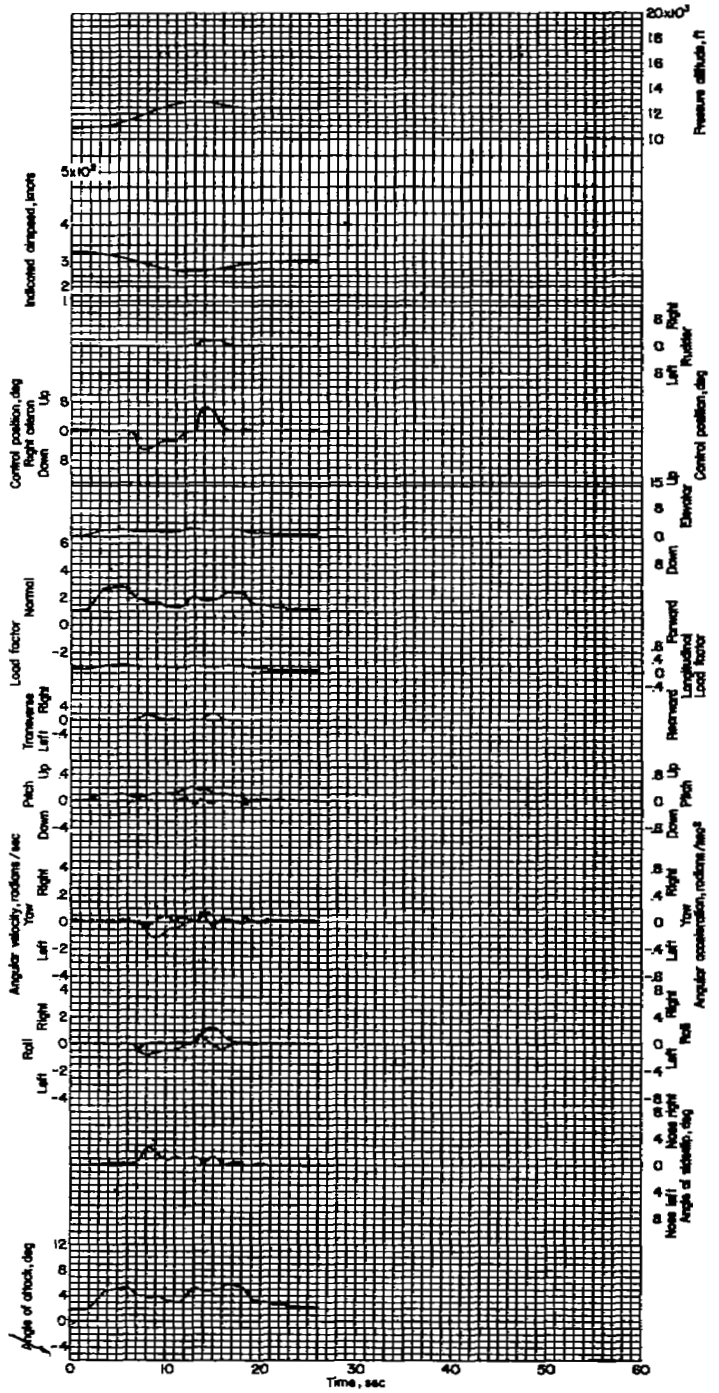
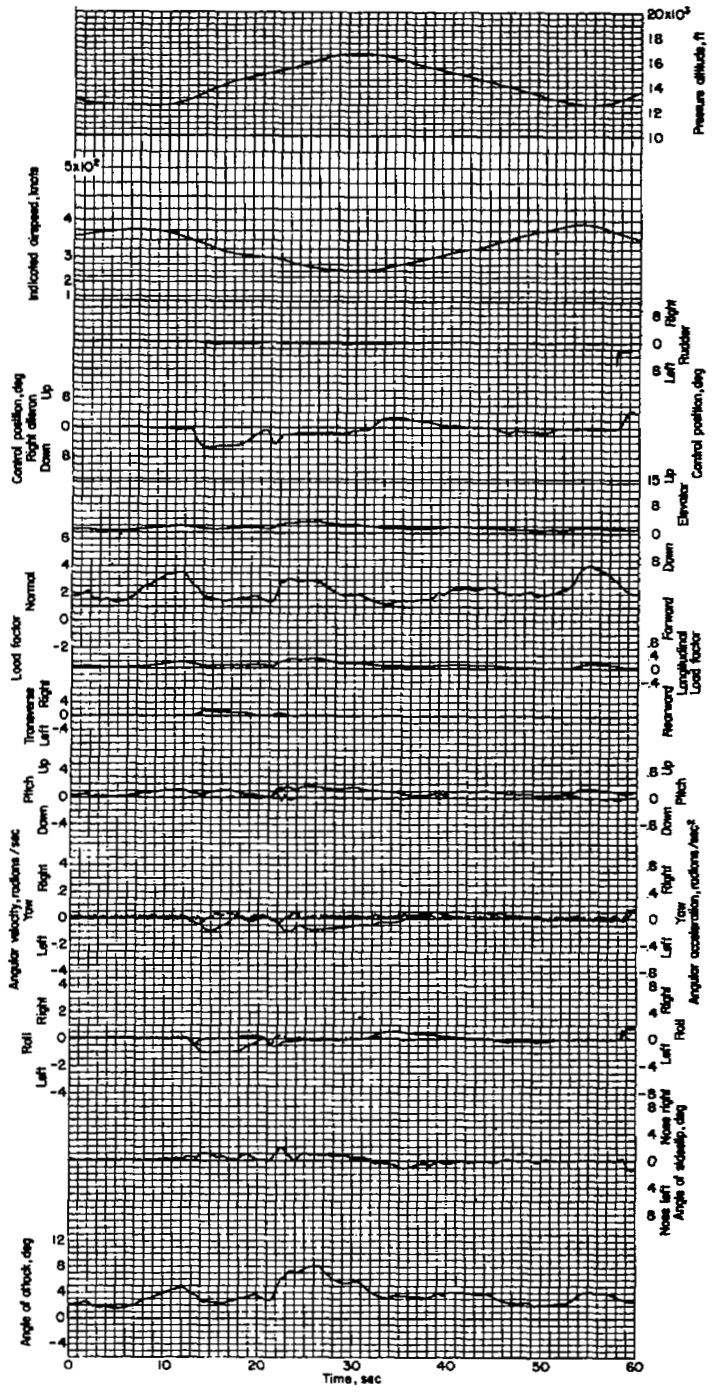


Figure 192.- Vertical recovery. Airplane weight, 16,590 pounds; center of gravity at 24.5 percent M.A.C.; flight 11.

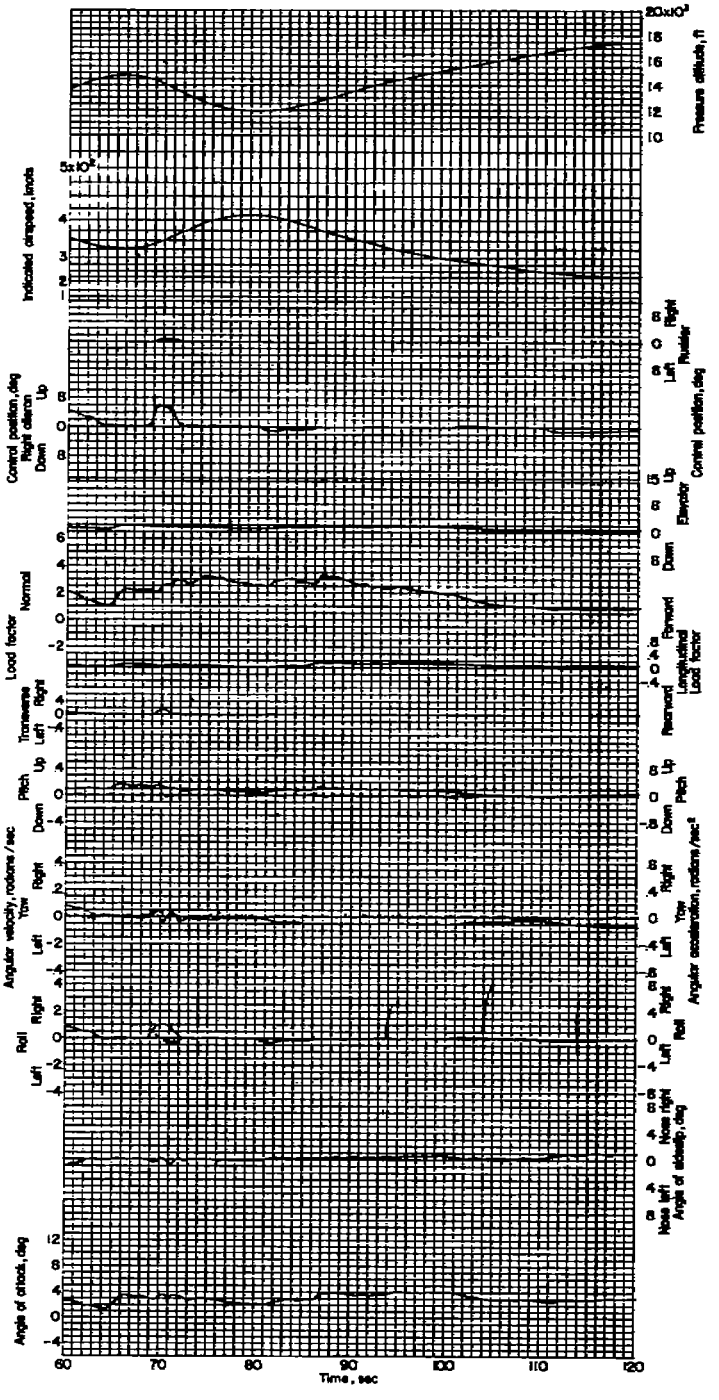


(a)

NACA

Figure 193.- Climbing left aileron roll and wing-over into dive followed by vertical recovery with pull-out into climbing left turn. Airplane weight, 16,440 pounds; center of gravity at 24.4 percent M.A.C.; flight 11.

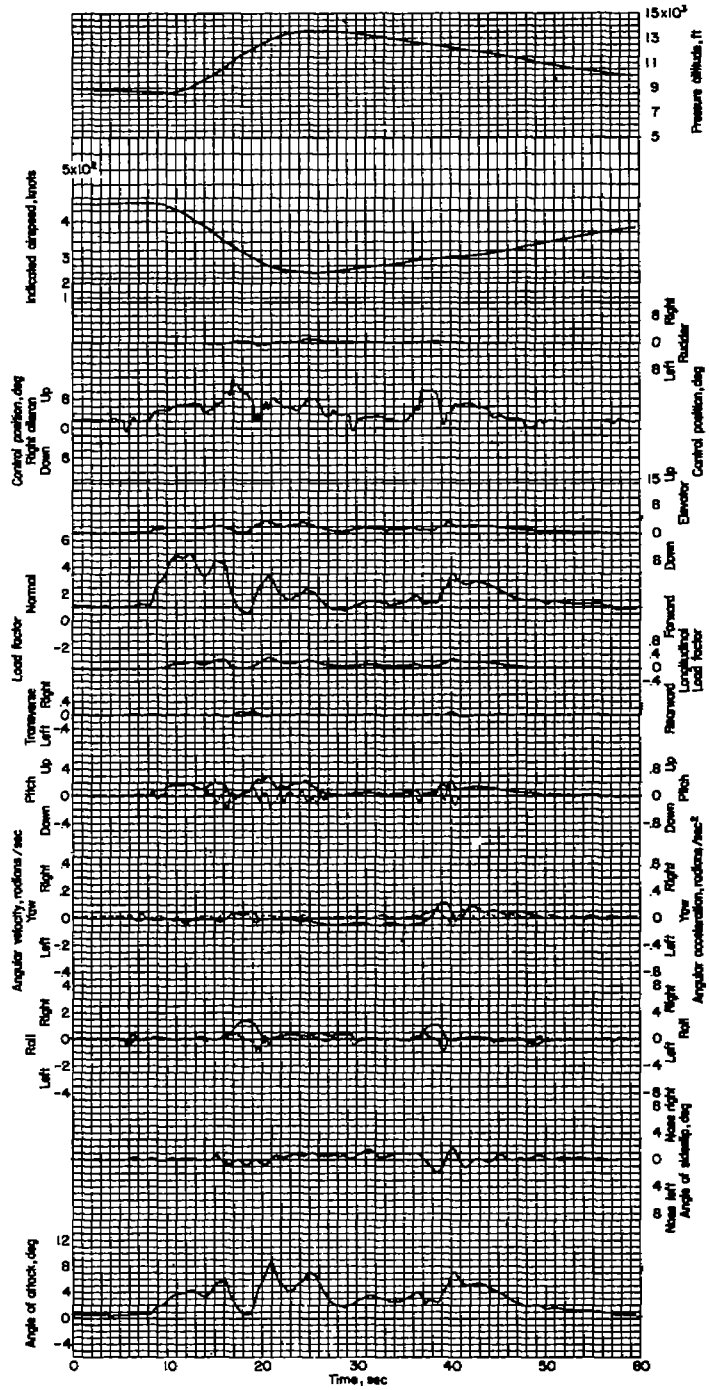
[redacted]



(b)

Figure 193.- Concluded.

[redacted]

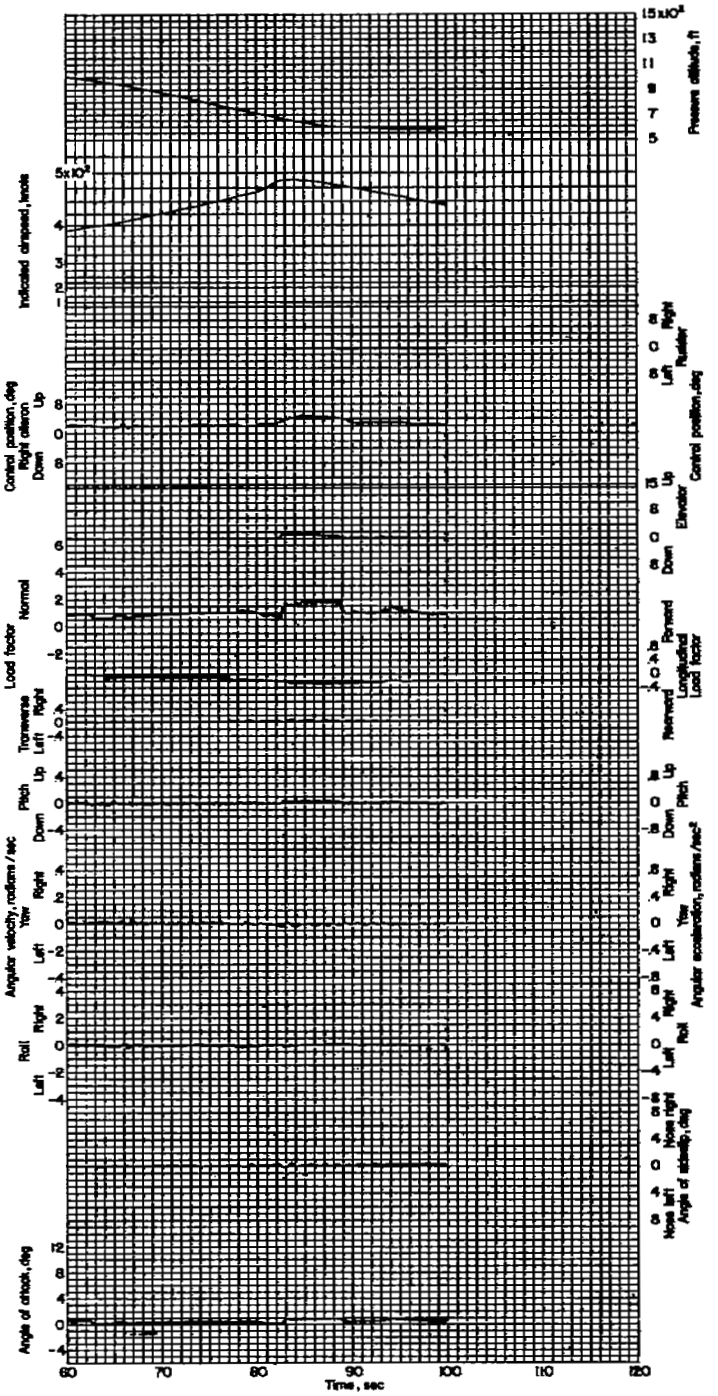


(a)

NACA

Figure 194.- Pull-up followed by climbing right aileron roll and shallow dive. Airplane weight, 17,520 pounds; center of gravity at 24.9 percent M.A.C.; flight 4.

[redacted]



(b)

Figure 194.- Concluded.

[redacted]

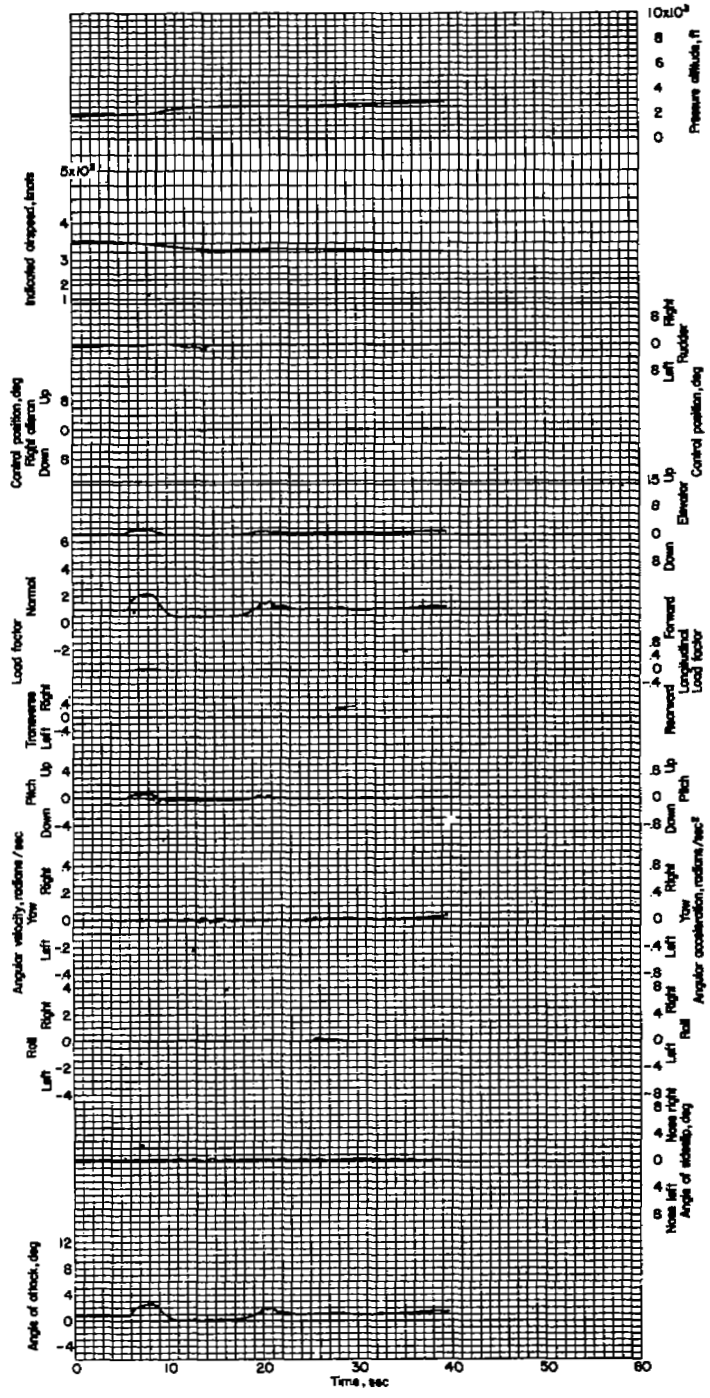


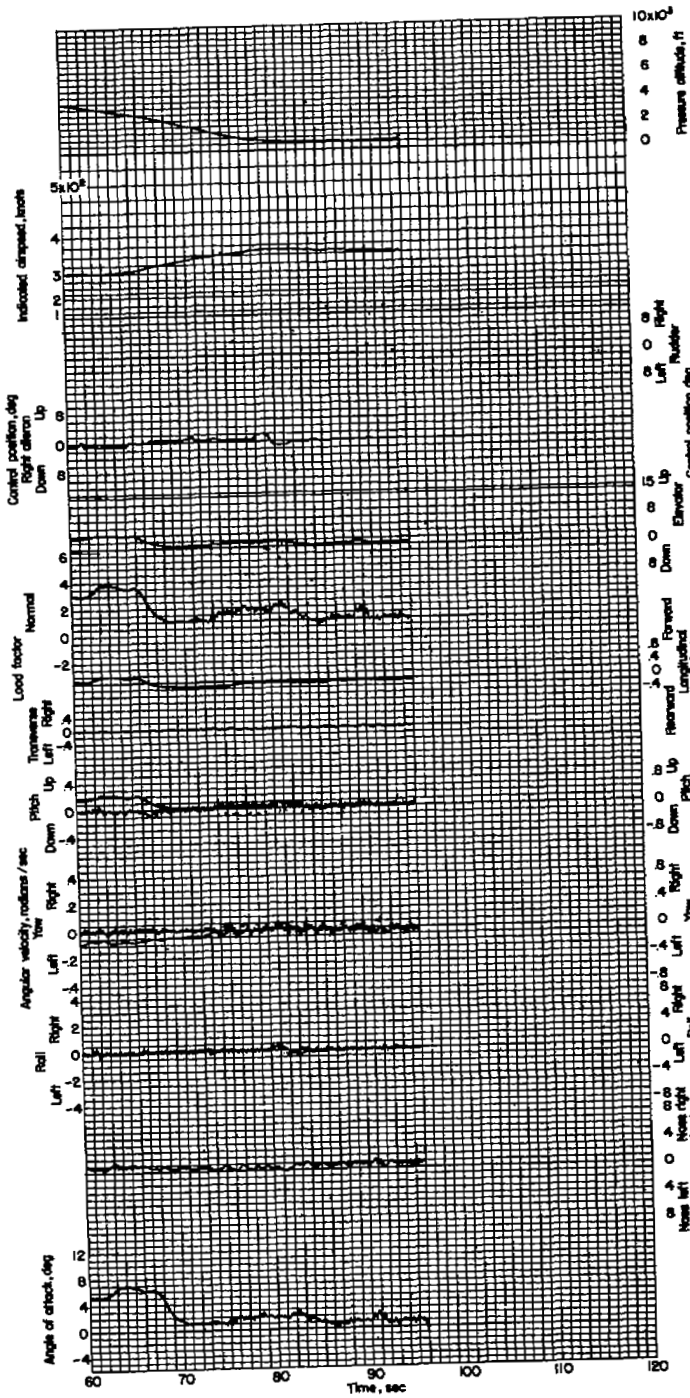
Figure 195.- Gentle pull-up and push-down. Airplane weight, 15,450 pounds; center of gravity at 23.8 percent M.A.C.; flight 5.

[redacted]

(a)

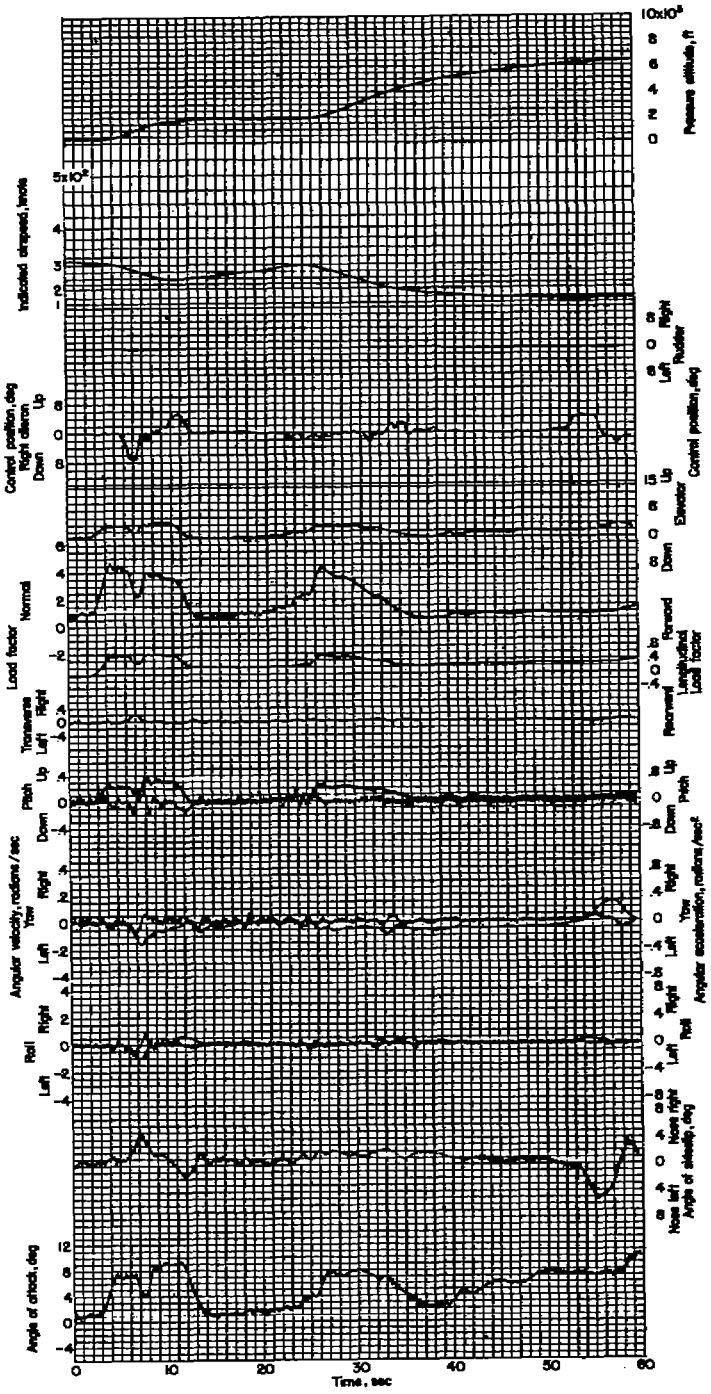
Figure 196.- Series of pull-ups followed by left turn. Airplane weight, 15,770 pounds; center of gravity at 24.0 percent M.A.C.; flight 7.

[redacted]



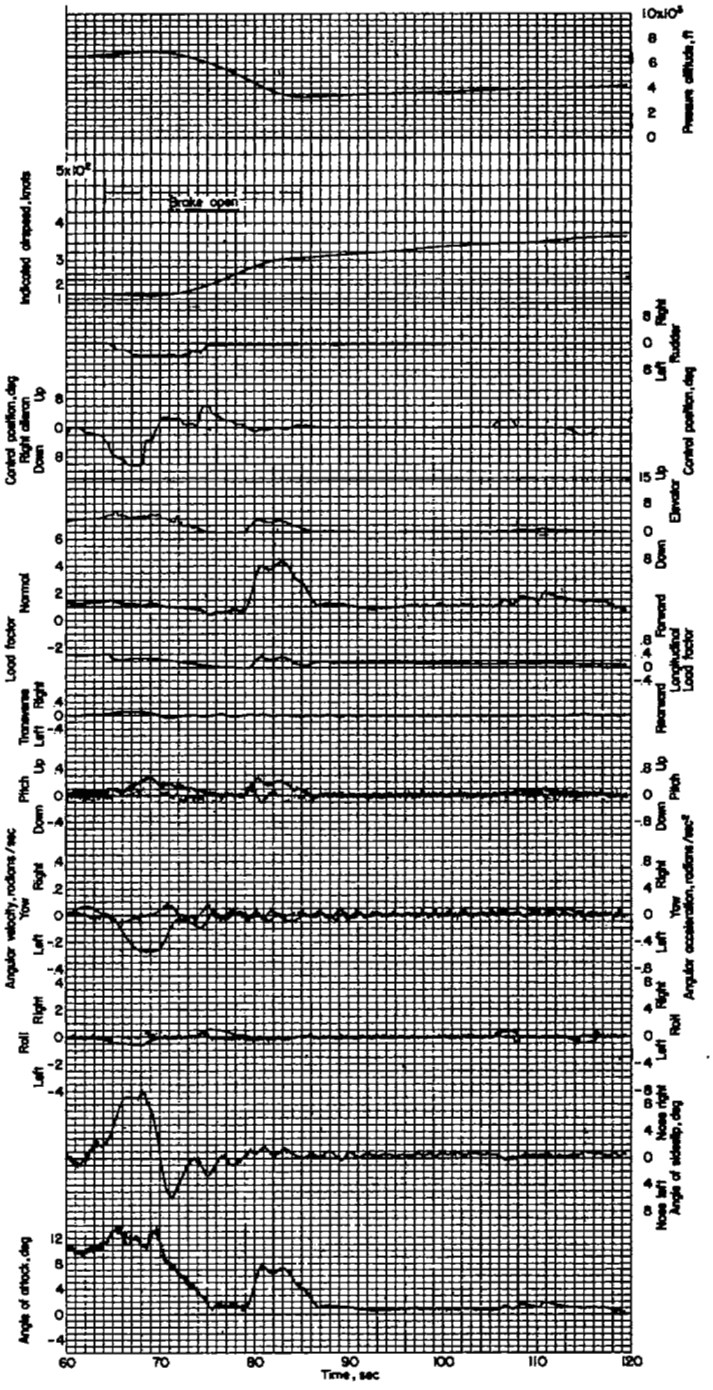
(b)

Figure 196.- Concluded.



(a)

Figure 197.- Pull-up into left turn followed by chandelle and peel-off into dive with pull-out. Airplane weight, 14,530 pounds; center of gravity at 24.9 percent M.A.C.; flight 7.



(b)

Figure 197.- Concluded.

[redacted]

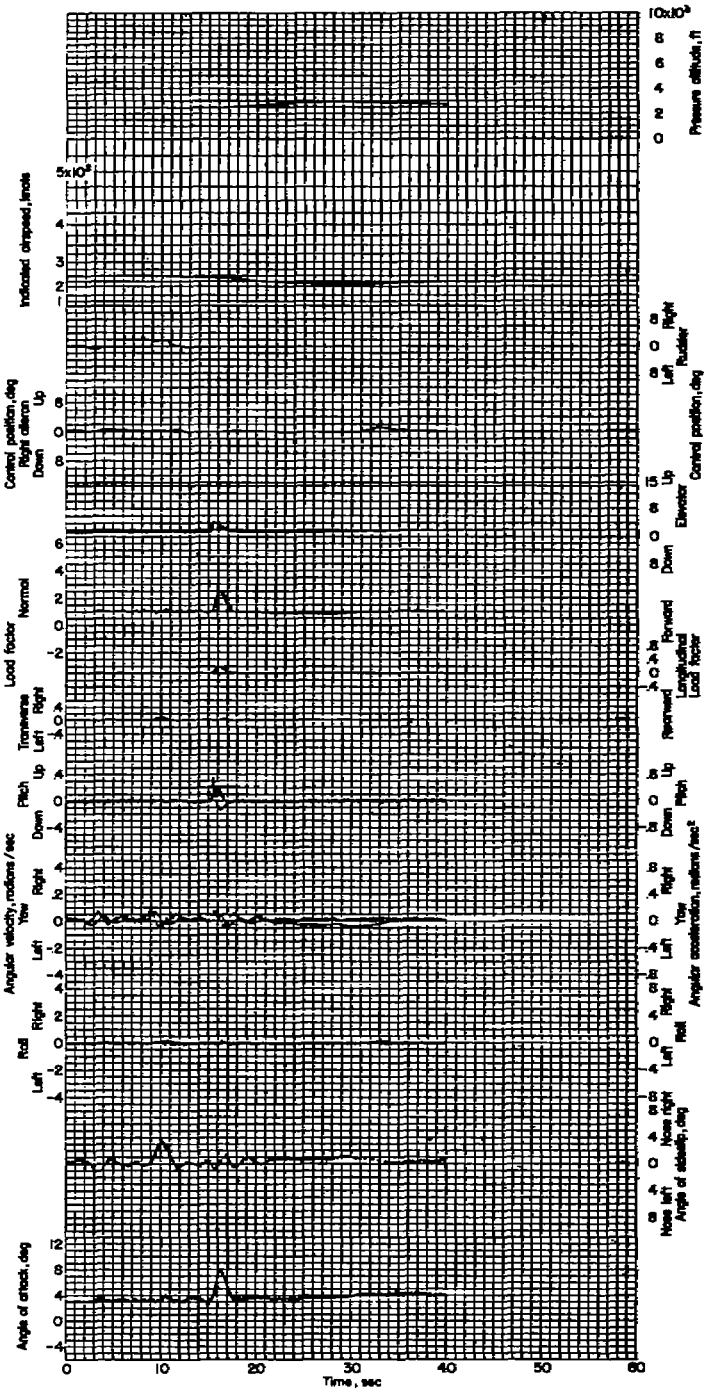


Figure 198.- Pull-up. Airplane weight, 15,050 pounds; center of gravity at 24.3 percent M.A.C.; flight 11.

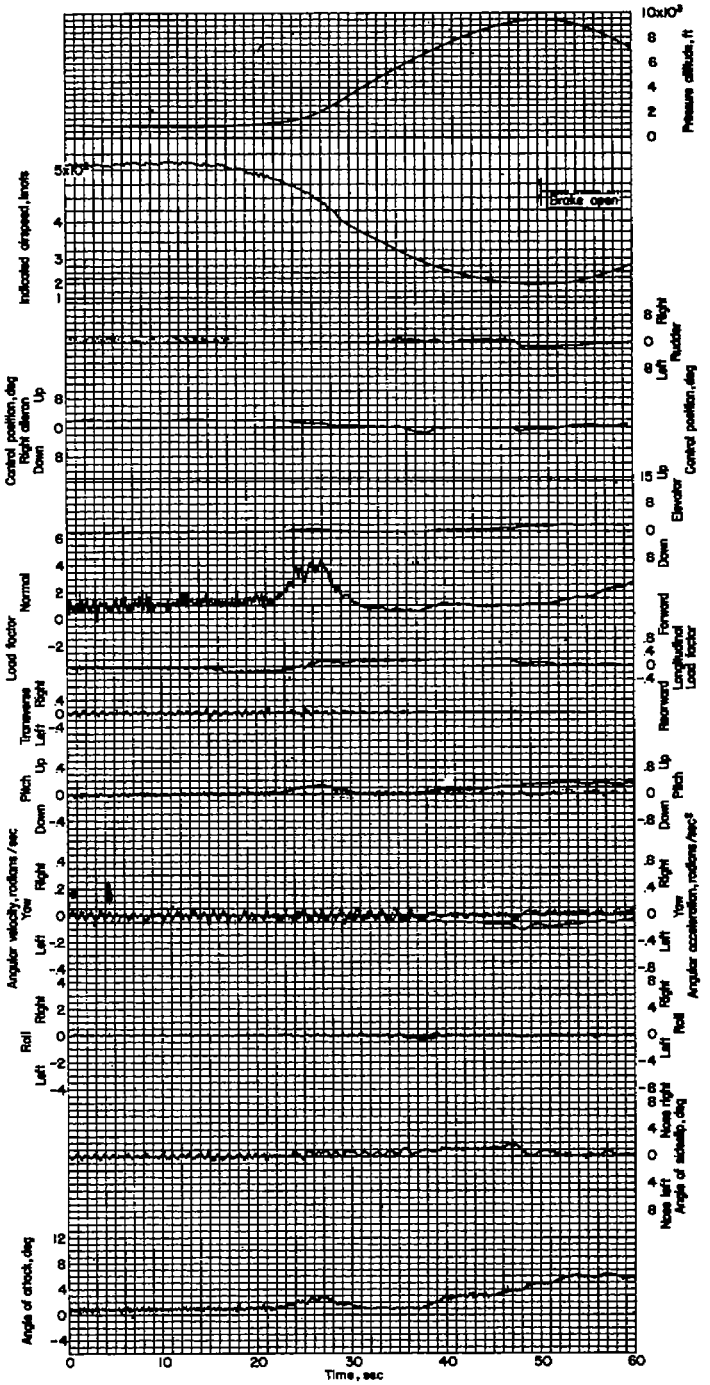


Figure 199.- High-speed run followed by pull-up into steep climbing left turn. Airplane weight, 13,860 pounds; center of gravity at 26.0 percent M.A.C.; flight 11.

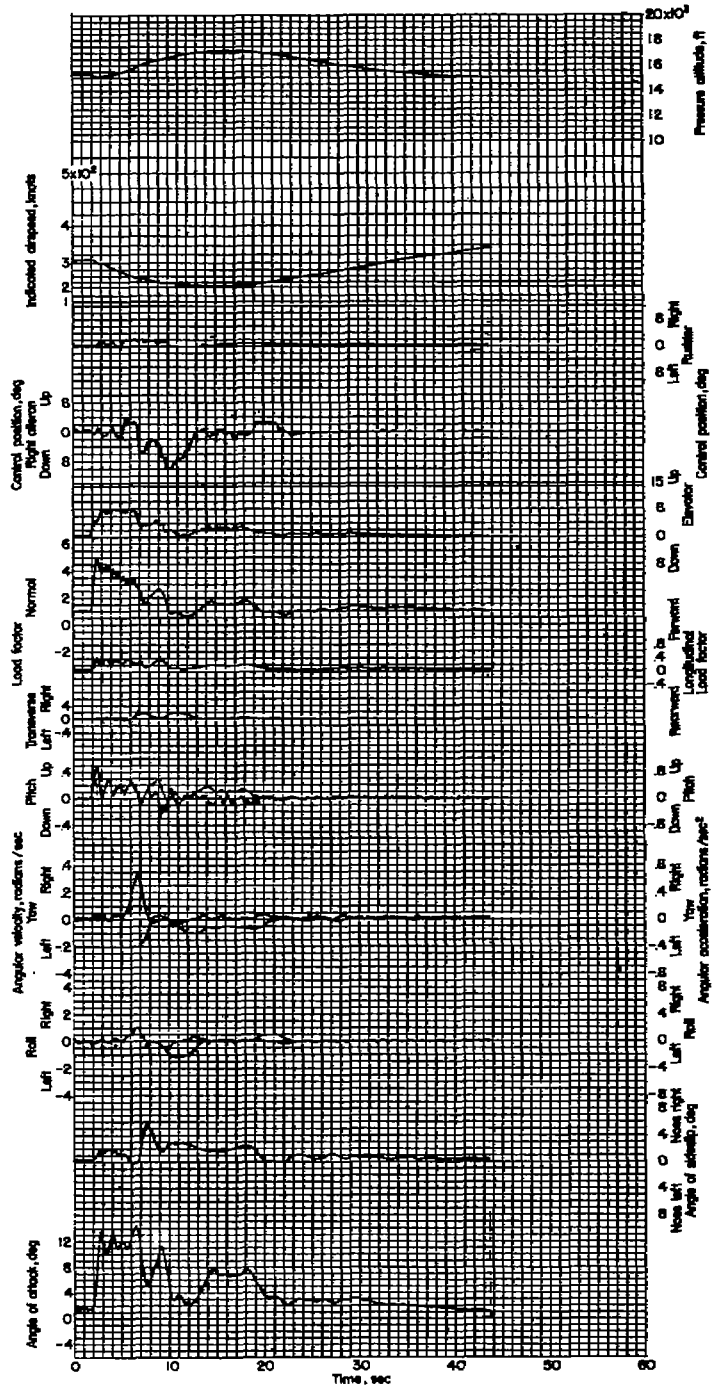


Figure 200.- Abrupt pull-up to stall and recovery. Airplane weight, 16,280 pounds; center of gravity at 24.3 percent M.A.C.; flight 16.

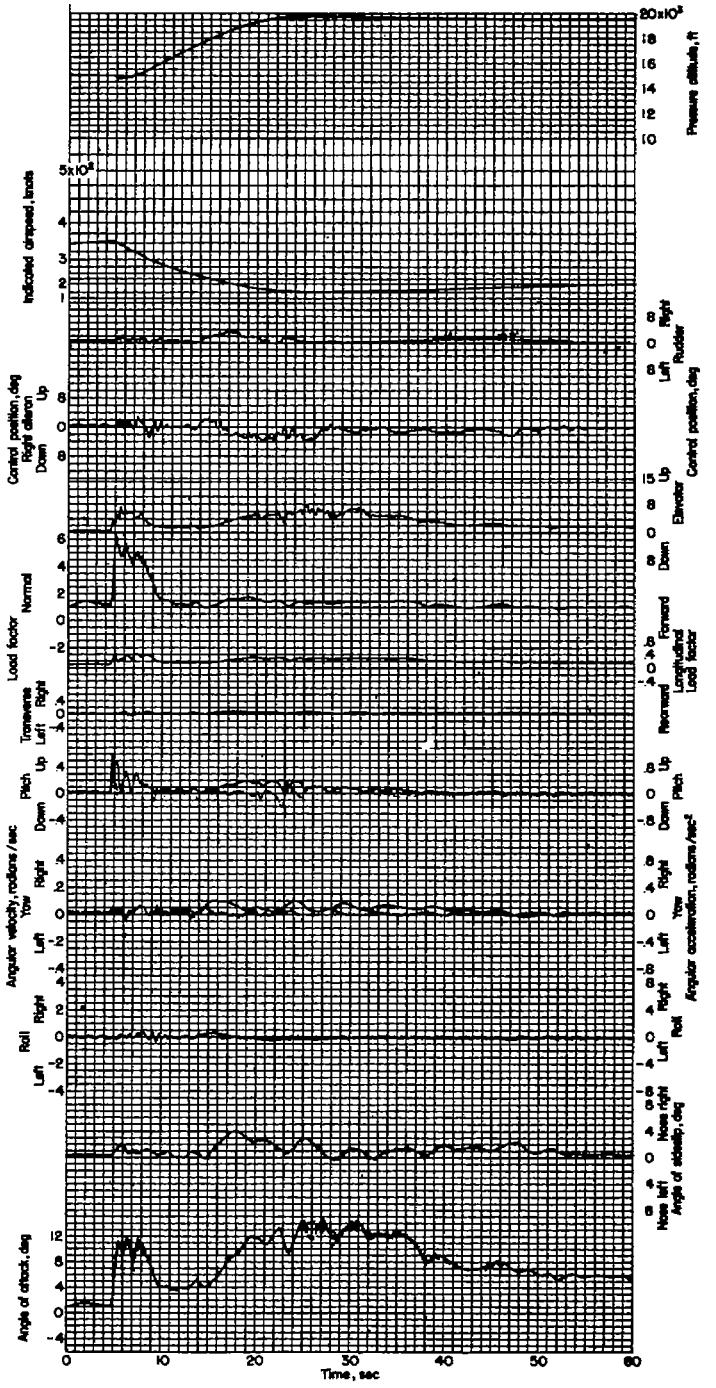


Figure 201.- Abrupt pull-up followed by stall right turn. Airplane weight, 16,240 pounds; center of gravity at 24.3 percent M.A.C.; flight 16.

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[redacted]

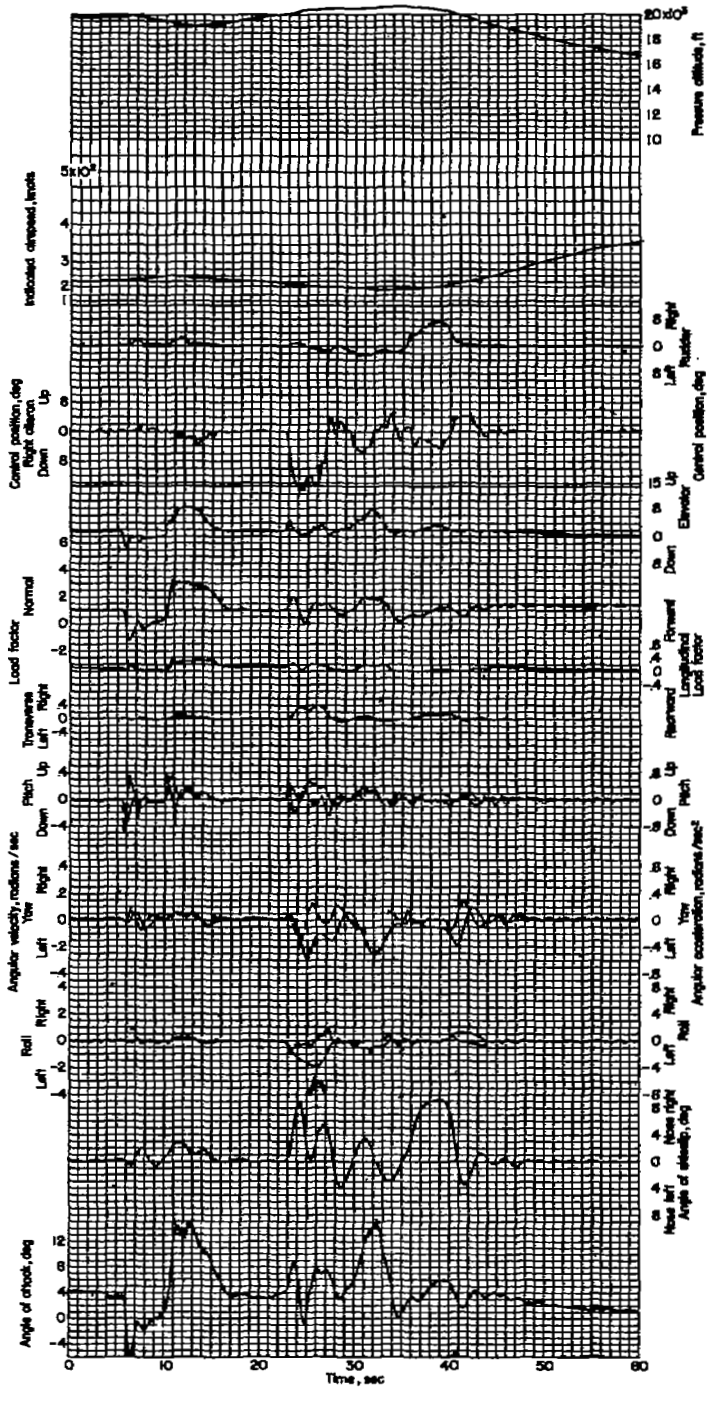

Figure 202.- Push-down and pull-up followed by left aileron roll into stall left turn and left sideslip into shallow dive. Airplane weight, 16,160 pounds; center of gravity at 24.2 percent M.A.C.; flight 16.

NACA

[redacted]

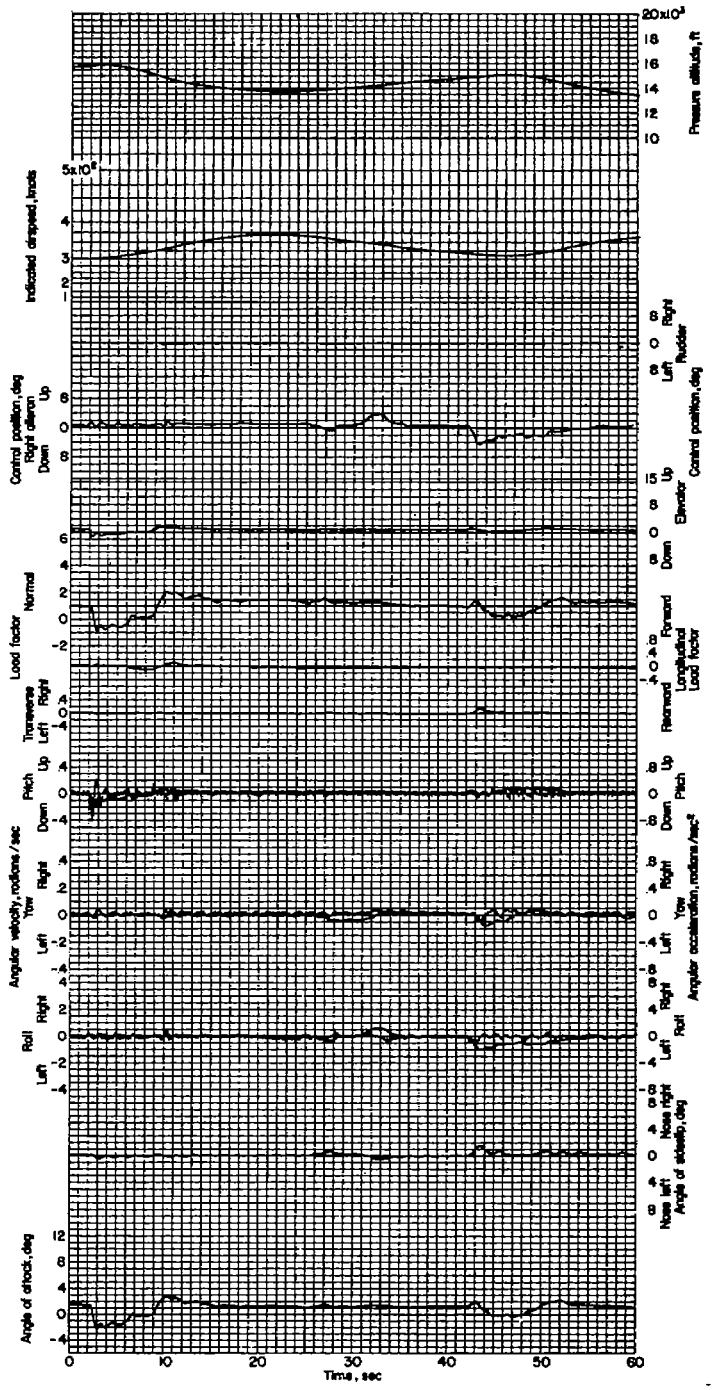

Figure 203.- Push-down followed by left aileron roll. Airplane weight, 15,070 pounds; center of gravity at 24.2 percent M.A.C.; flight 18.

[redacted]

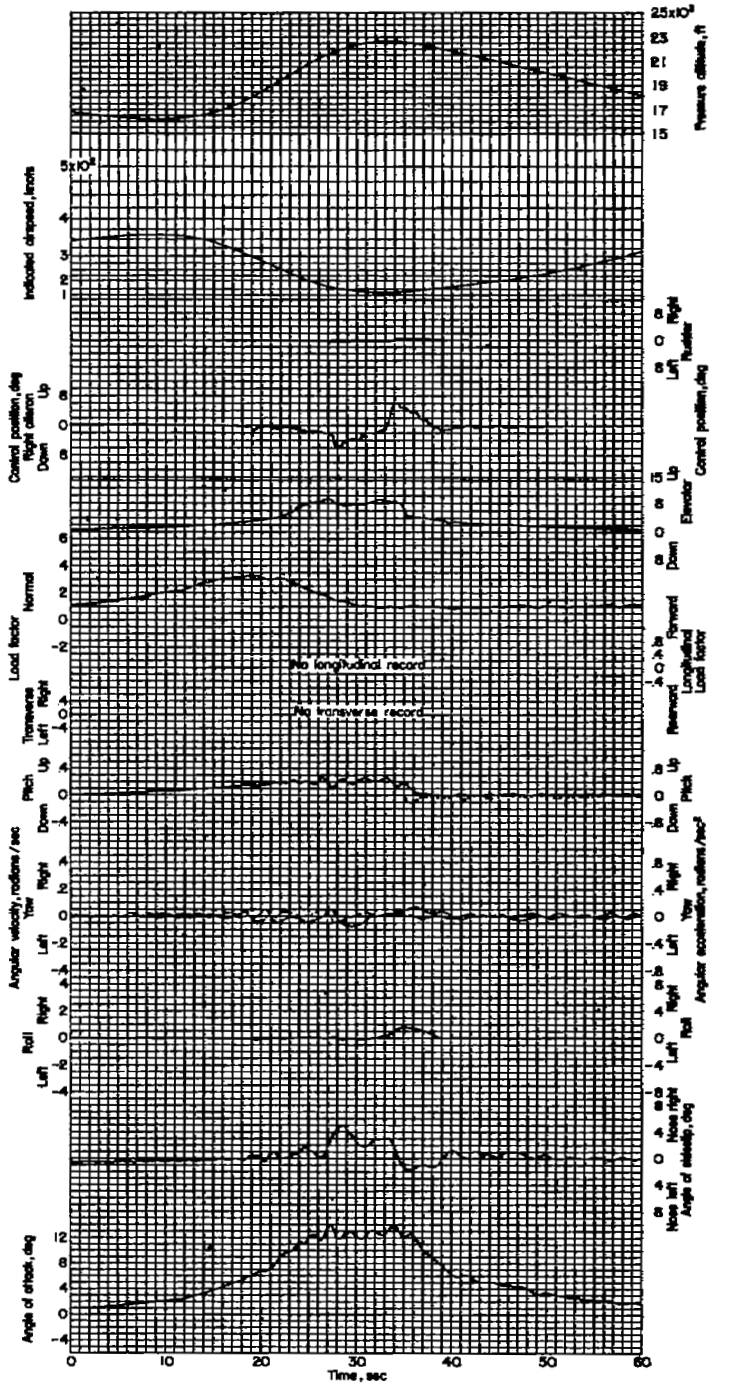

Figure 204.- Immelman. Airplane weight, 15,630 pounds; center of gravity at 23.9 percent M.A.C.; flight 1.

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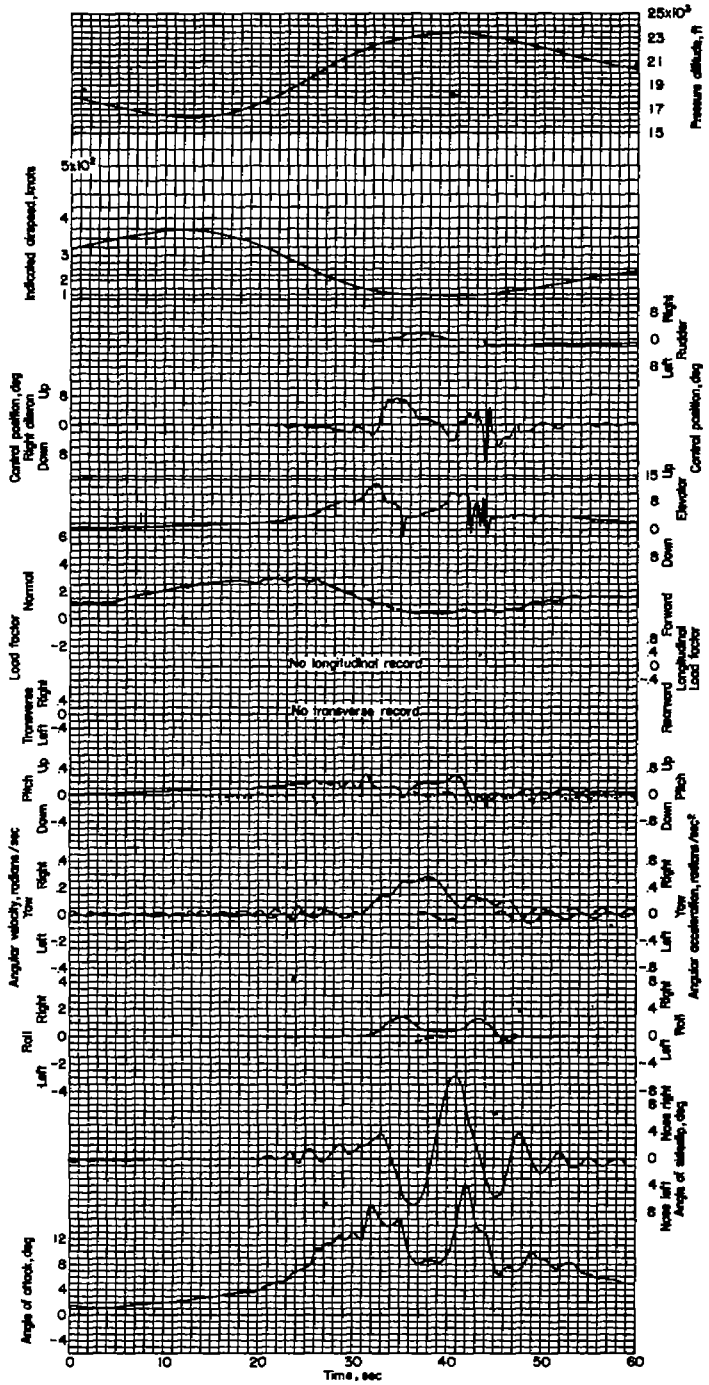
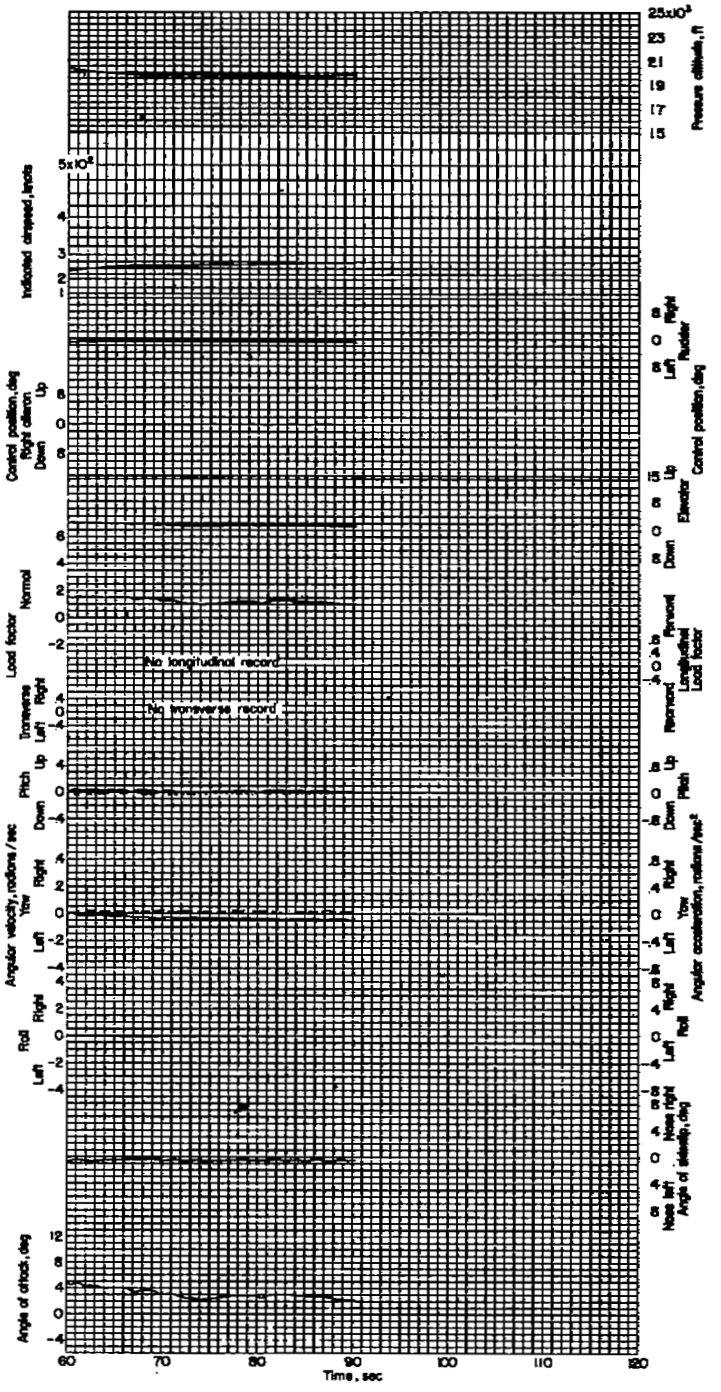


(a)

Figure 205.- Immelman with partial stall and right-roll recovery. Airplane weight, 15,590 pounds; center of gravity at 23.9 percent M.A.C.; flight 1.



(b)

Figure 205.- Concluded.

[redacted]

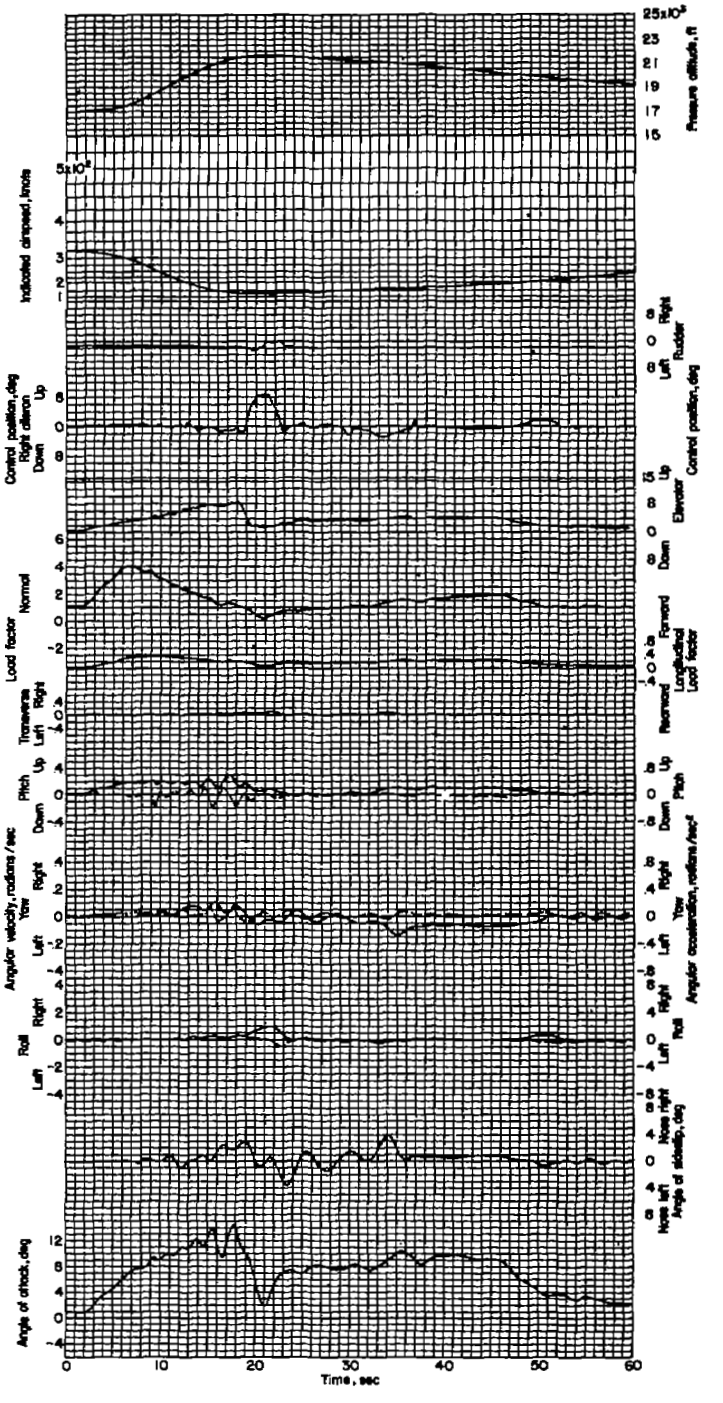
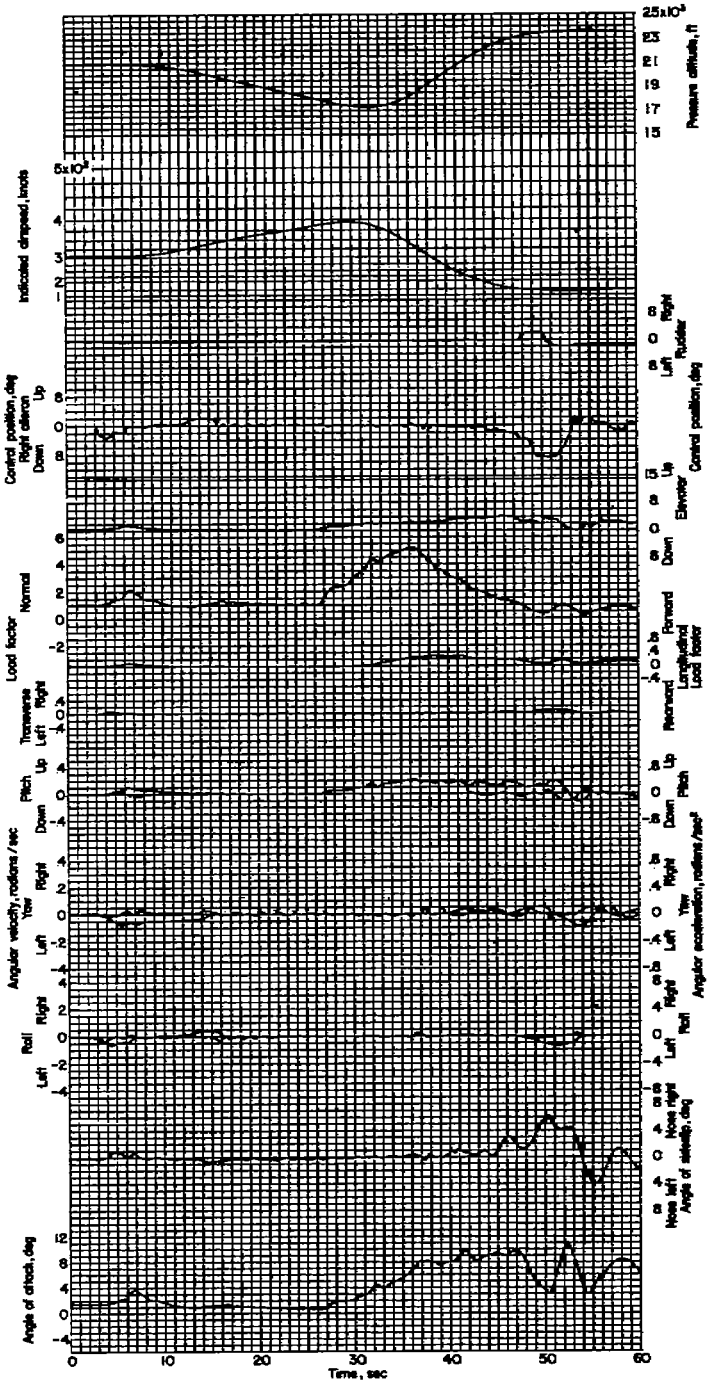


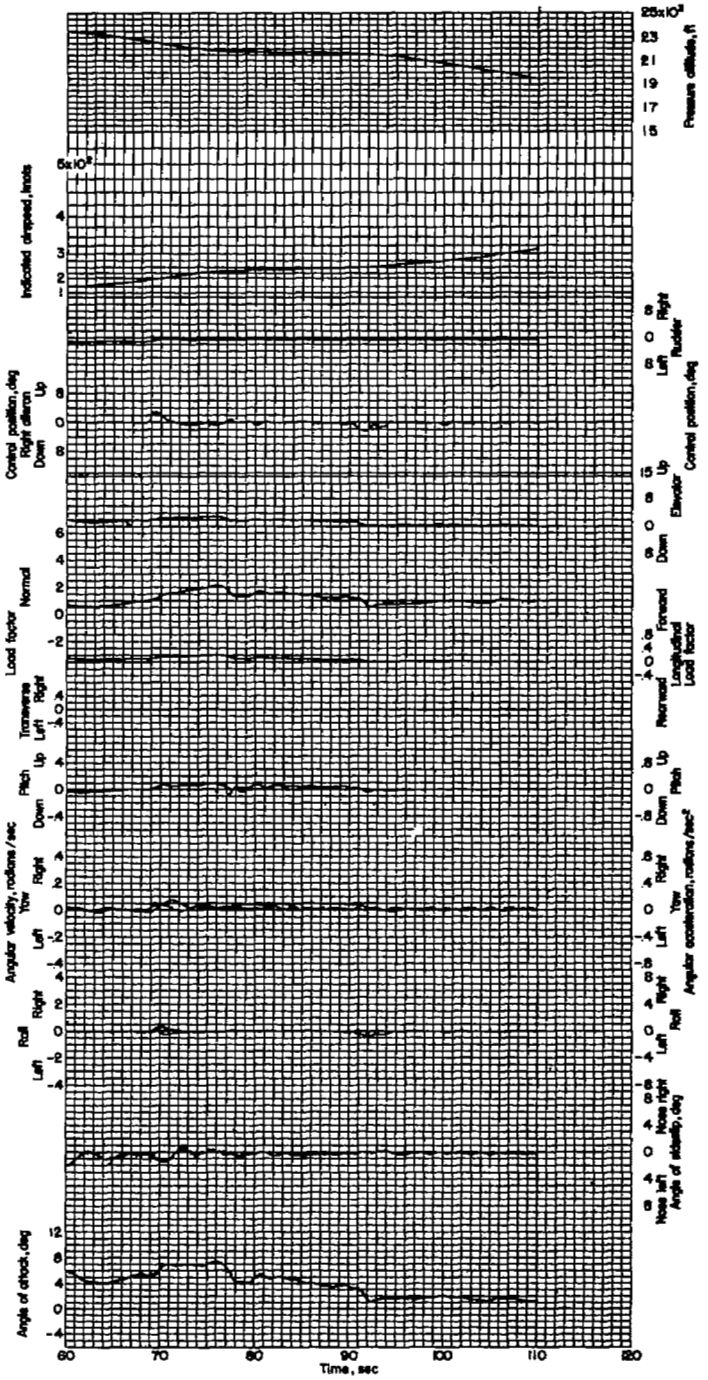
Figure 206.- Immelman. Airplane weight, 15,970 pounds: center of gravity at 24.1 percent M.A.C.; flight 2.



(a)

NACA

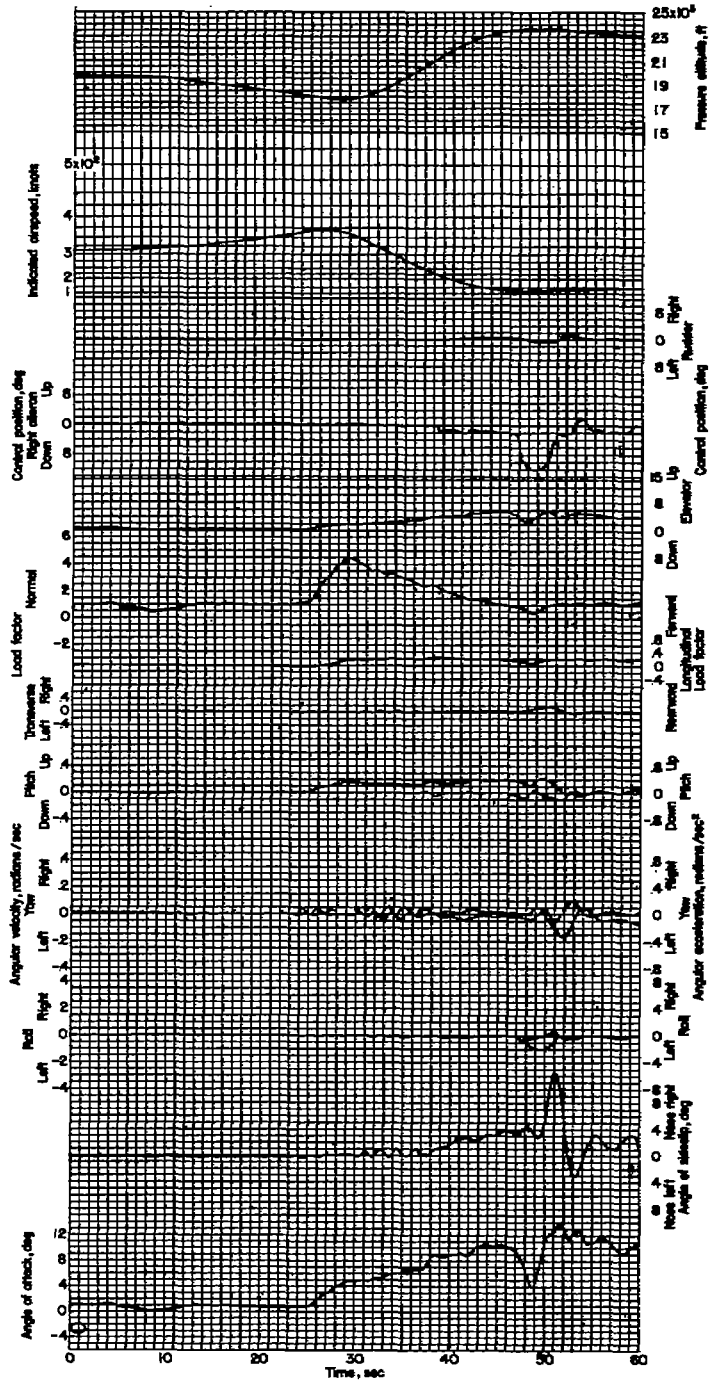
Figure 207.- Left turn followed by Immelman and right turn. Airplane weight, 16,470 pounds; center of gravity at 24.4 percent M.A.C.; flight 3.



(b)

Figure 207.- Concluded.

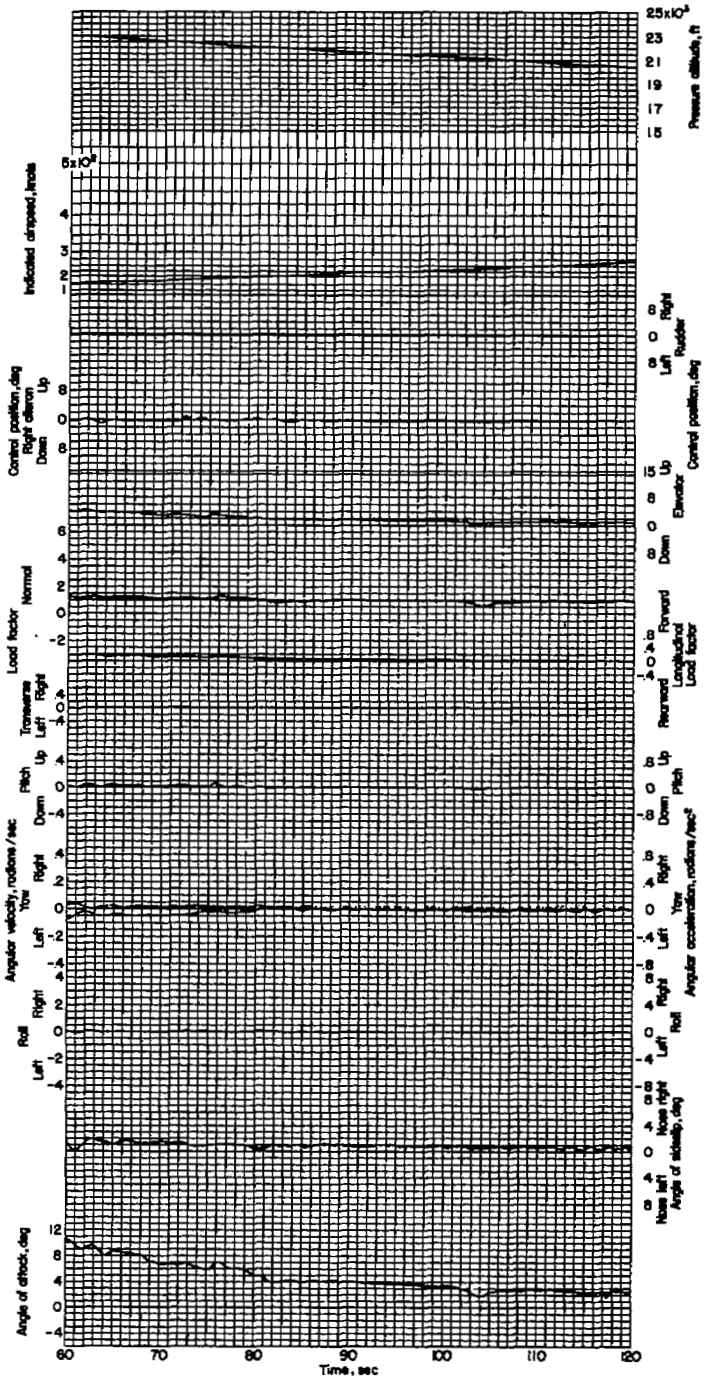
[redacted]



(a)

Figure 208.- Immelman followed by left turn. Airplane weight, 15,850 pounds; center of gravity at 24.0 percent M.A.C.; flight 3.

[redacted]



(b)

Figure 208.- Concluded.

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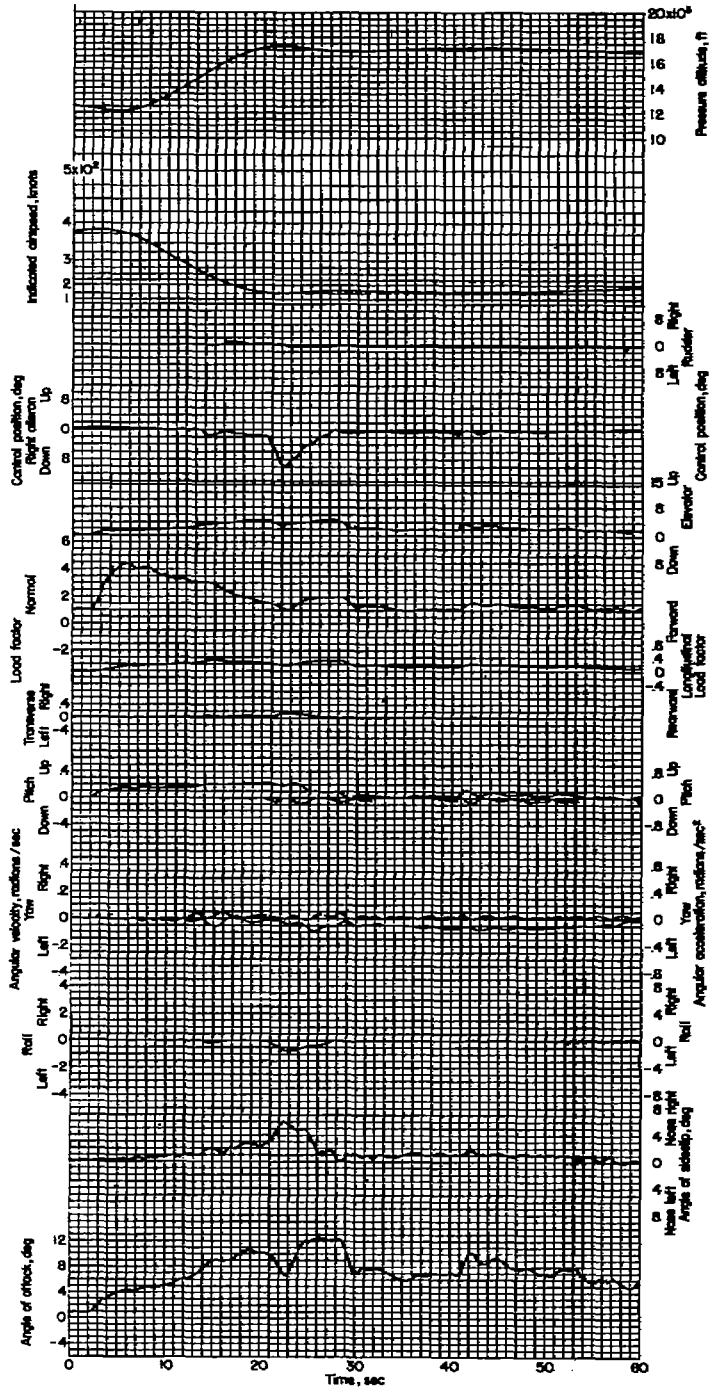
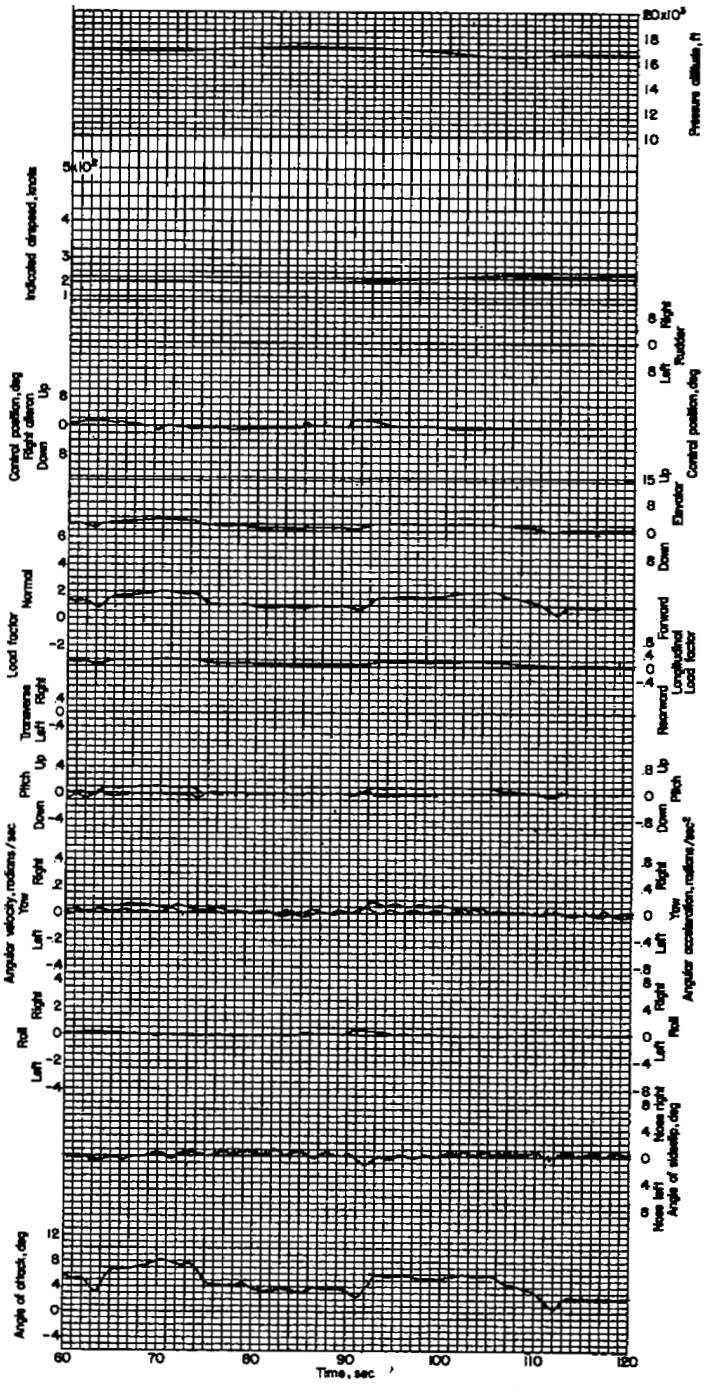


(a)

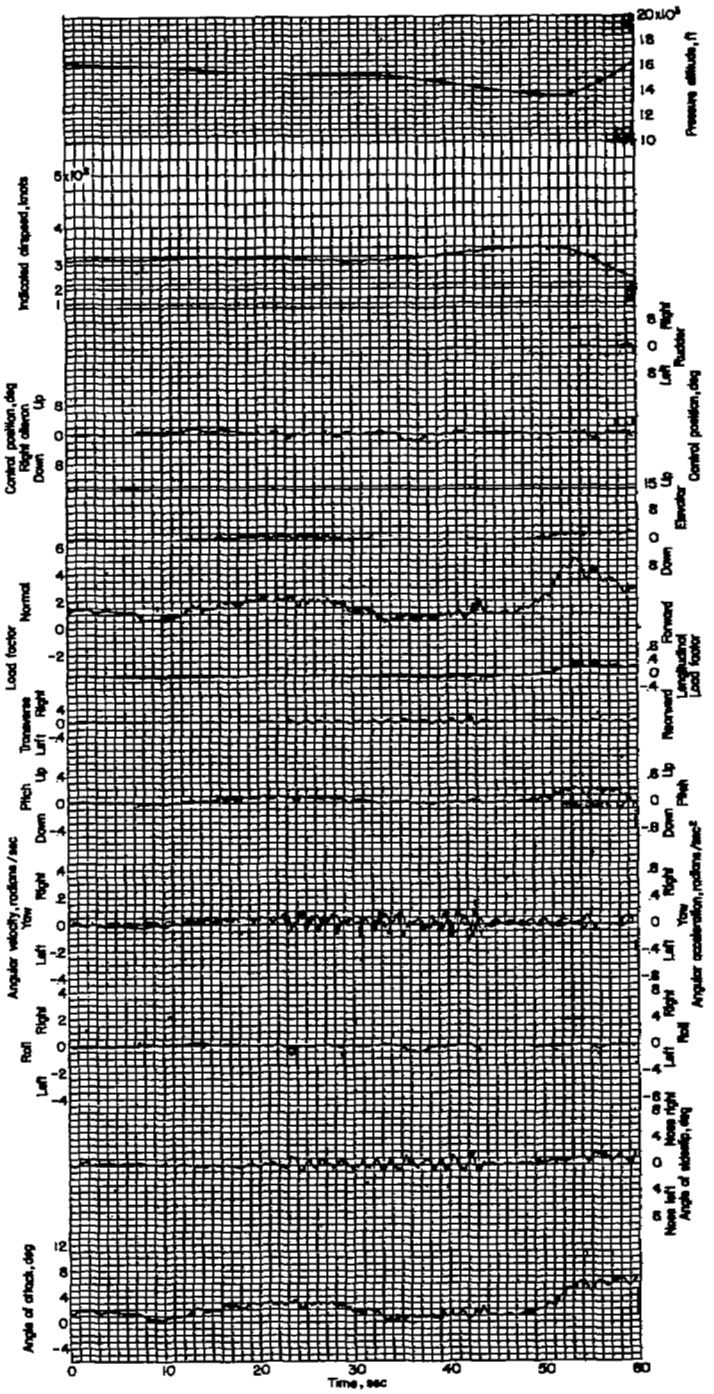
Figure 209.- Immelman followed by series of turns. Airplane weight, 14,500 pounds; center of gravity at 25.0 percent M.A.C.; flight 3.



(b)

Figure 209.- Concluded.

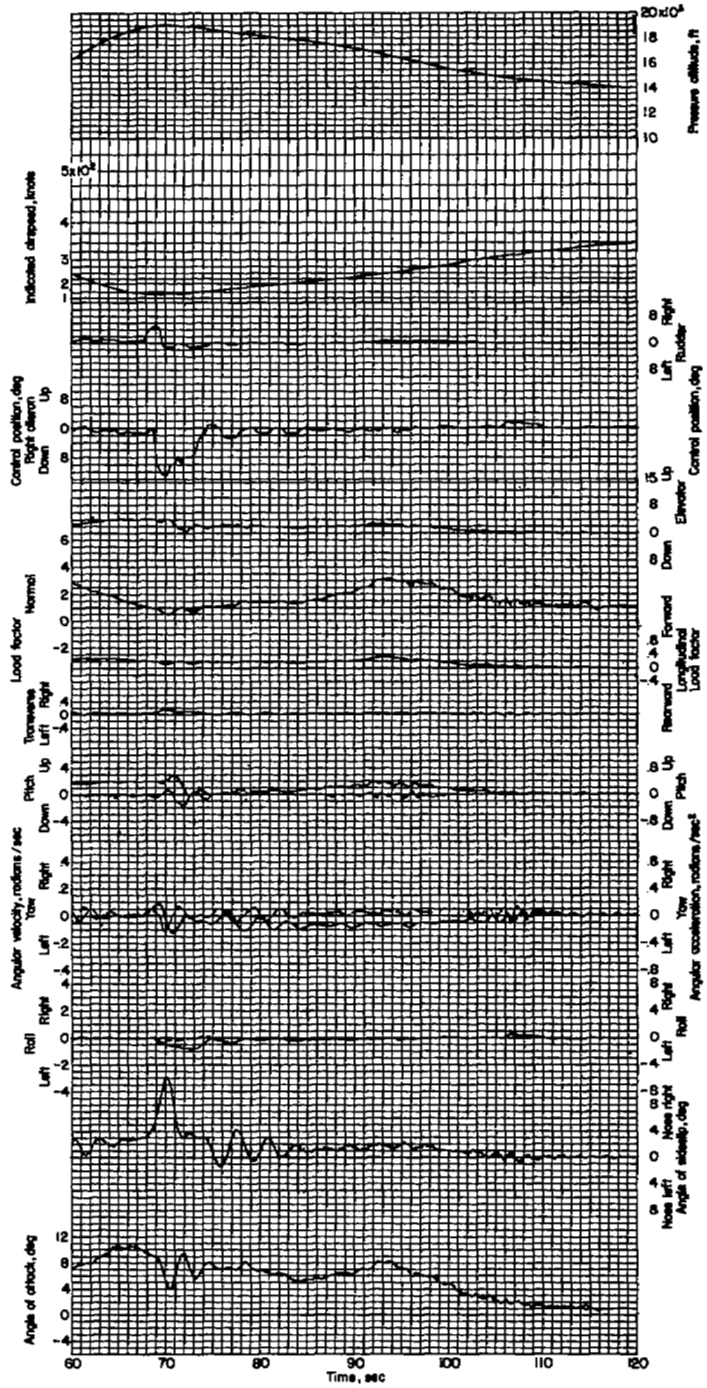
[redacted]



(a)

Figure 210.- Right turn followed by Immelman and left turn. Airplane weight, 14,150 pounds; center of gravity at 25.5 percent M.A.C.; flight 3.

[redacted]



(b)

Figure 210.- Concluded.

[redacted]

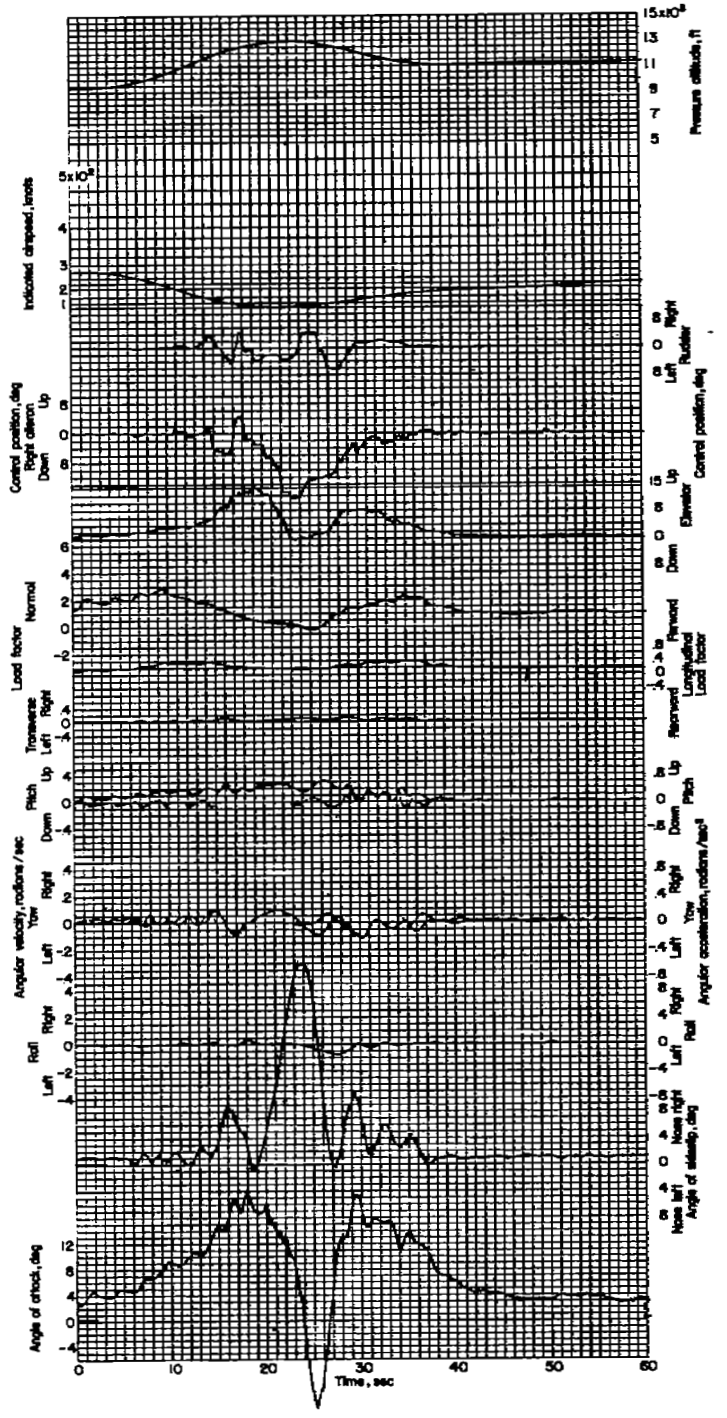


Figure 211.- Immelman with stall at top. Airplane weight, 13,940 pounds; center of gravity at 25.8 percent M.A.C.; flight 3.

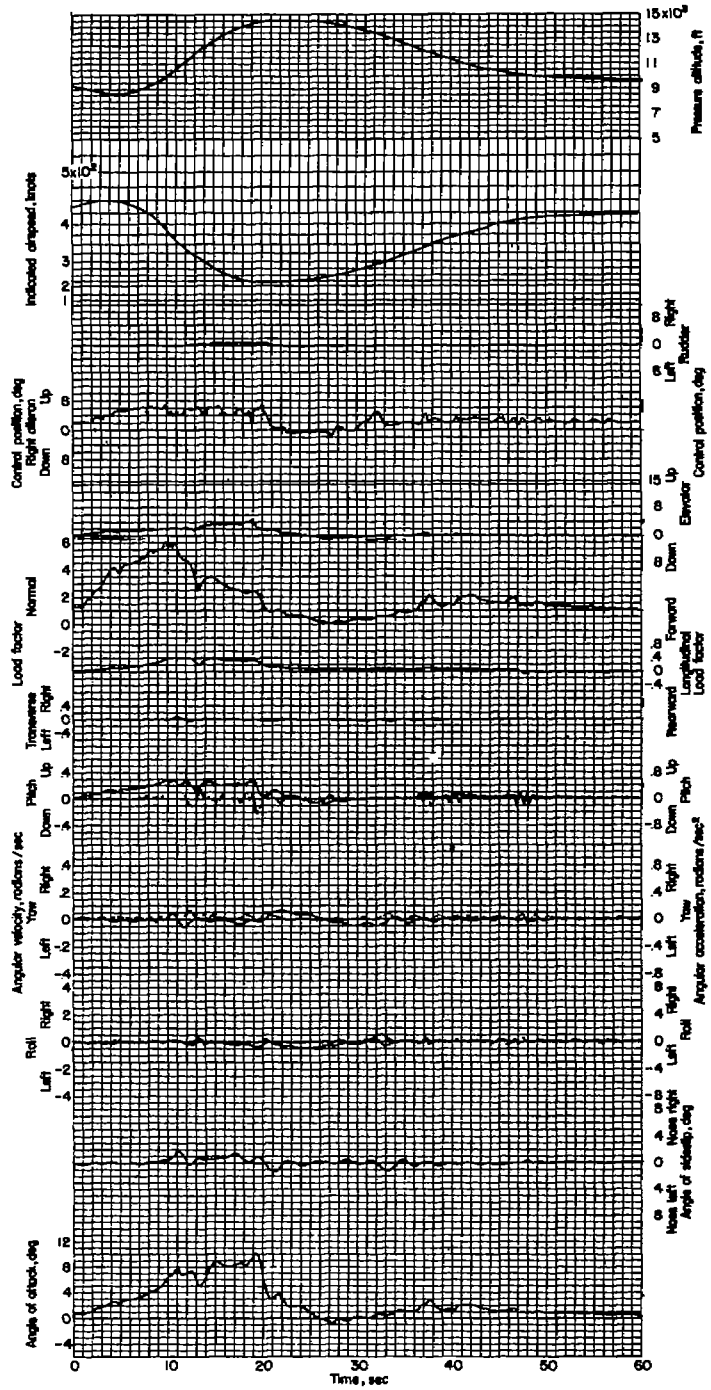


Figure 212.- Immelman. Airplane weight, 17,660 pounds; center of gravity at 25.0 percent M.A.C.; flight 4.

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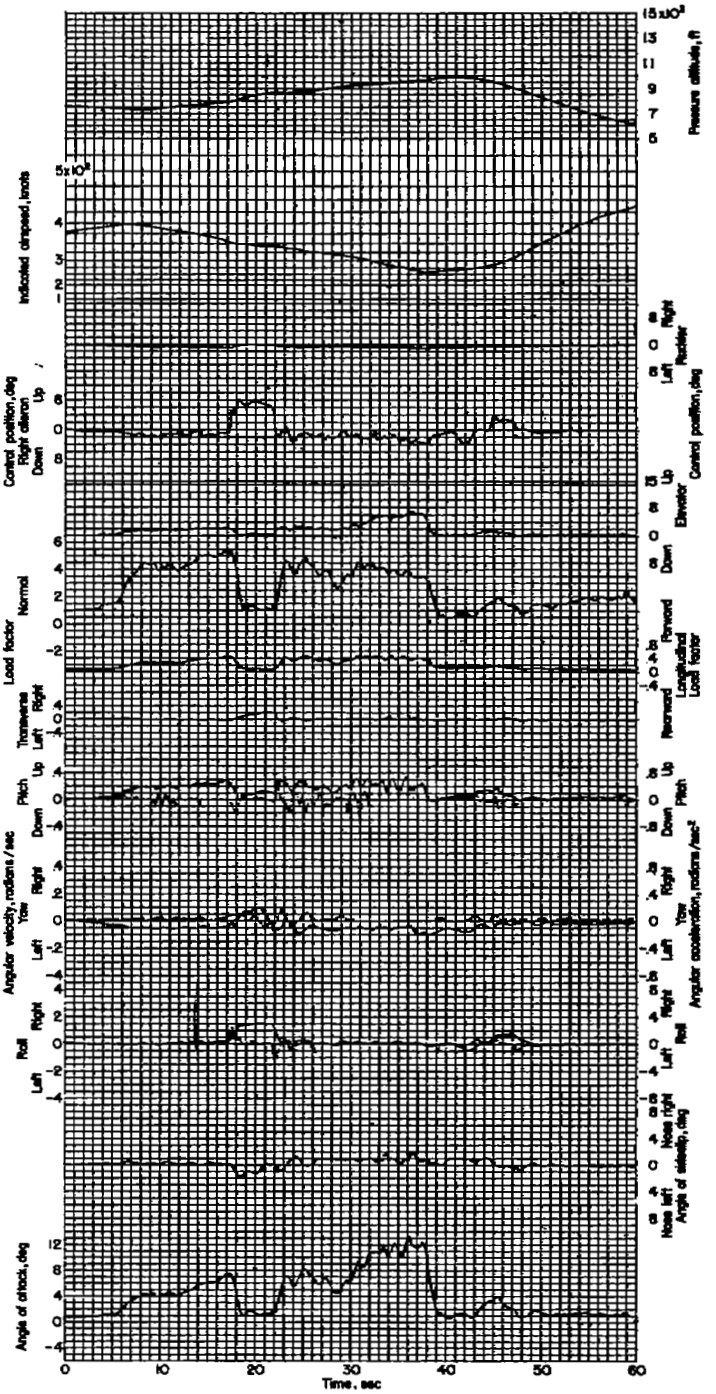
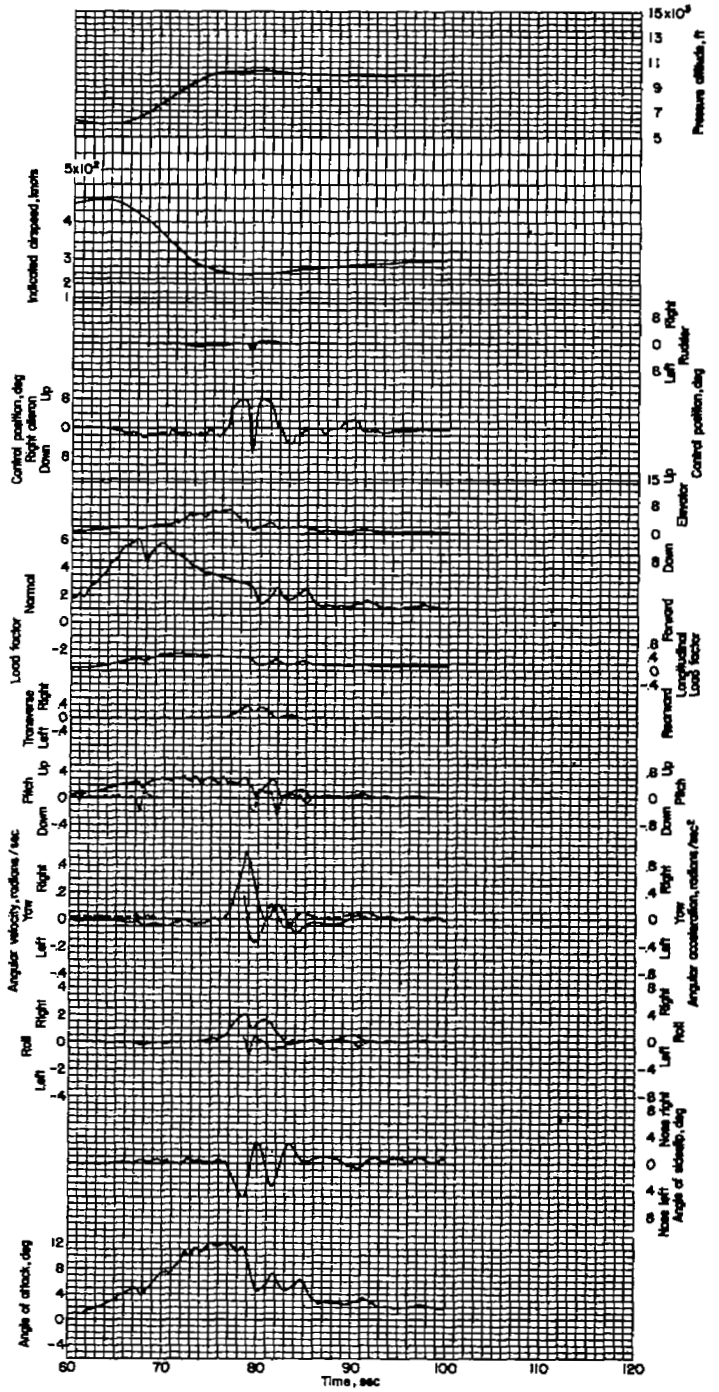


(a)

NACA

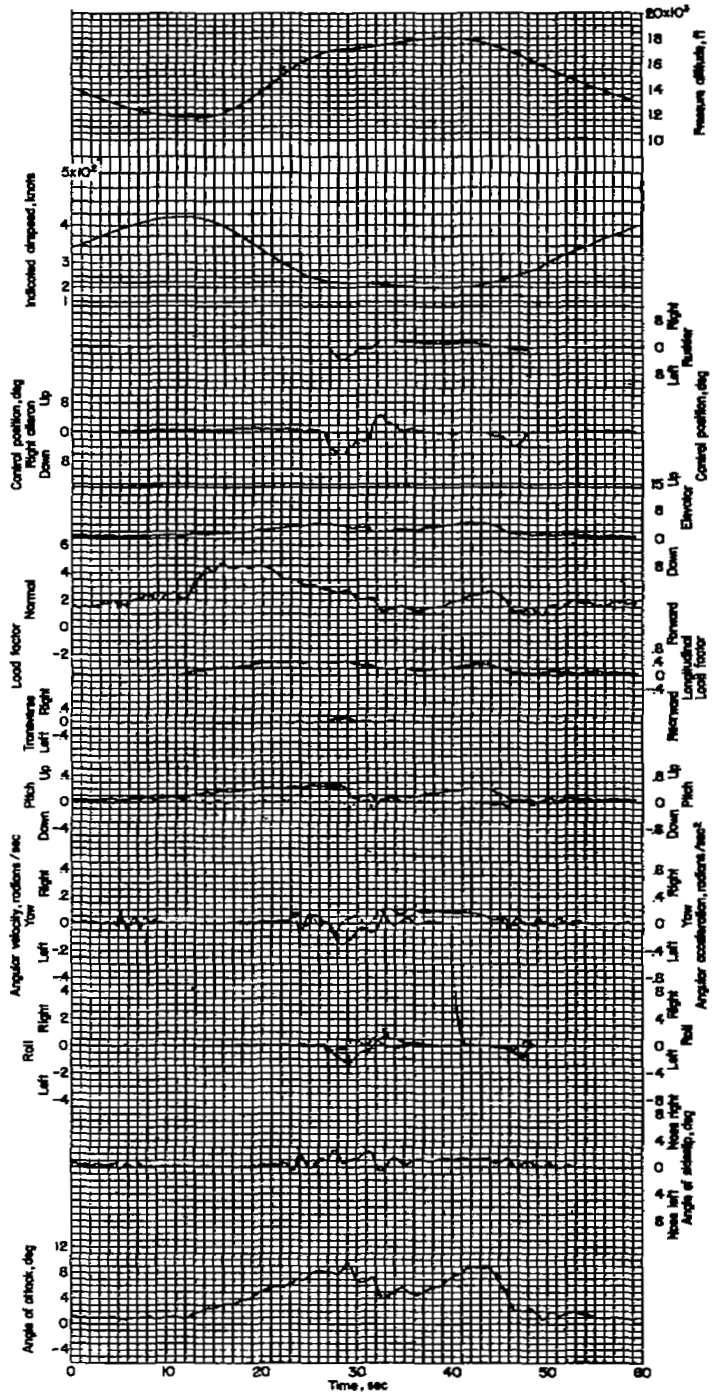
Figure 213.- Pull-up into right aileron roll followed by Immelman and right barrel roll. Airplane weight, 17,280 pounds; center of gravity at 24.8 percent M.A.C.; flight 5.

[redacted]



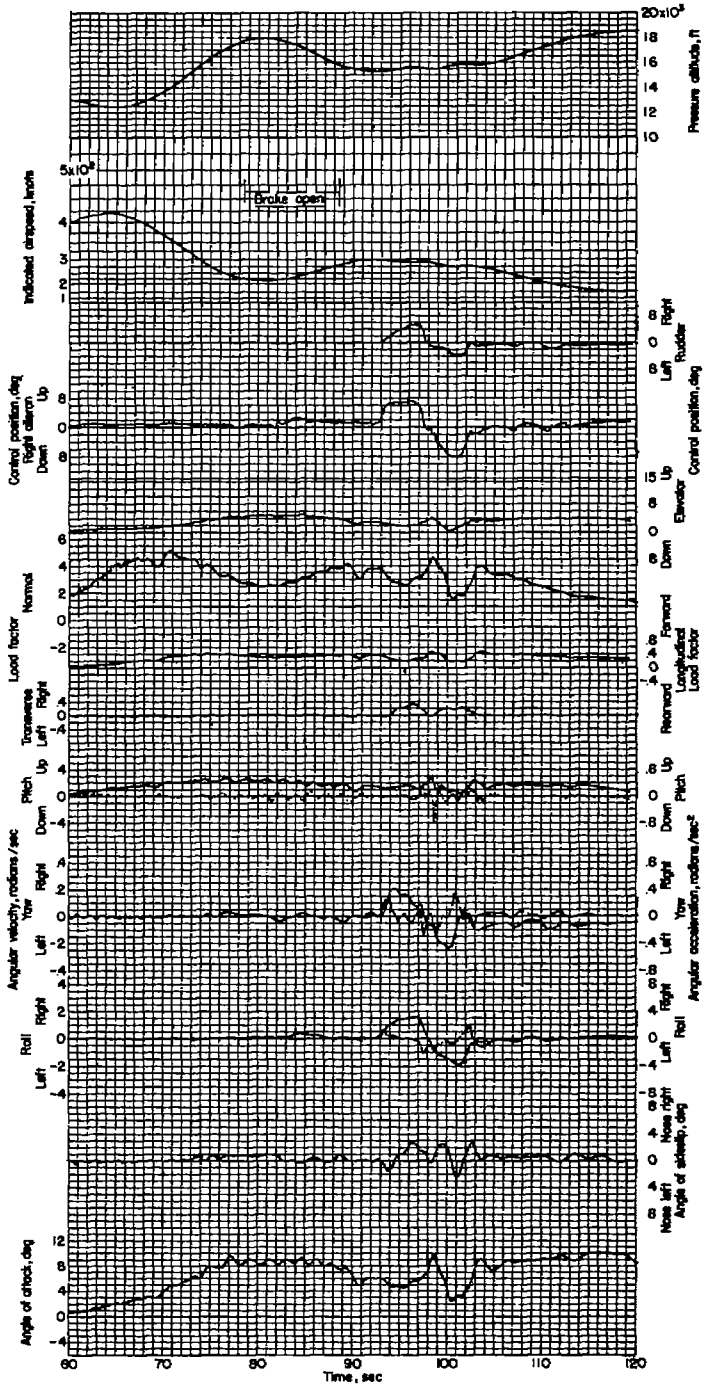
(b)

Figure 213.- Concluded.



(a)

Figure 214.- Immelman followed by three-quarter loop and right and left barrel roll. Airplane weight, 14,700 pounds; center of gravity at 24.8 percent M.A.C.; flight 6.



(b)

Figure 214.- Concluded.

[redacted]

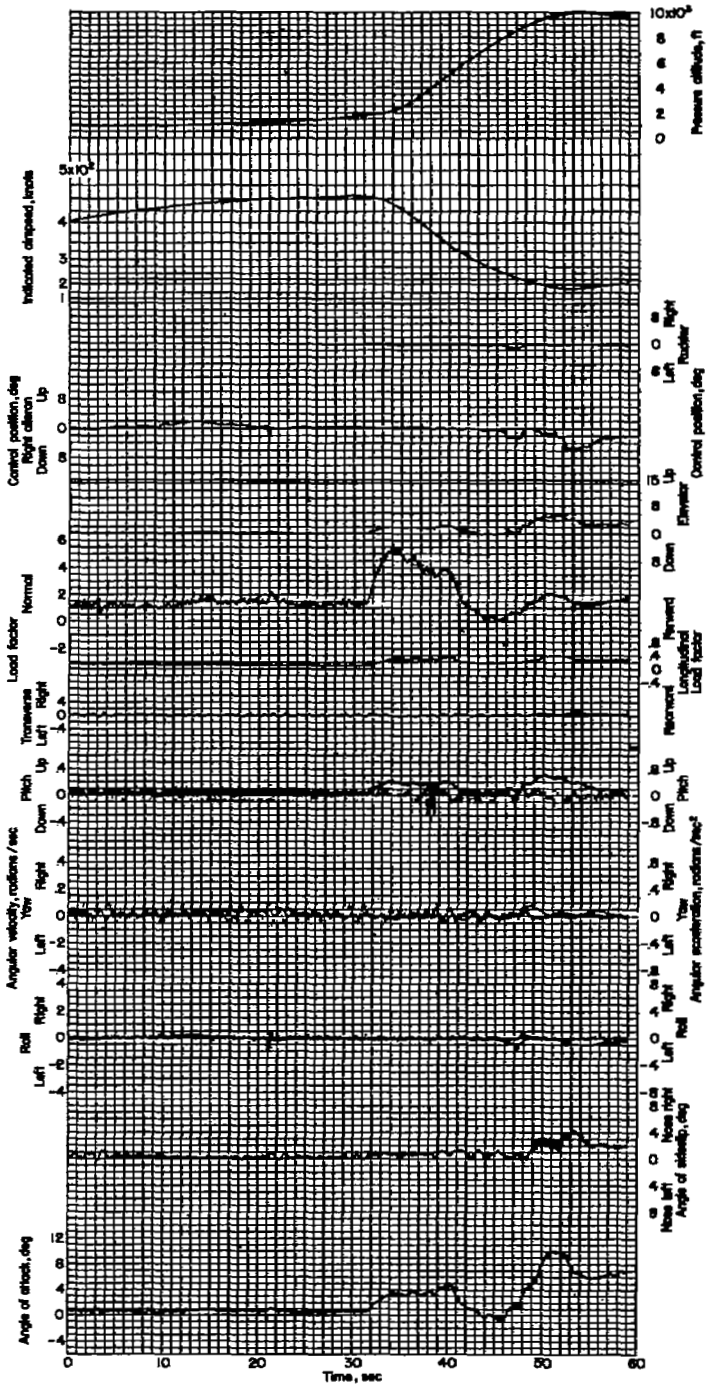
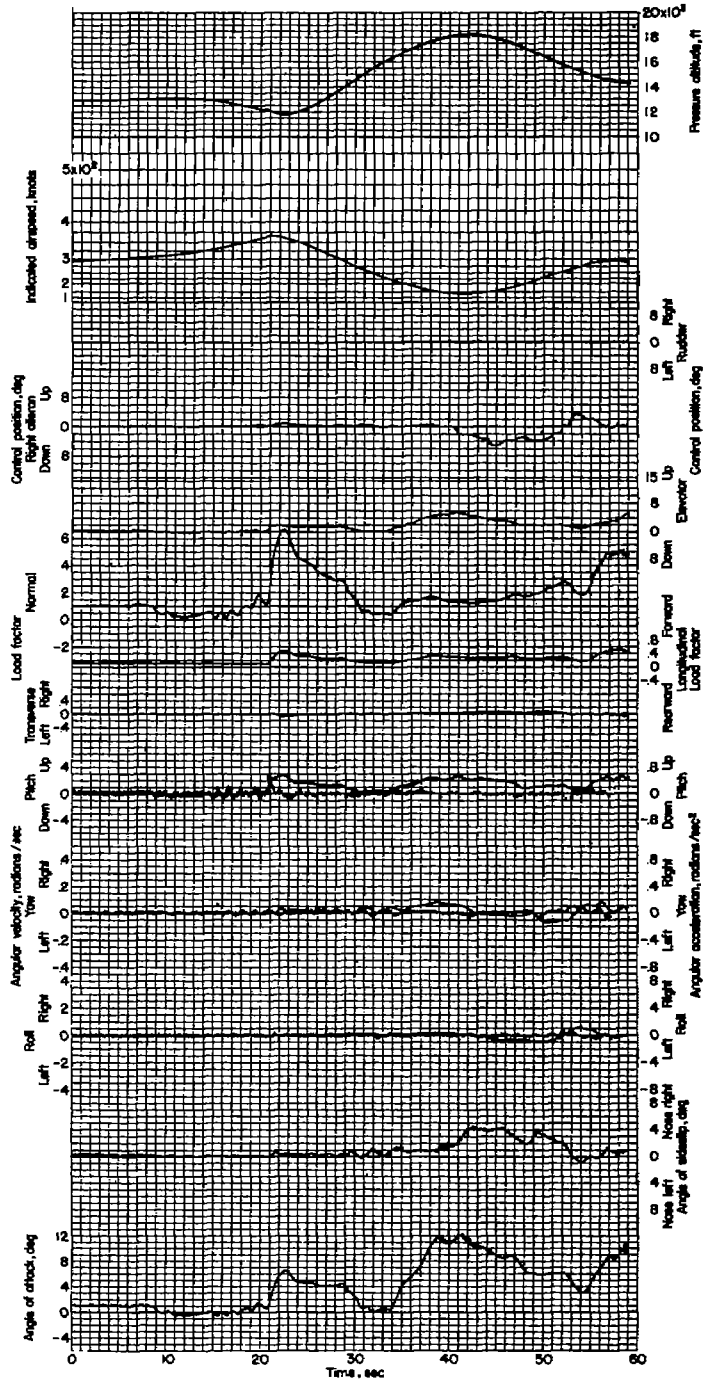


Figure 215.- Immelman. Airplane weight, 15,400 pounds; center of gravity at 23.8 percent M.A.C.; flight 7.

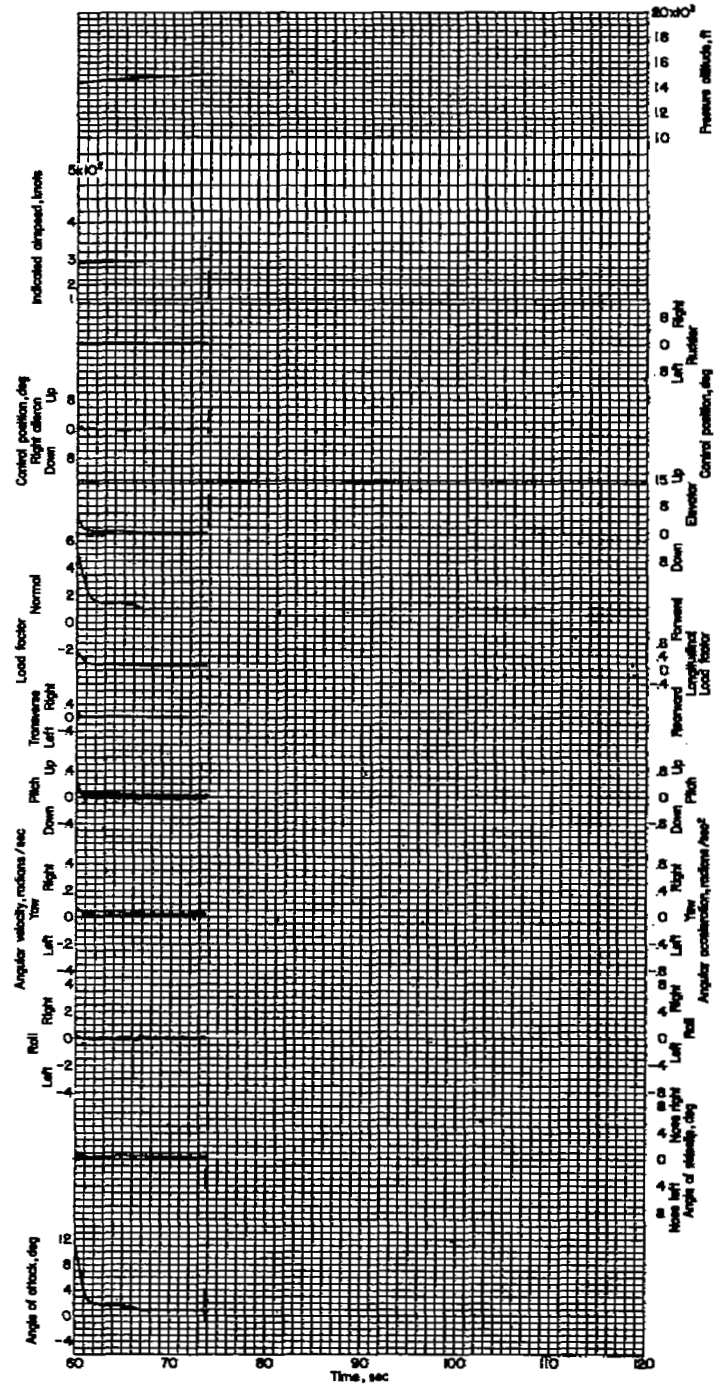
[redacted]



(a)

Figure 216.- Pull-out from shallow dive into Immelman followed by diving right turn and pull-out. Airplane weight, 14,130 pounds; center of gravity at 25.6 percent M.A.C.; flight 7.

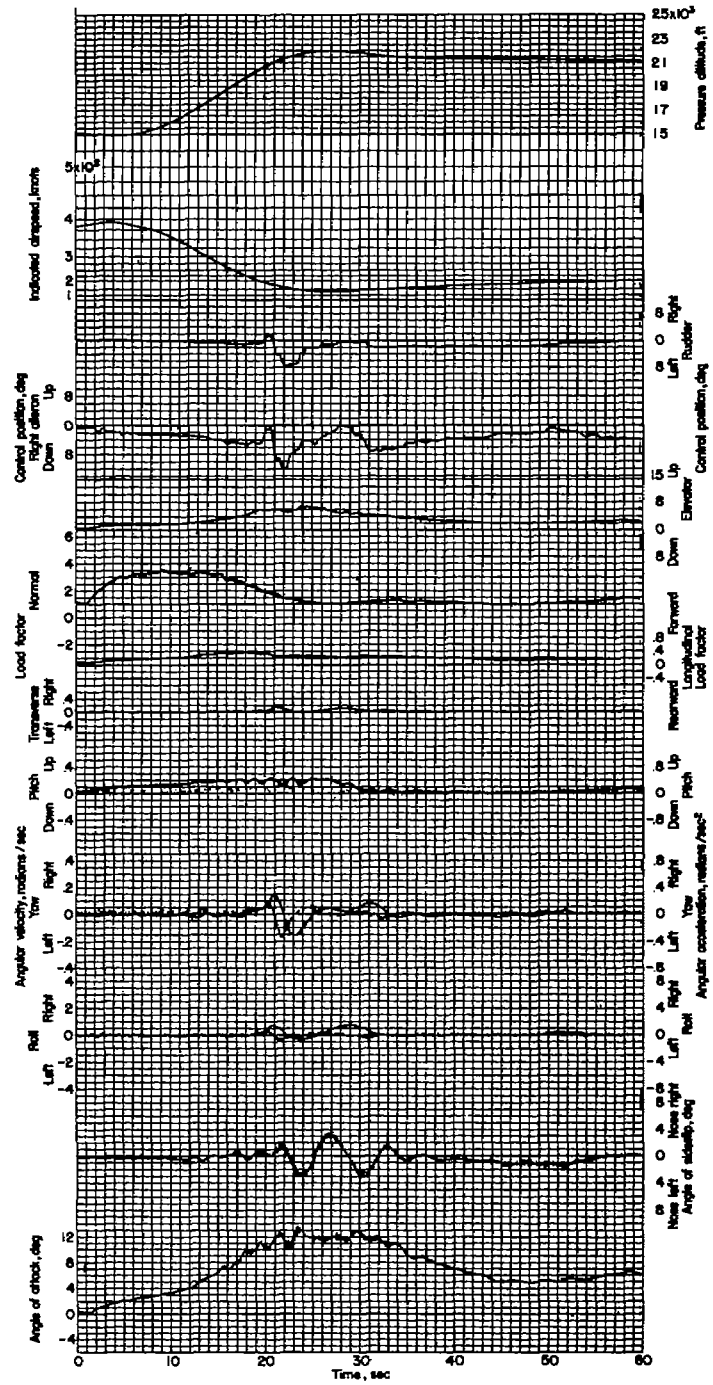
[redacted]



(b)

Figure 216.- Concluded.

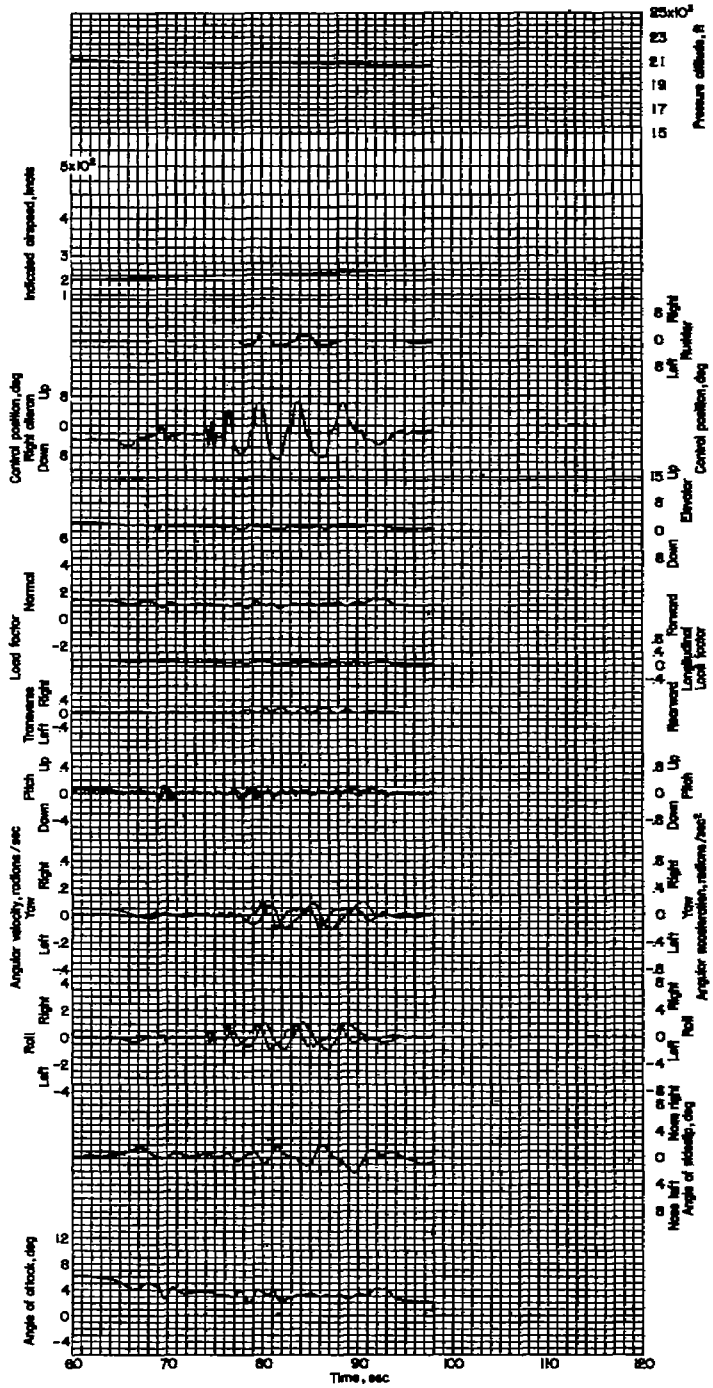
[redacted]



(a)

Figure 217.- Immelman with partial stall at top followed by series of banks. Airplane weight, 16,440 pounds; center of gravity at 24.4 percent M.A.C.; flight 9.

[redacted]



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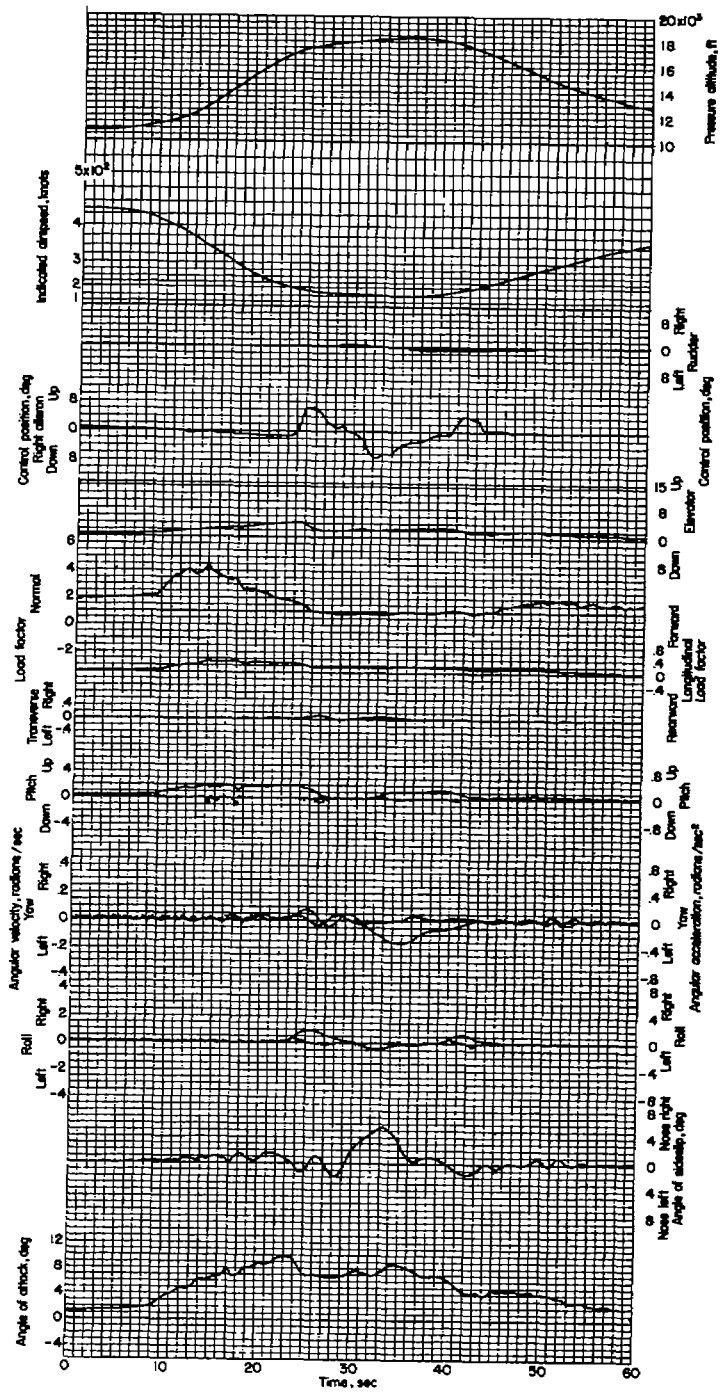

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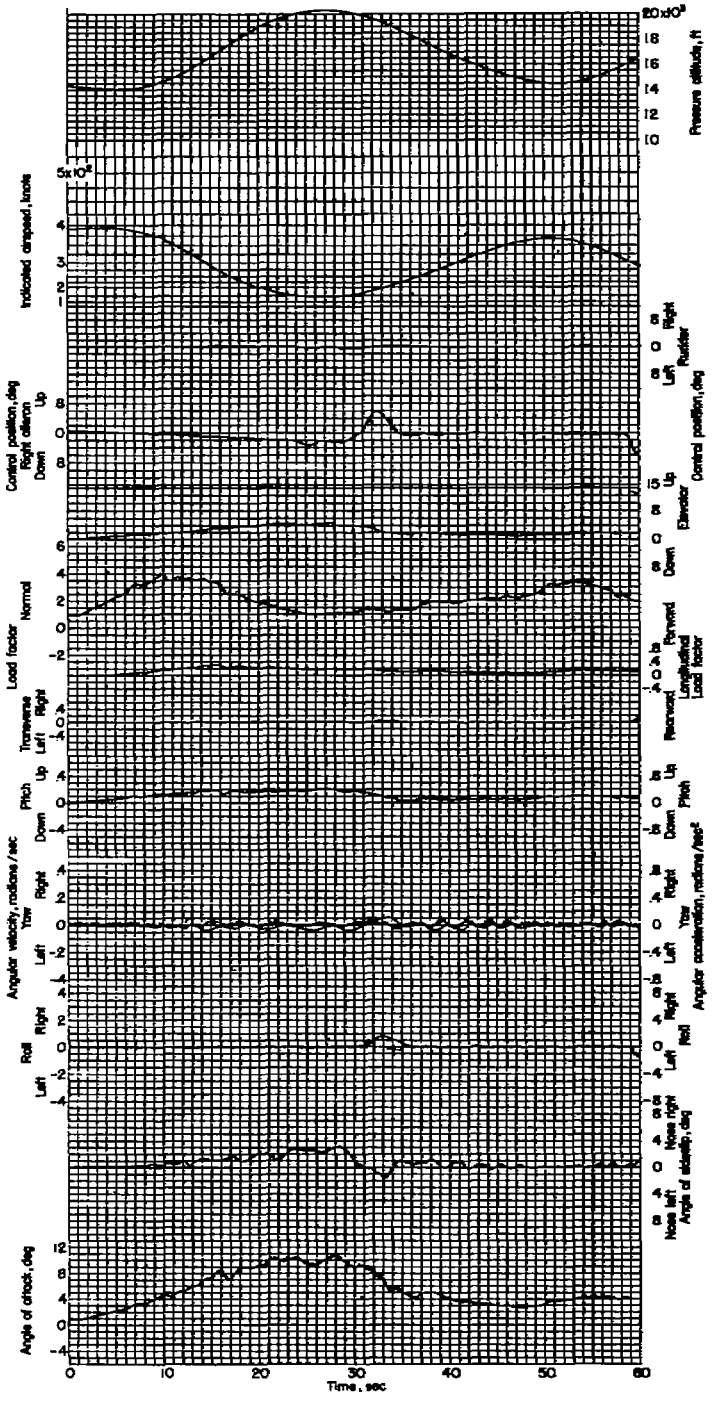
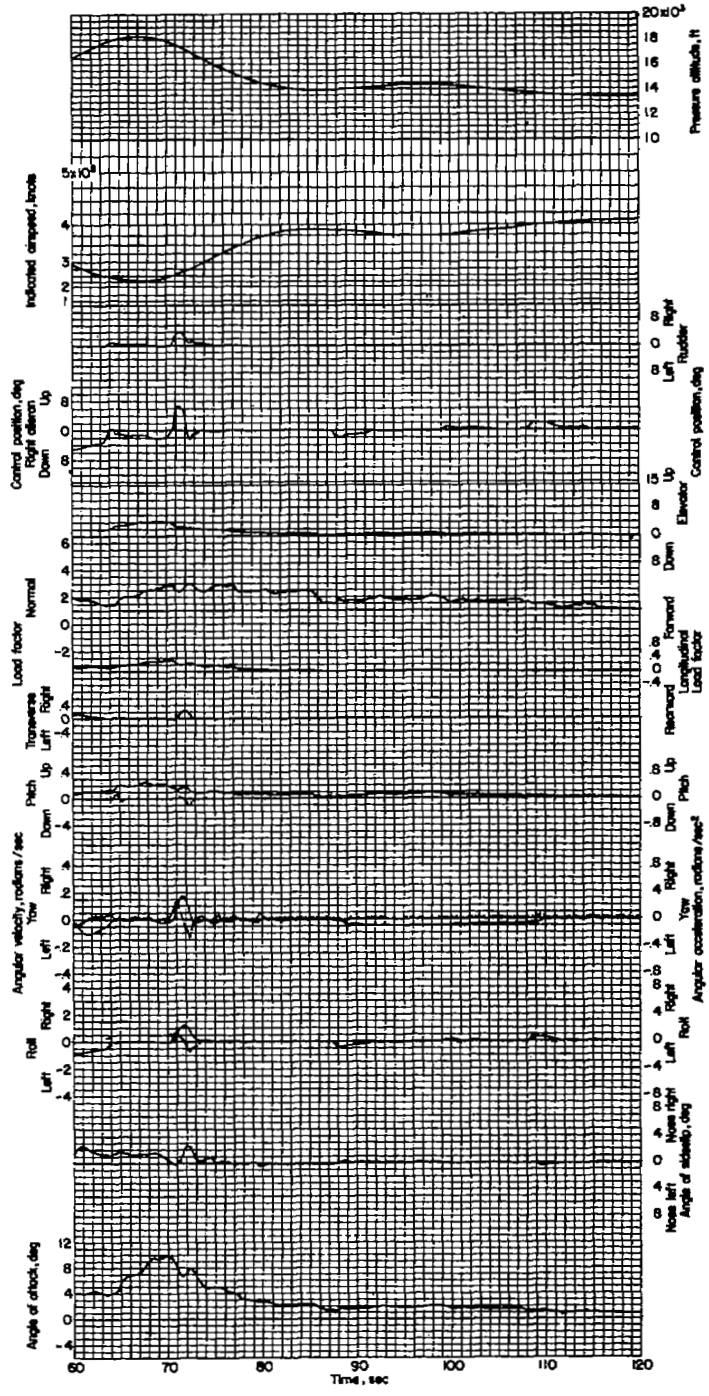
Figure 218.- Immelman followed by peel-off into dive. Airplane weight, 16,510 pounds; center of gravity at 24.4 percent M.A.C.; flight 11.

[redacted]



(a)

Figure 219.- Immelman followed by dive and pull-up into vertical recovery and left turn. Airplane weight, 16,310 pounds; center of gravity at 24.3 percent M.A.C.; flight 11.



(b)

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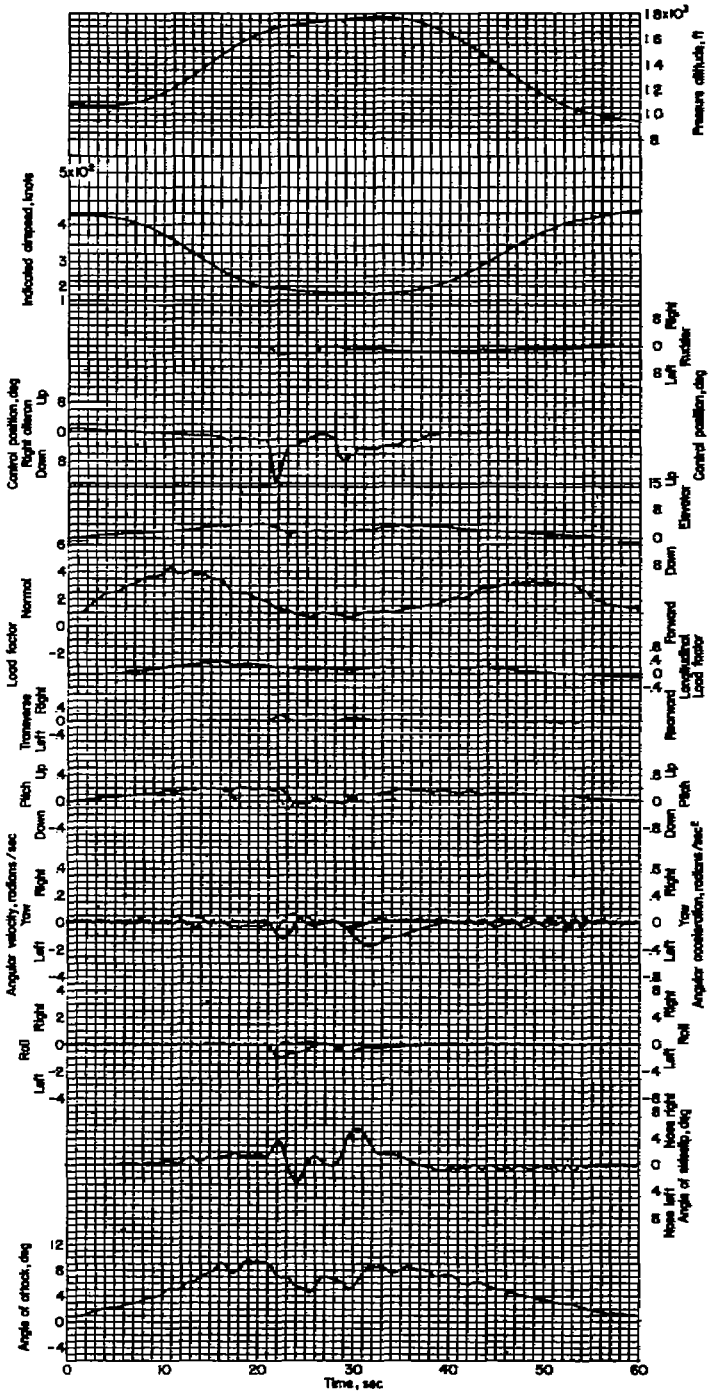
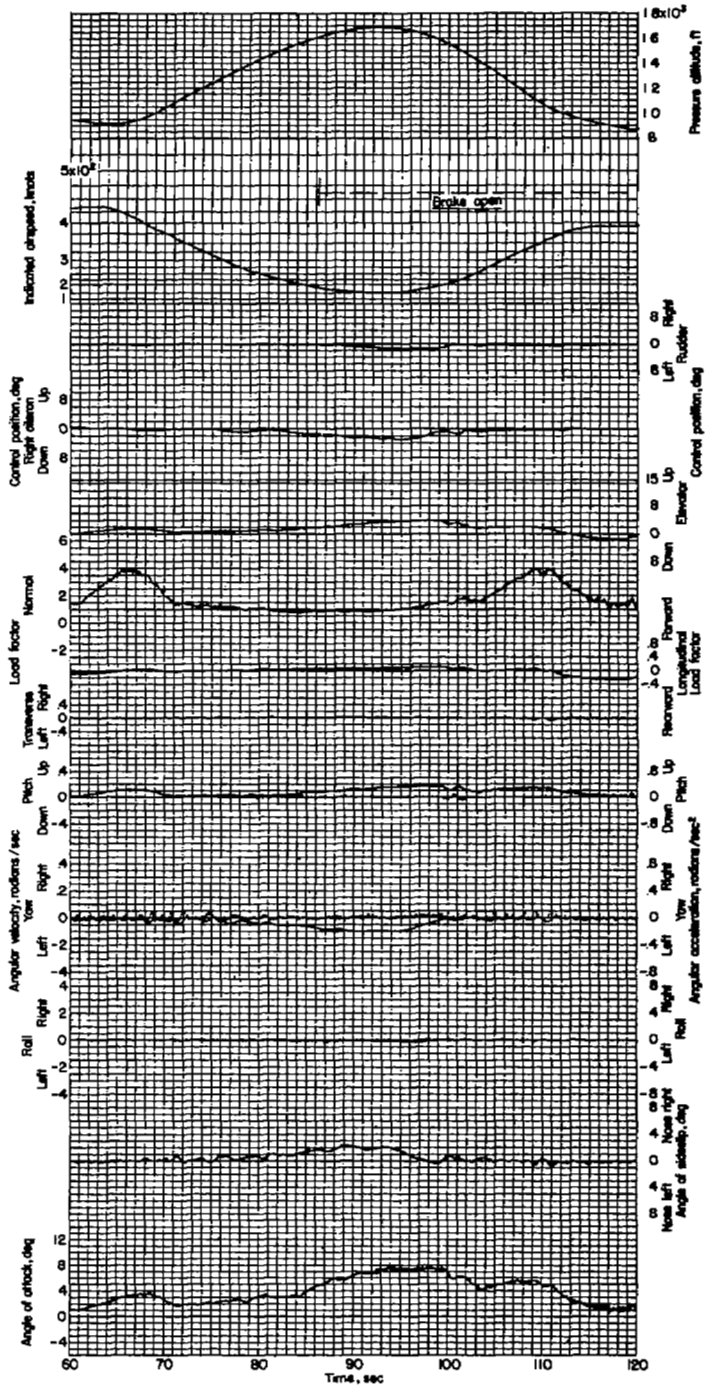


(a)

Figure 220.- Immelman and peel-off into dive followed by wing-over. Airplane weight, 16,110 pounds; center of gravity at 24.2 percent M.A.C.; flight 11.

[redacted]



(b)

Figure 220.- Concluded.

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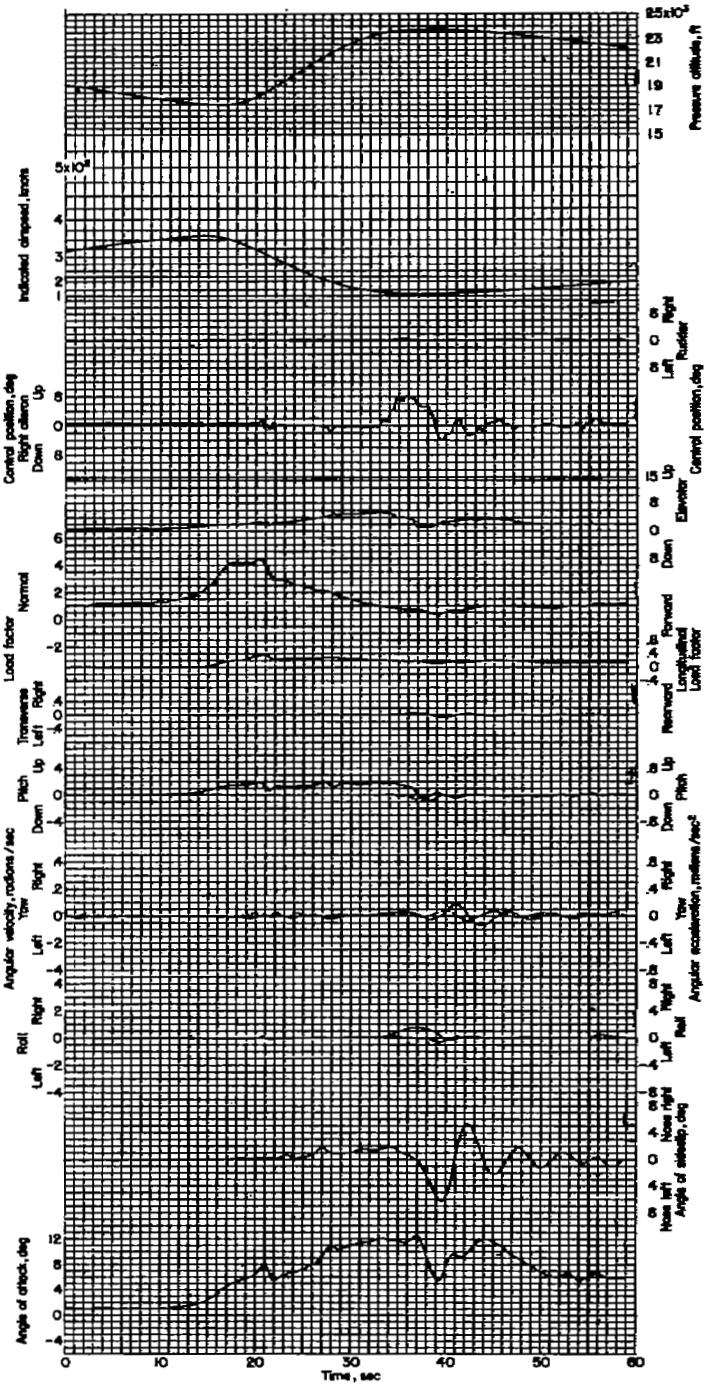
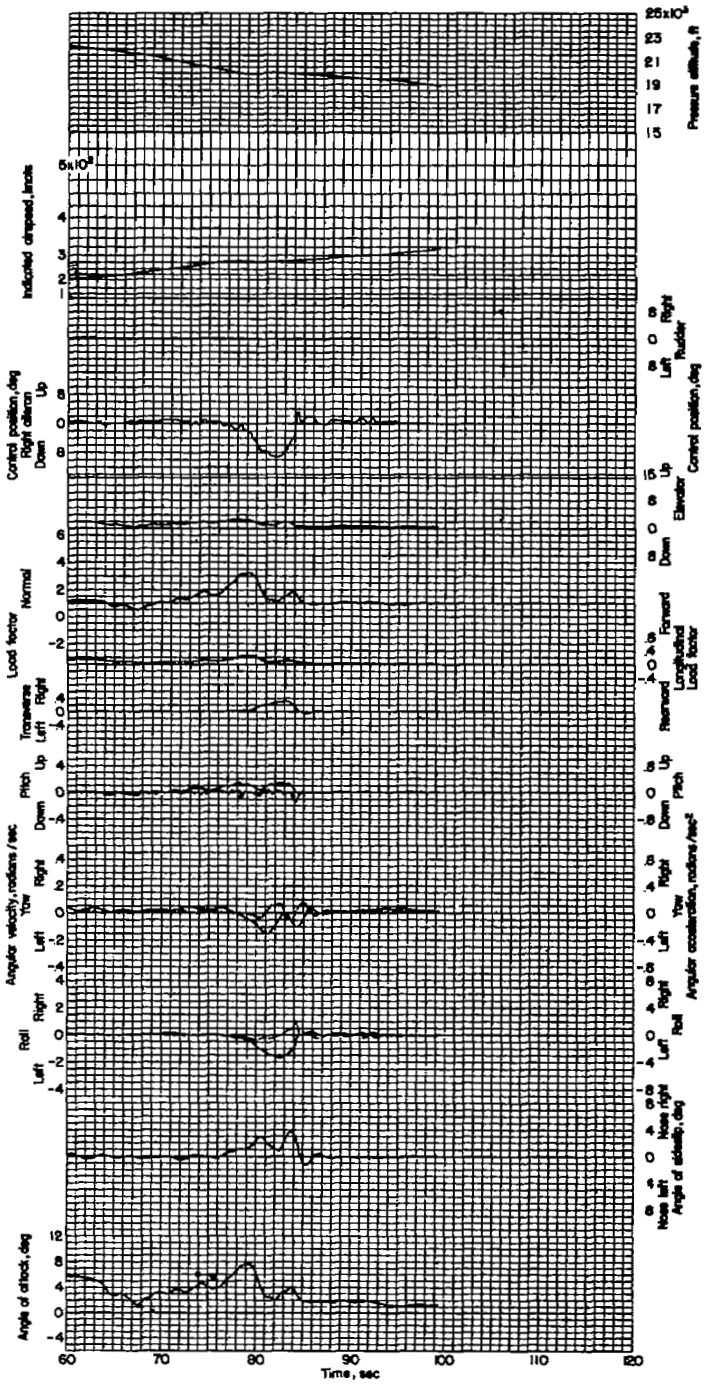


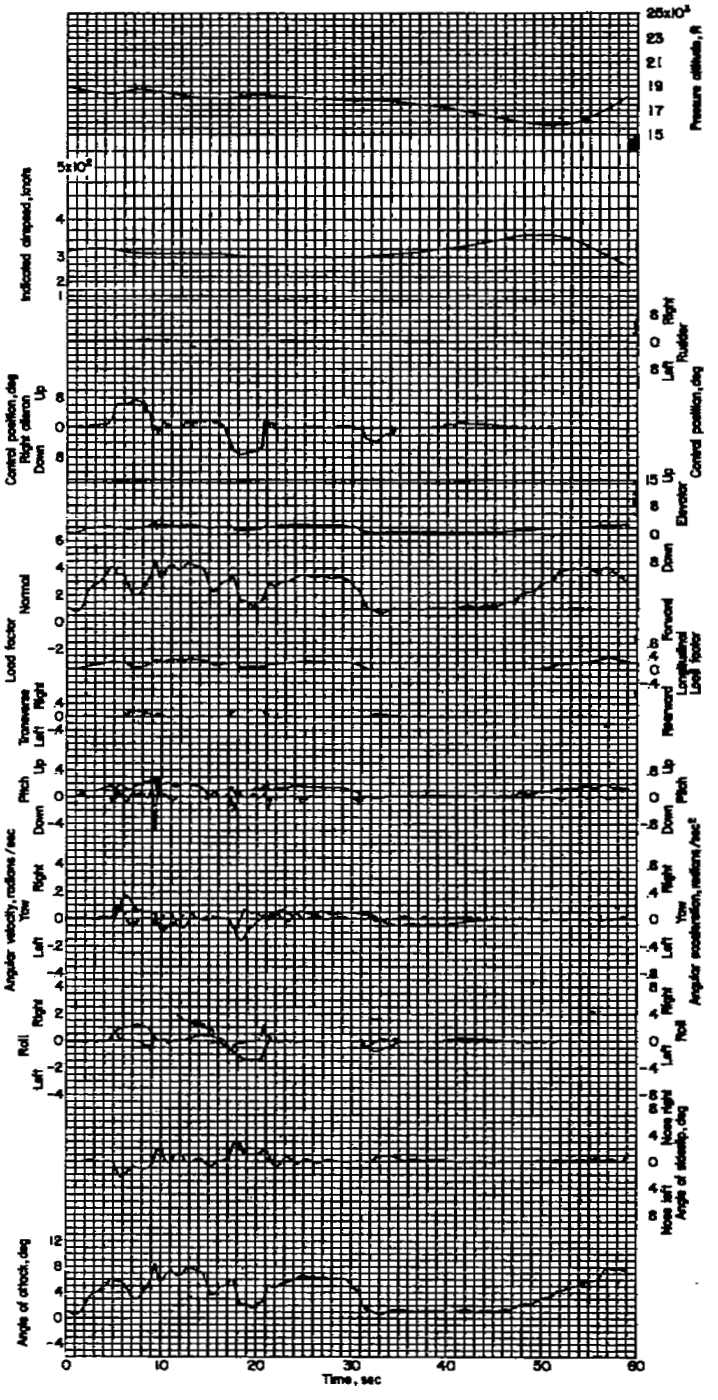
(a)

Figure 221.- Immelman followed by left aileron roll. Airplane weight, 16,450 pounds; center of gravity at 24.4 percent M.A.C.; flight 12.



(b)

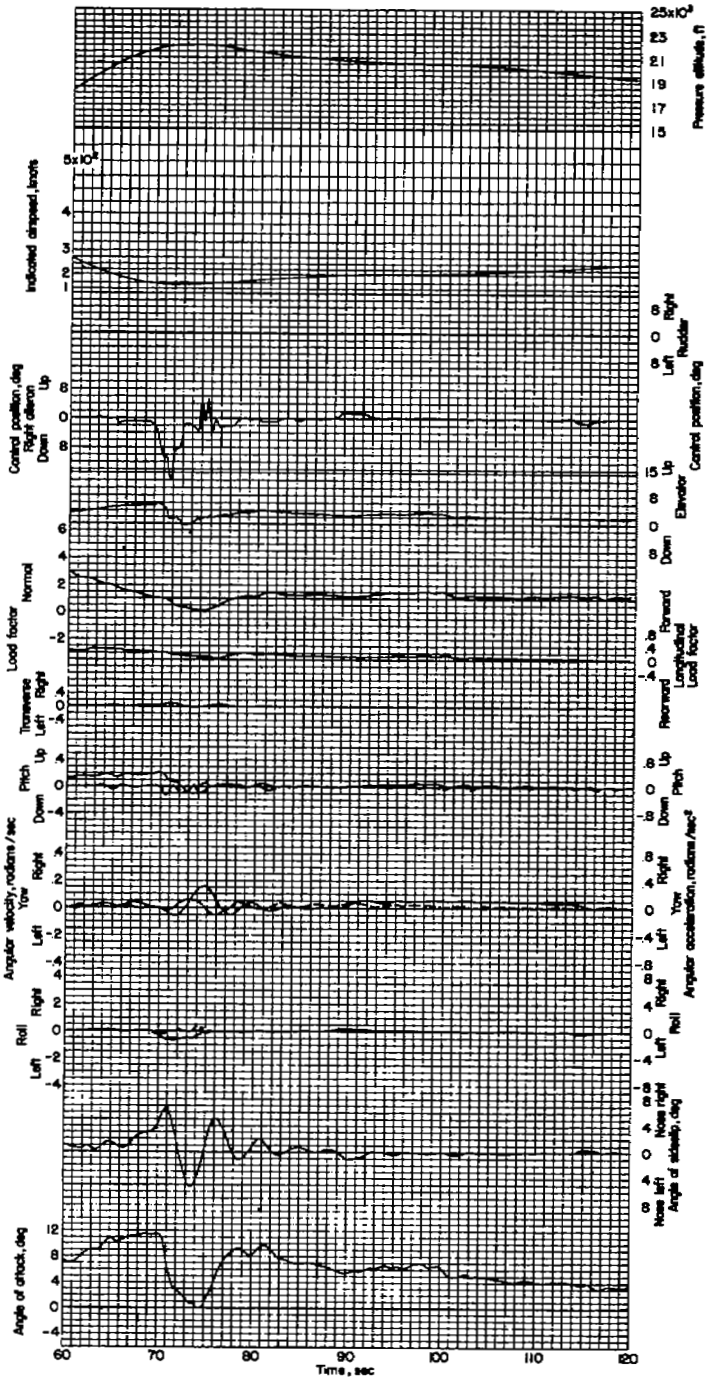
Figure 221.- Concluded.



(a)

Figure 222.- Right and left barrel roll followed by Immelman. Airplane weight, 16,370 pounds; center of gravity at 24.3 percent M.A.C.; flight 12.

[redacted]



(b)

Figure 222.- Concluded.

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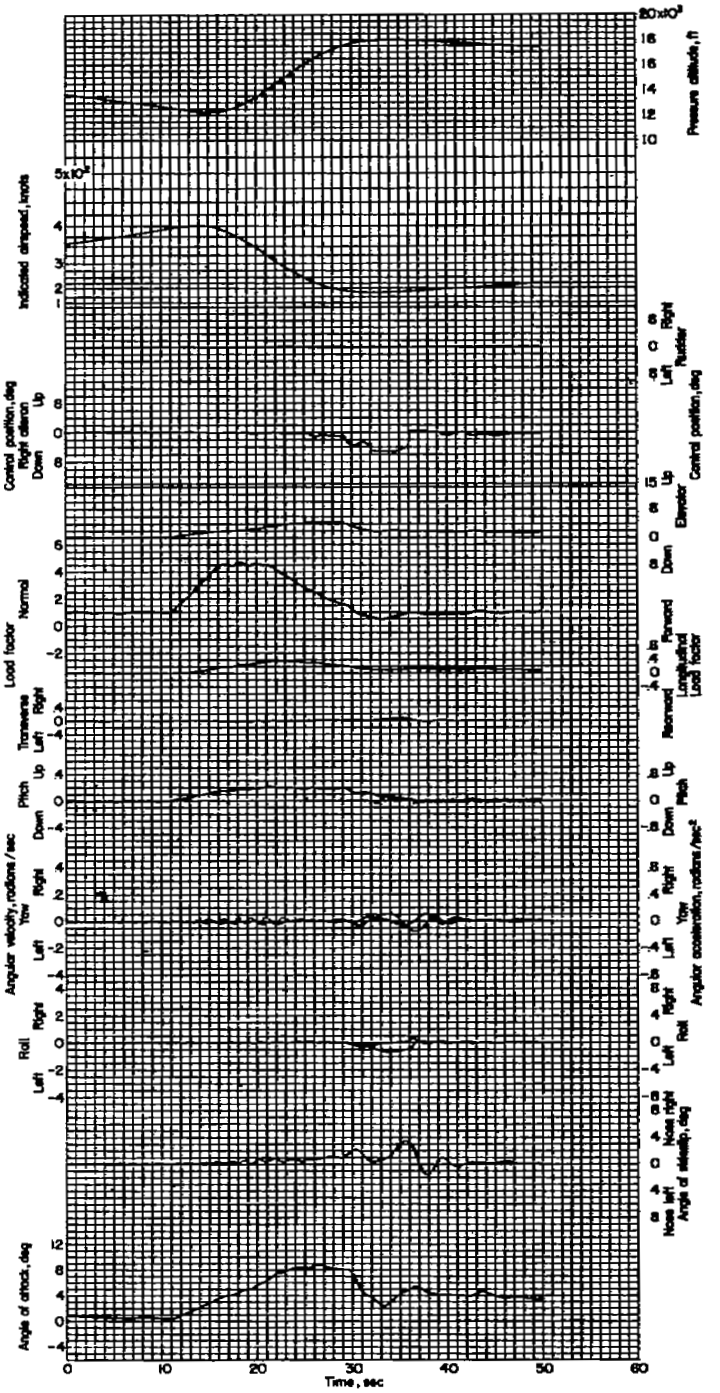
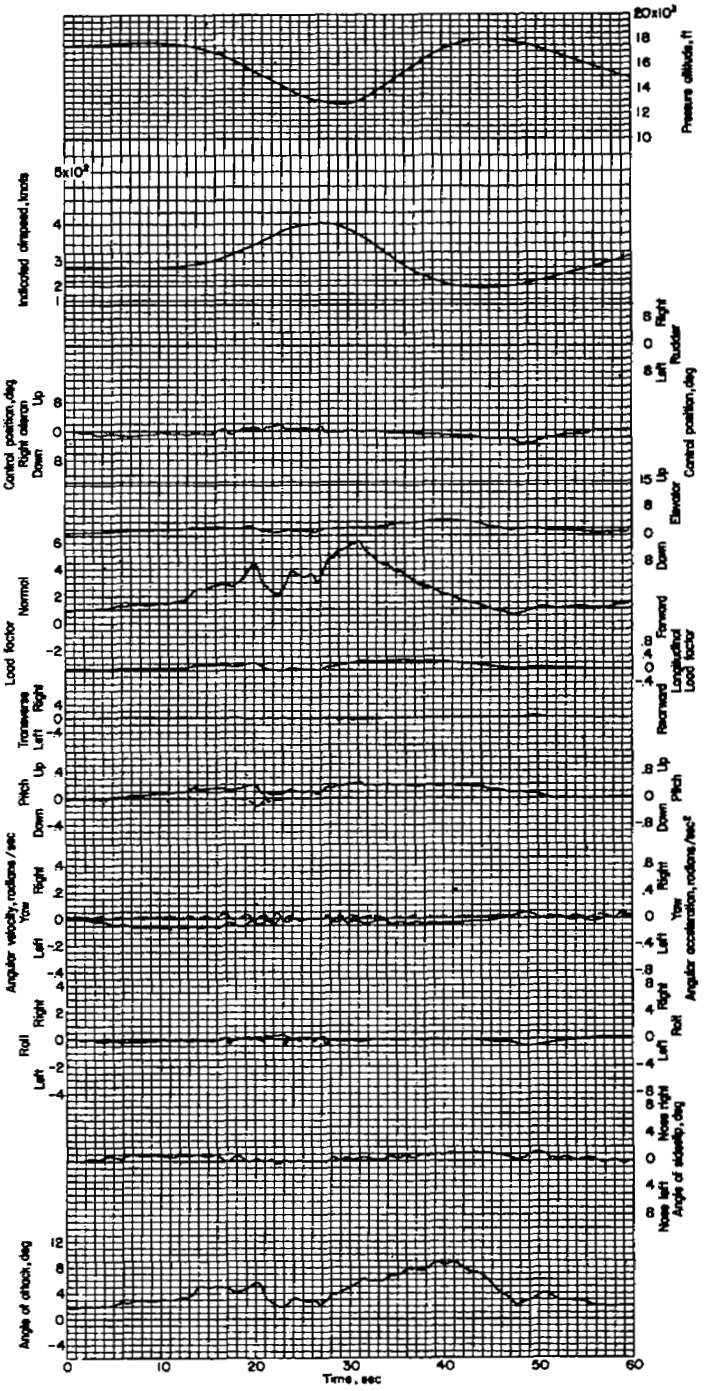


Figure 223.- Immelman. Airplane weight, 15,910 pounds; center of gravity at 24.1 percent M.A.C.; flight 13.

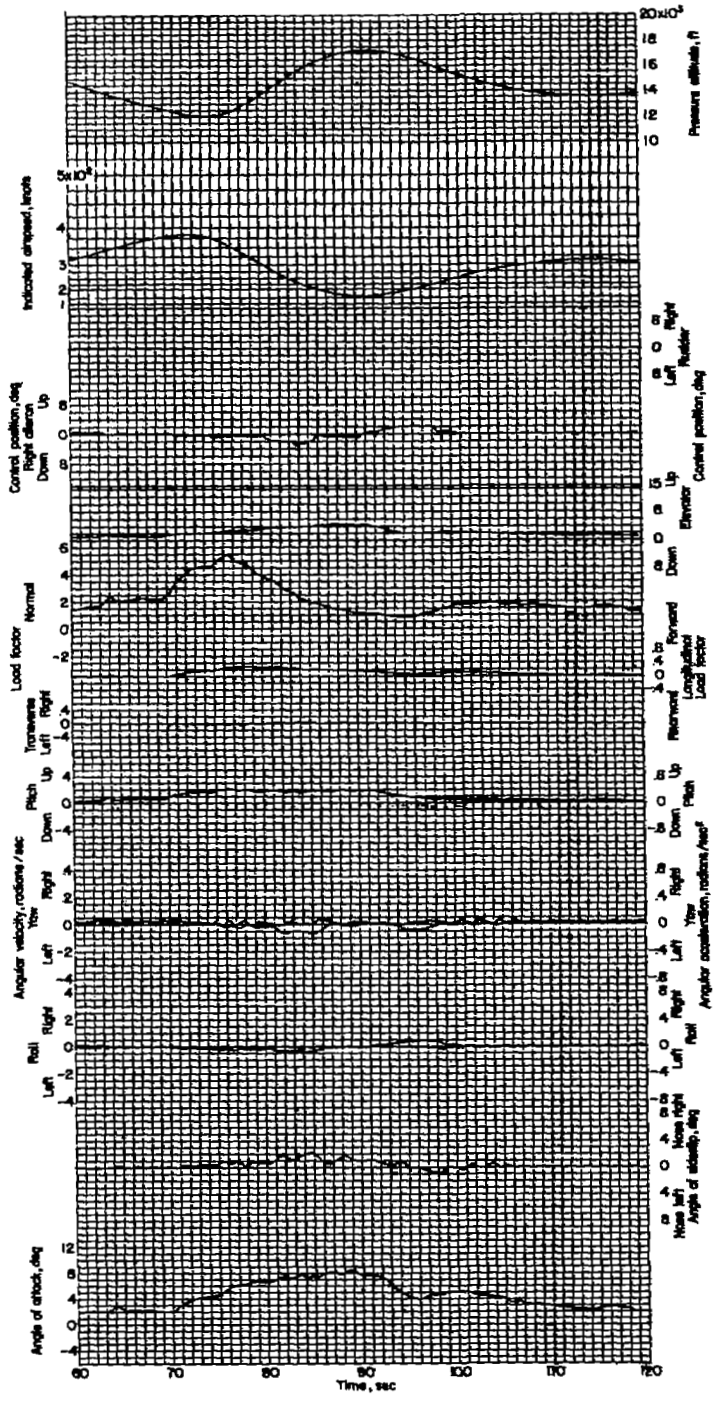
[redacted]



(a)

Figure 224.- Diving left turn into Immelman followed by dive and pull-up into chandelle. Airplane weight, 15,810 pounds; center of gravity at 24.0 percent M.A.C.; flight 13.

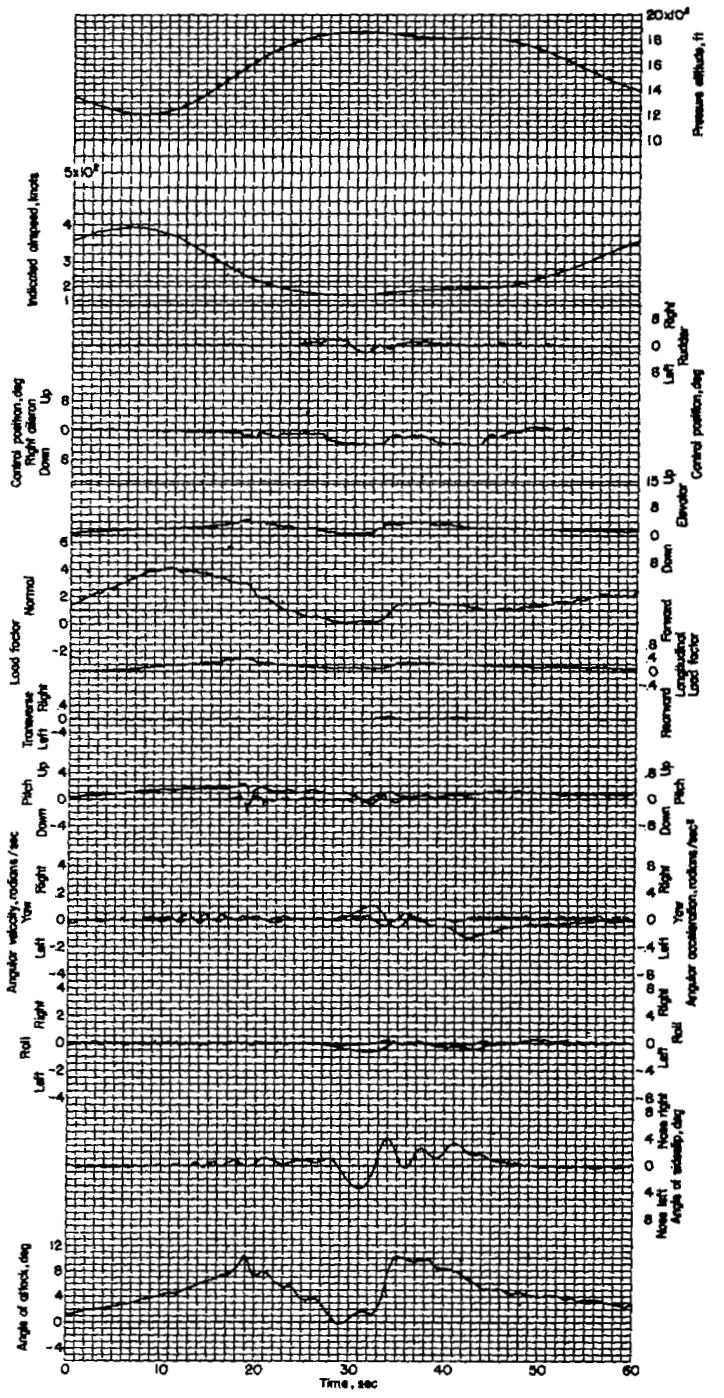
[redacted]



(b)

Figure 224.- Concluded.

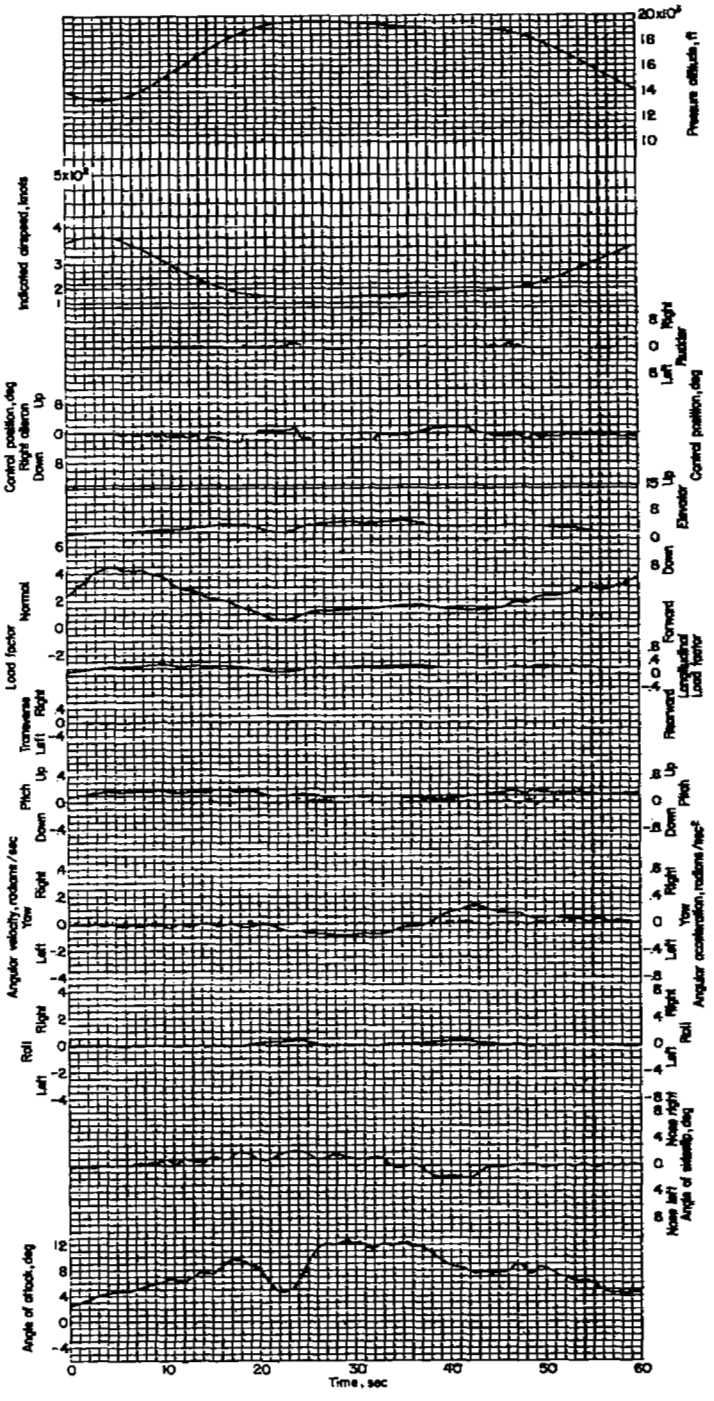
[redacted]



NACA

Figure 225.- Immelman followed by diving left turn. Airplane weight, 16,250 pounds; center of gravity at 24.3 percent M.A.C.; flight 14.

[redacted]

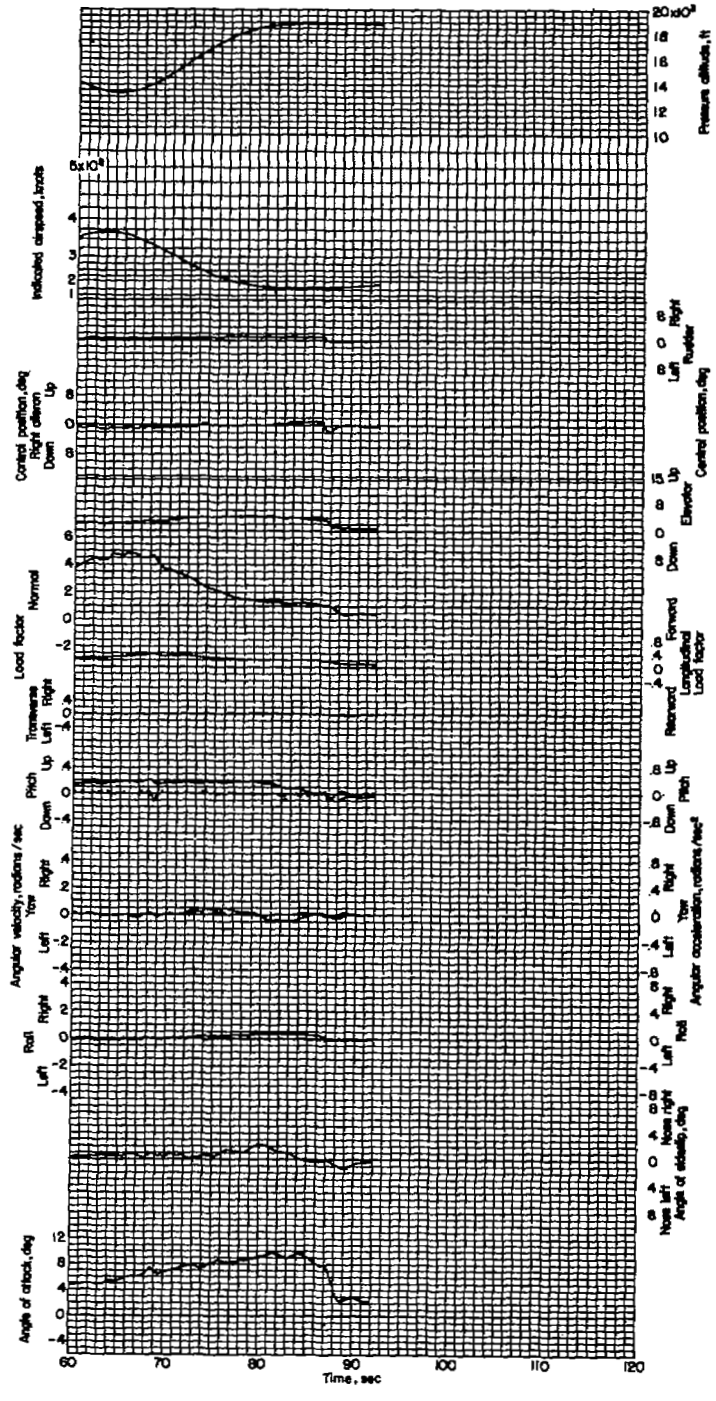


(a)

NACA

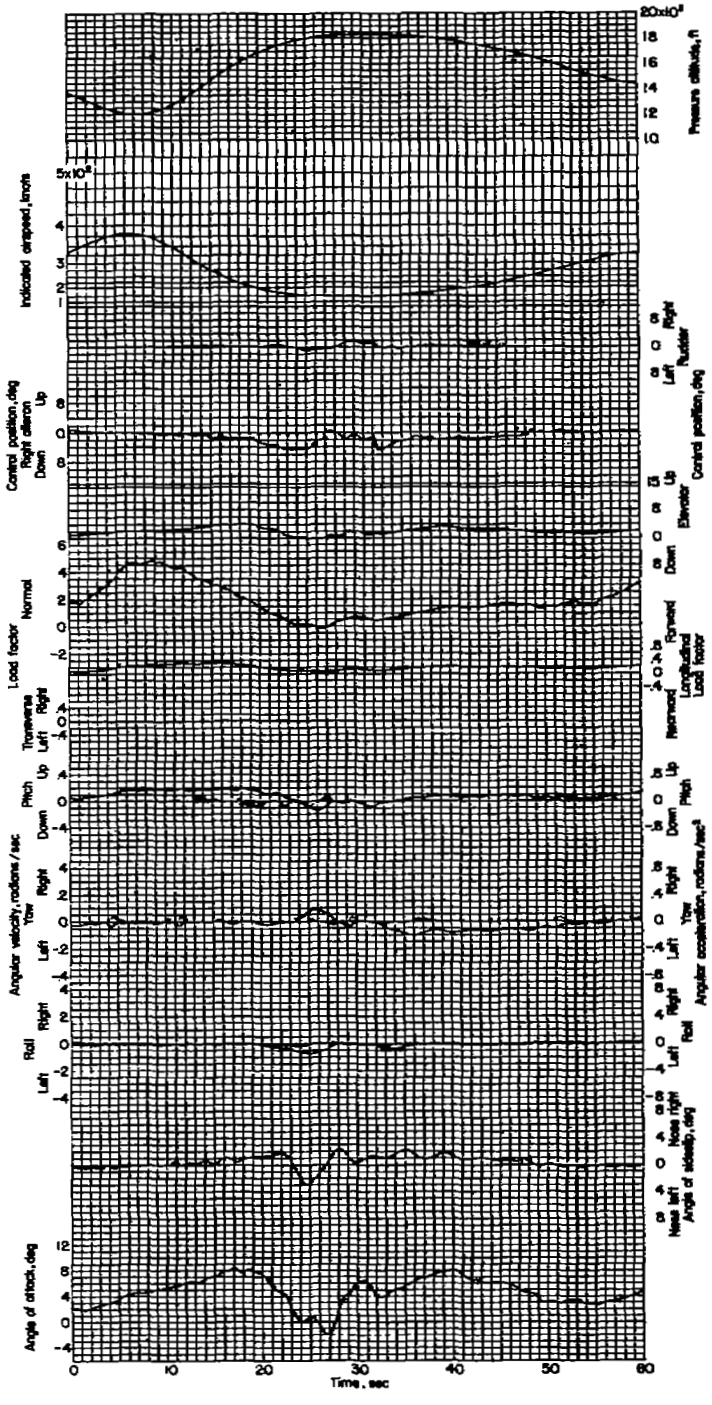
Figure 226.- Immelman followed by split-S into Immelman. Airplane weight, 16,180 pounds; center of gravity at 24.2 percent M.A.C.; flight 14.

[redacted]



(b)

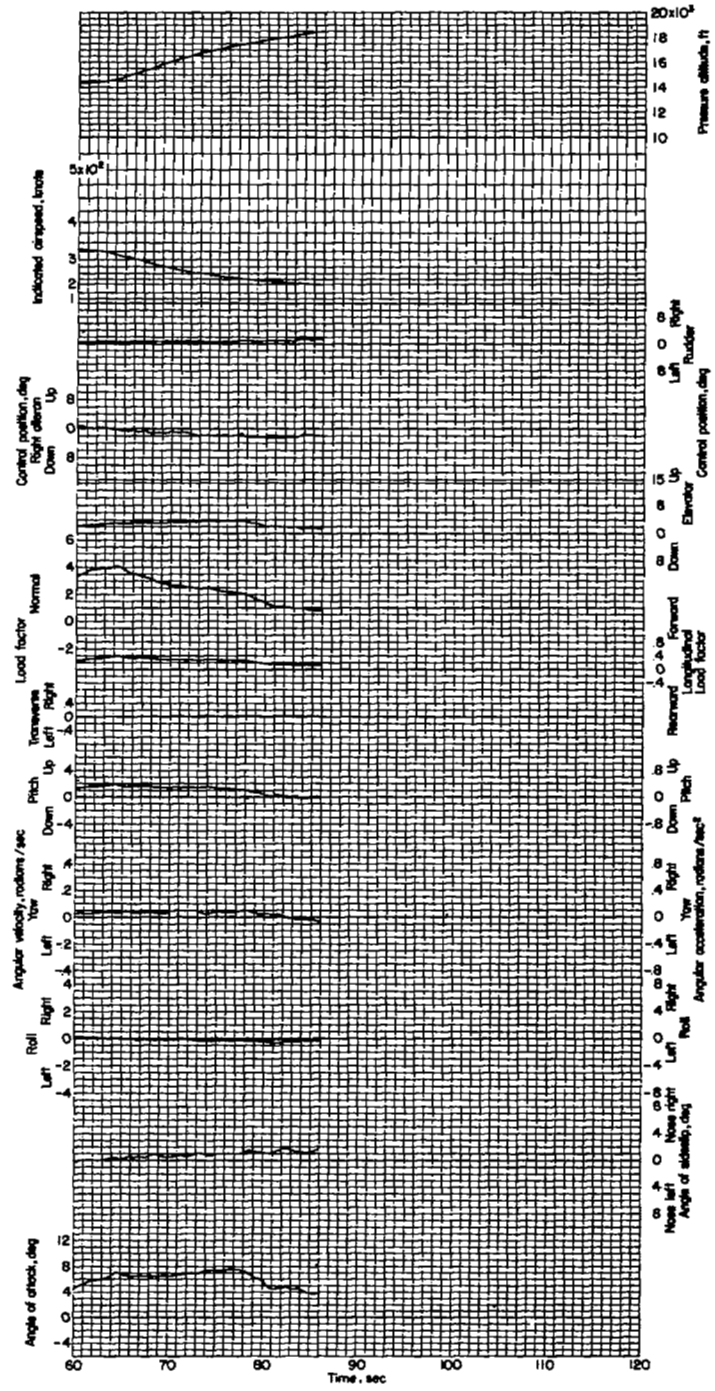
Figure 226.- Concluded.



(a)

Figure 227.- Immelman followed by diving left turn and climbing right turn. Airplane weight, 16,040 pounds; center of gravity at 24.2 percent M.A.C.; flight 14.

[redacted]



(b)

Figure 227.- Concluded.

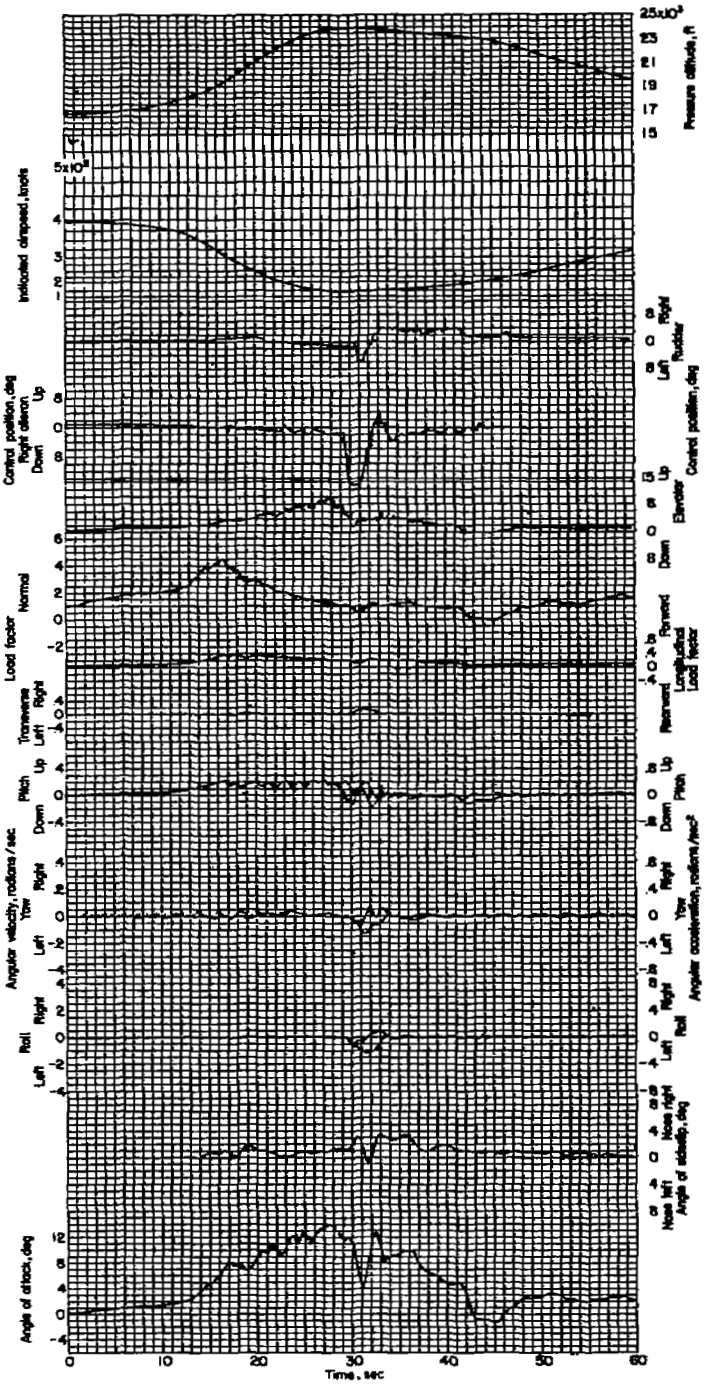
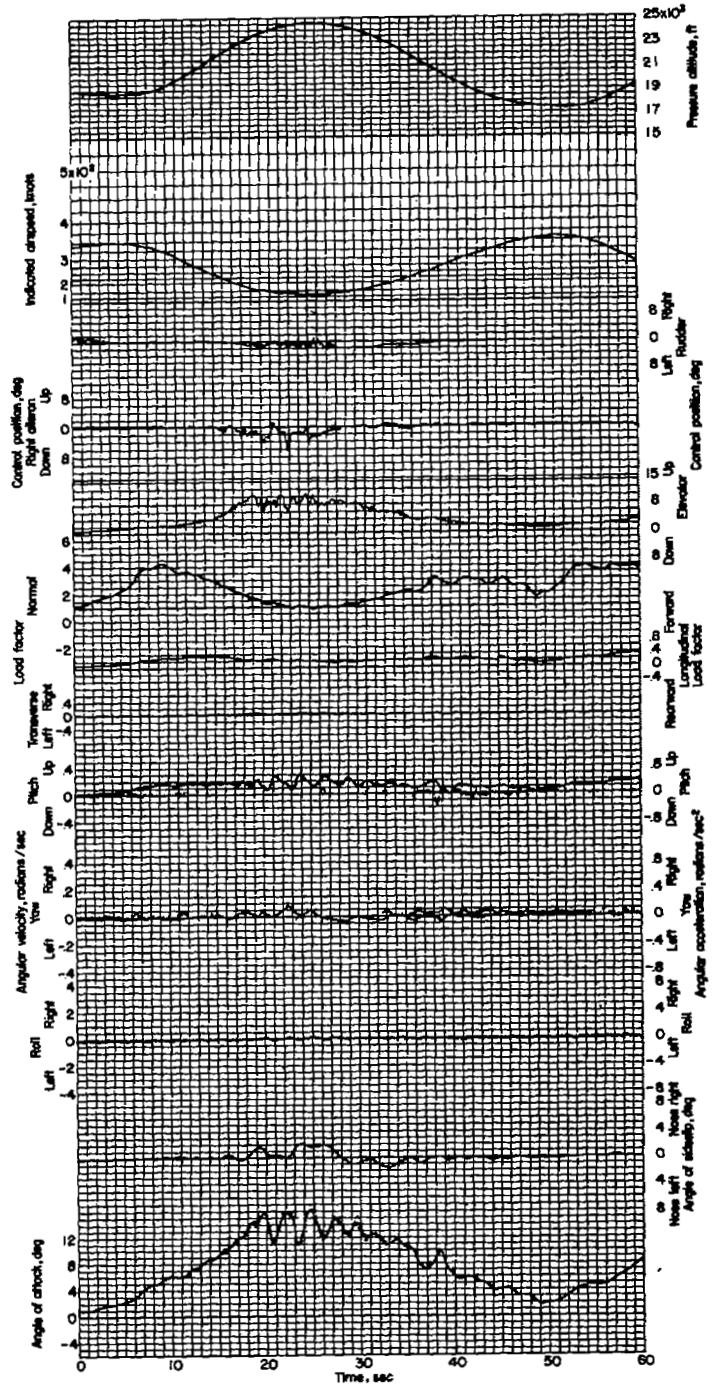


Figure 228.- Immelman. Airplane weight, 16,090 pounds; center of gravity at 24.2 percent M.A.C.; flight 16.

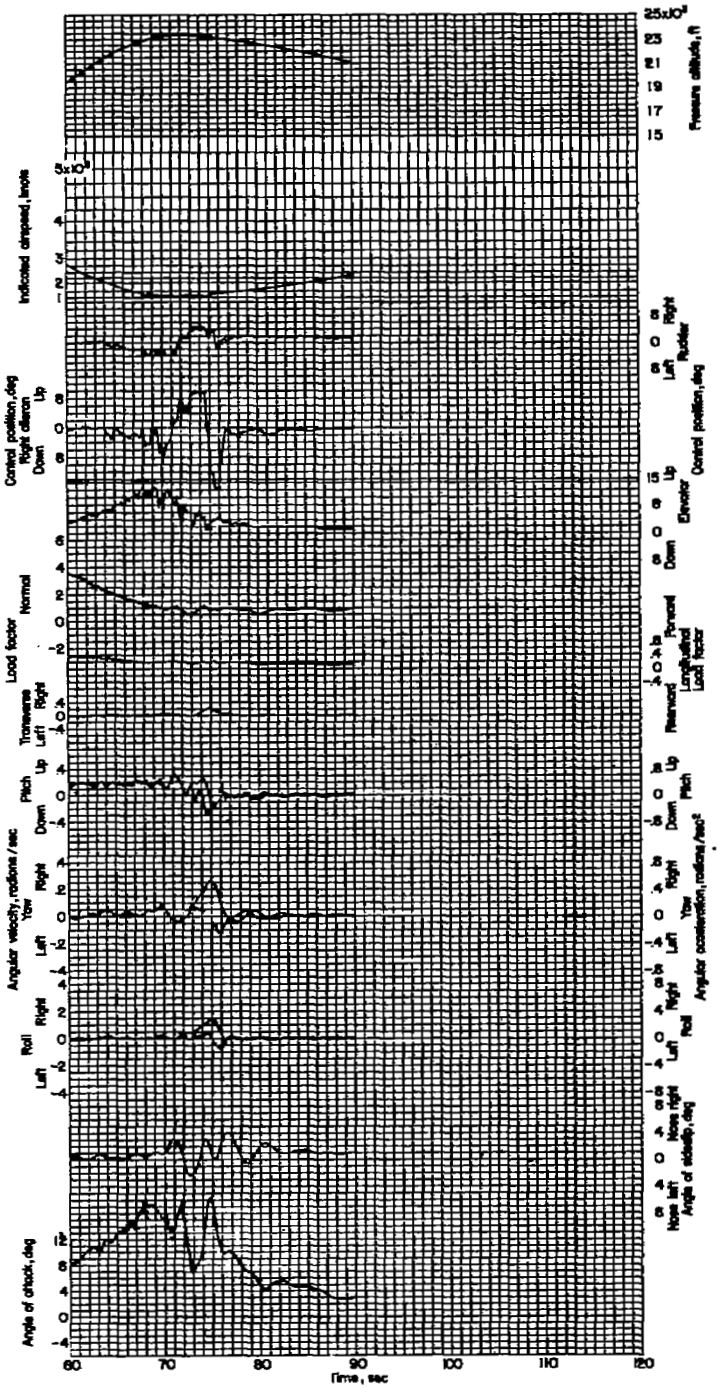


(a)

NACA

Figure 229.- Loop followed by Immelman. Airplane weight, 16,140 pounds; center of gravity at 24.2 percent M.A.C.; flight 18.

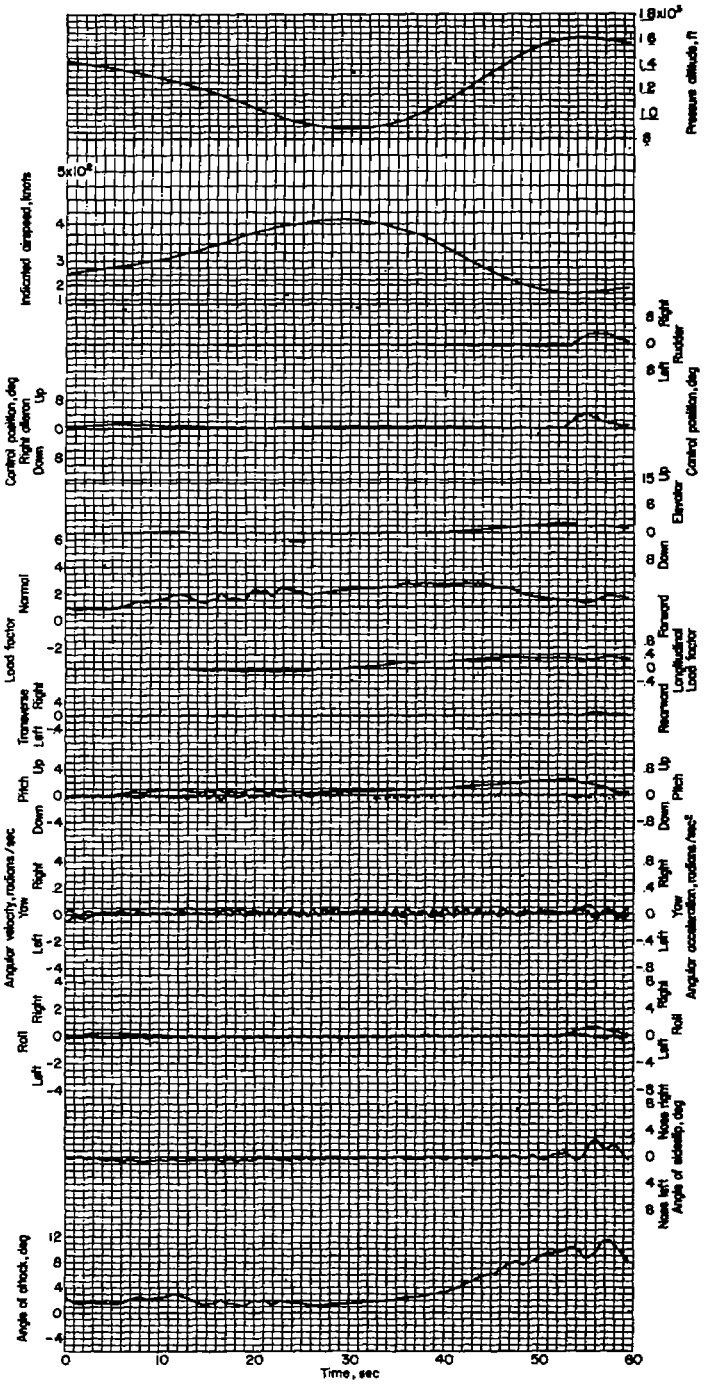
[redacted]



(b)

Figure 229.- Concluded.

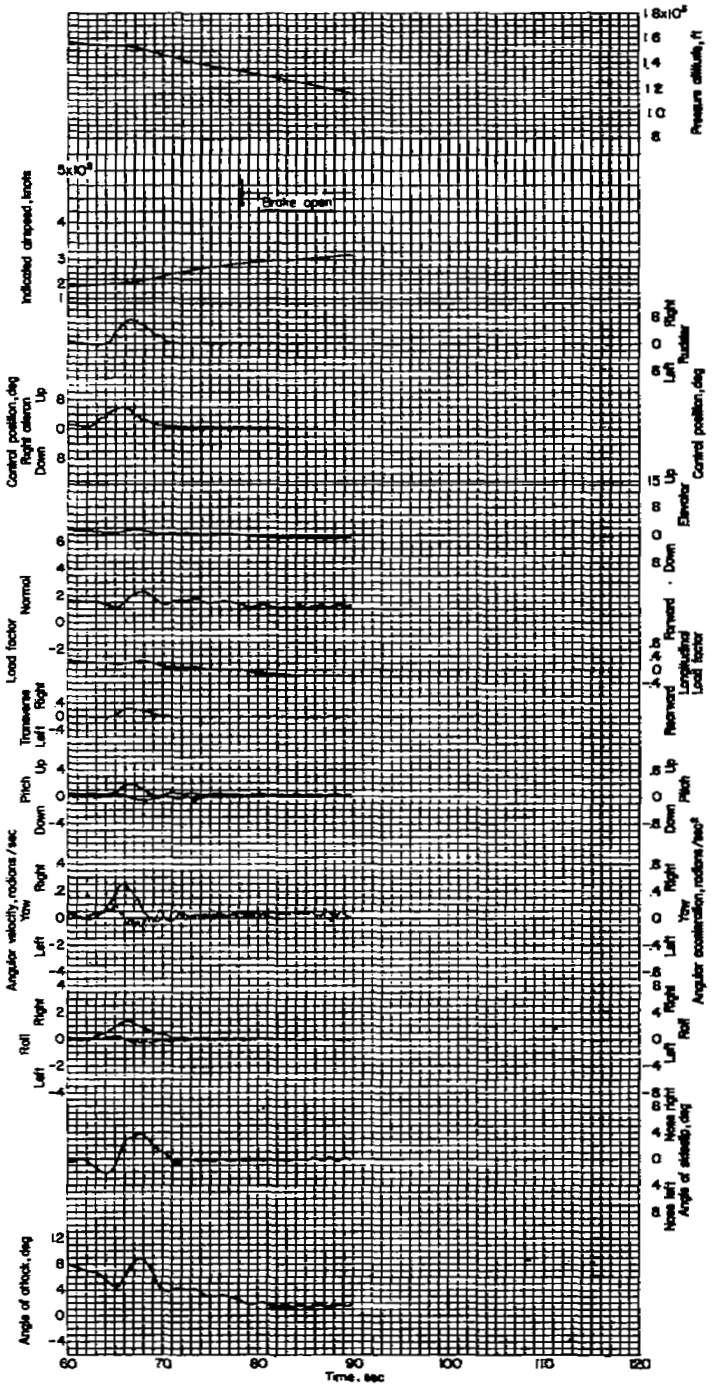
[redacted]



(a)

Figure 230.- Diving right turn into Immelman followed by right aileron roll. Airplane weight, 13,470 pounds; center of gravity at 25.7 percent M.A.C.; flight 19.

[redacted]



(b)

Figure 230.- Concluded.

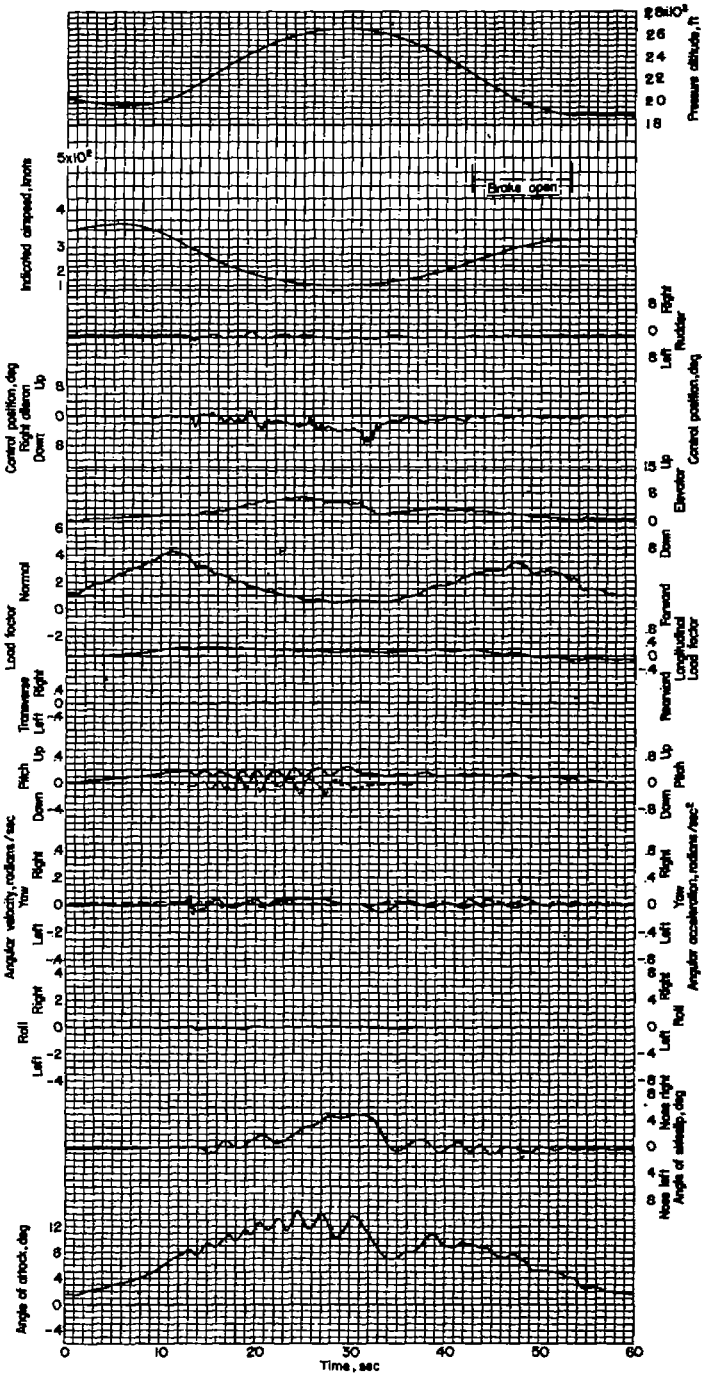
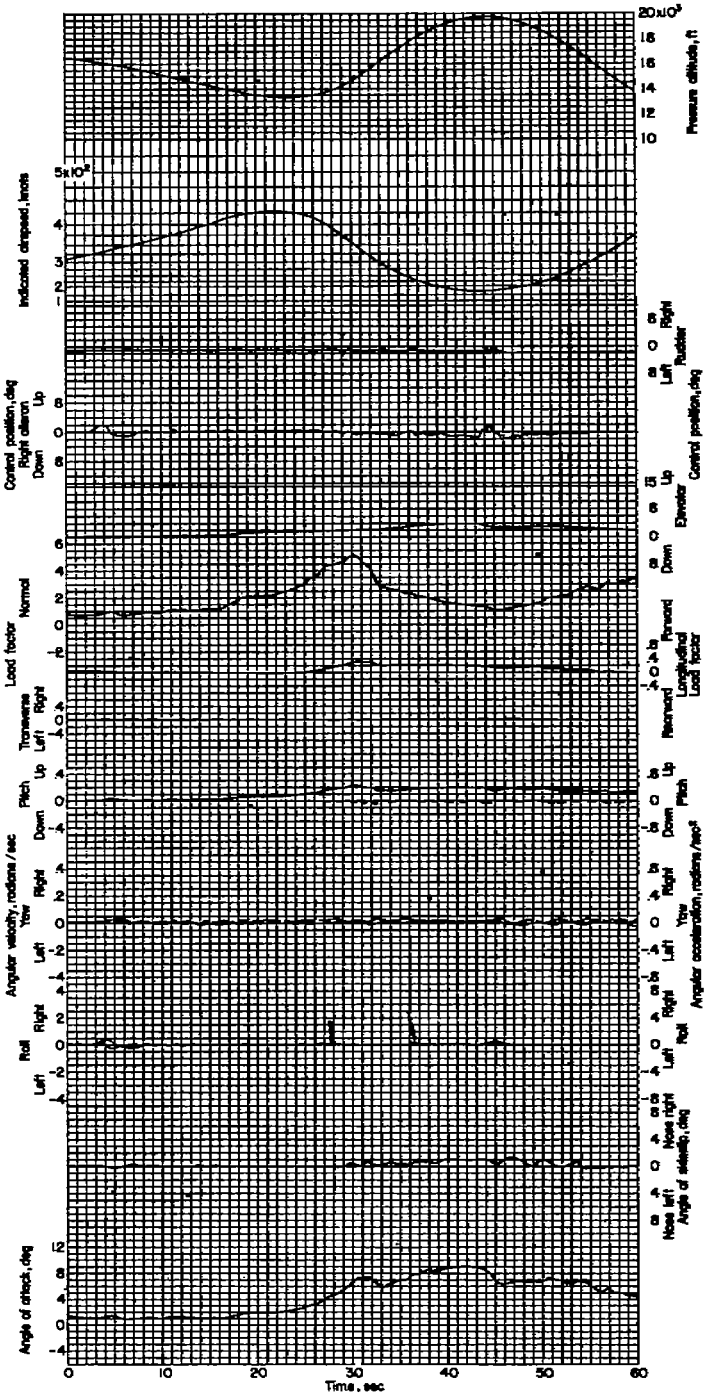


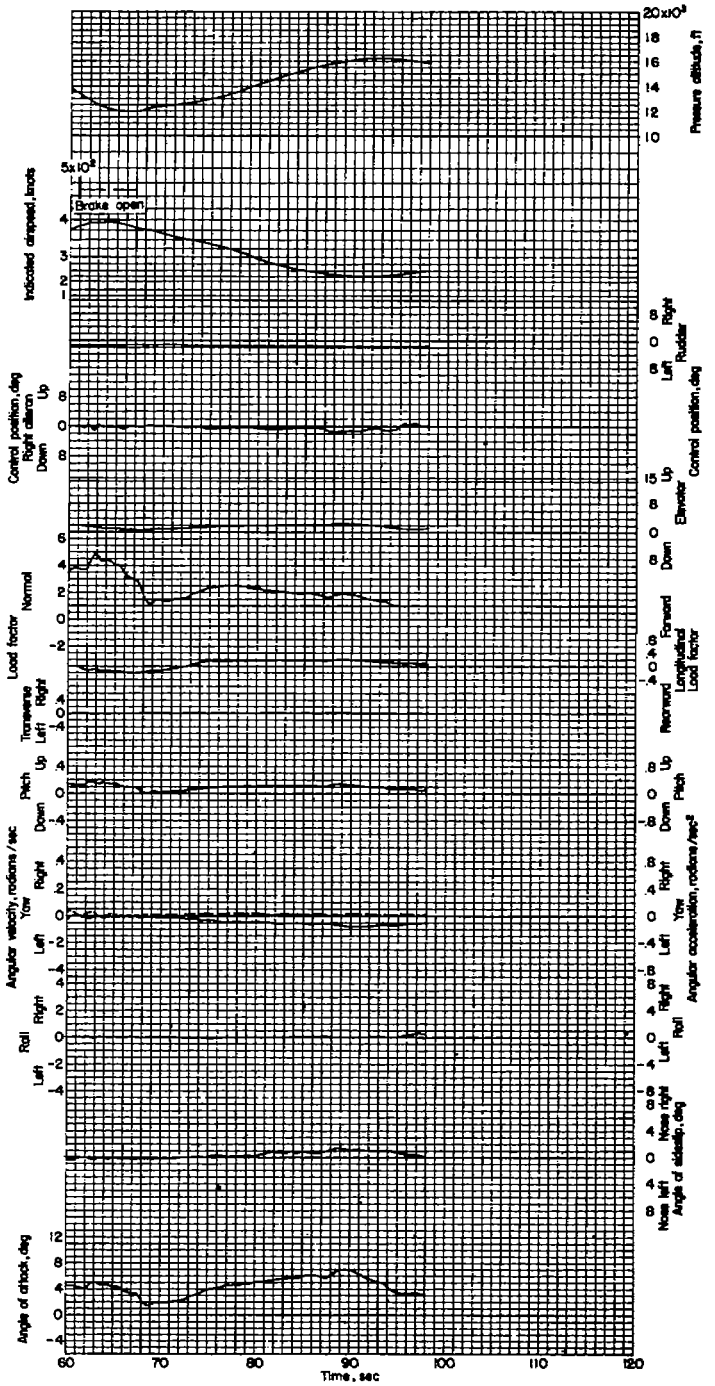
Figure 231.- Loop. Airplane weight, 17,690 pounds; center of gravity at 25.0 percent M.A.C.; flight 2.

[redacted]



(a)

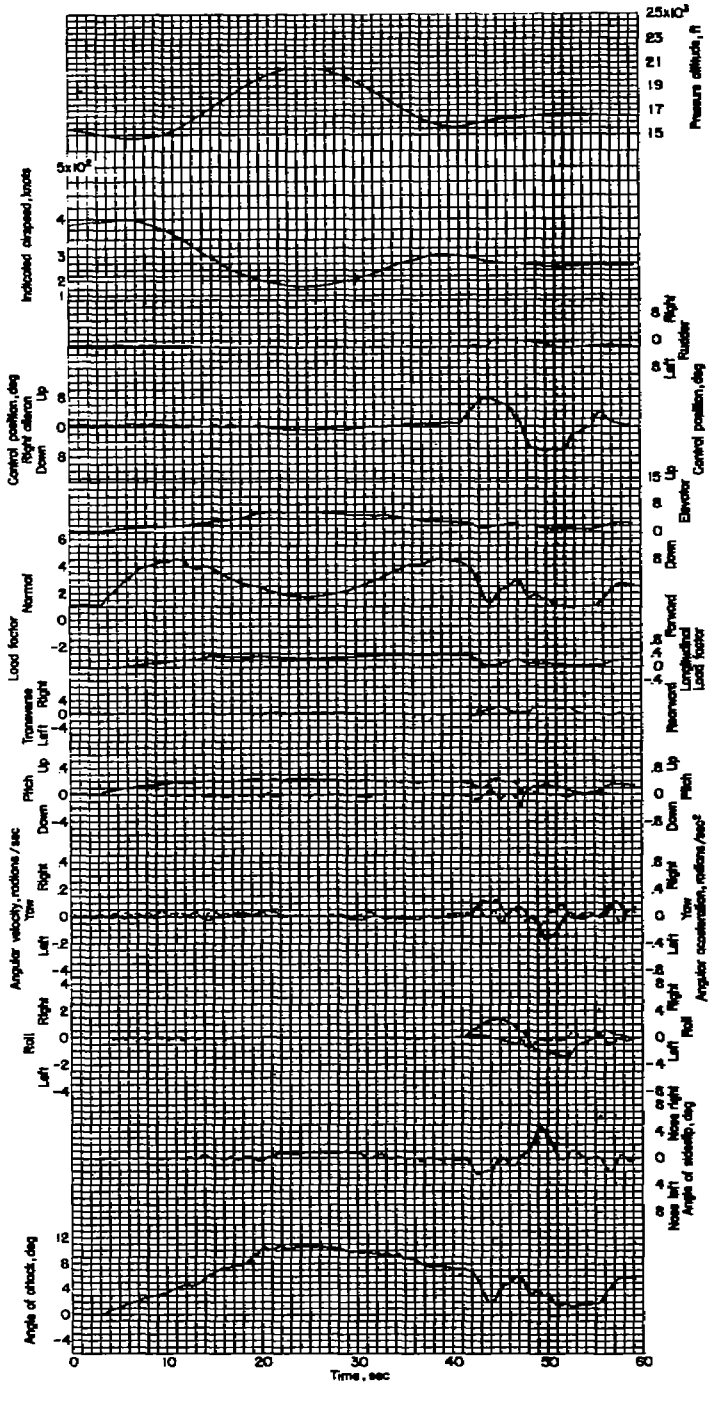
Figure 232.- Loop followed by climbing left turn. Airplane weight, 17,330 pounds; center of gravity at 24.8 percent M.A.C.; flight 2.



(b)

Figure 232.- Concluded.

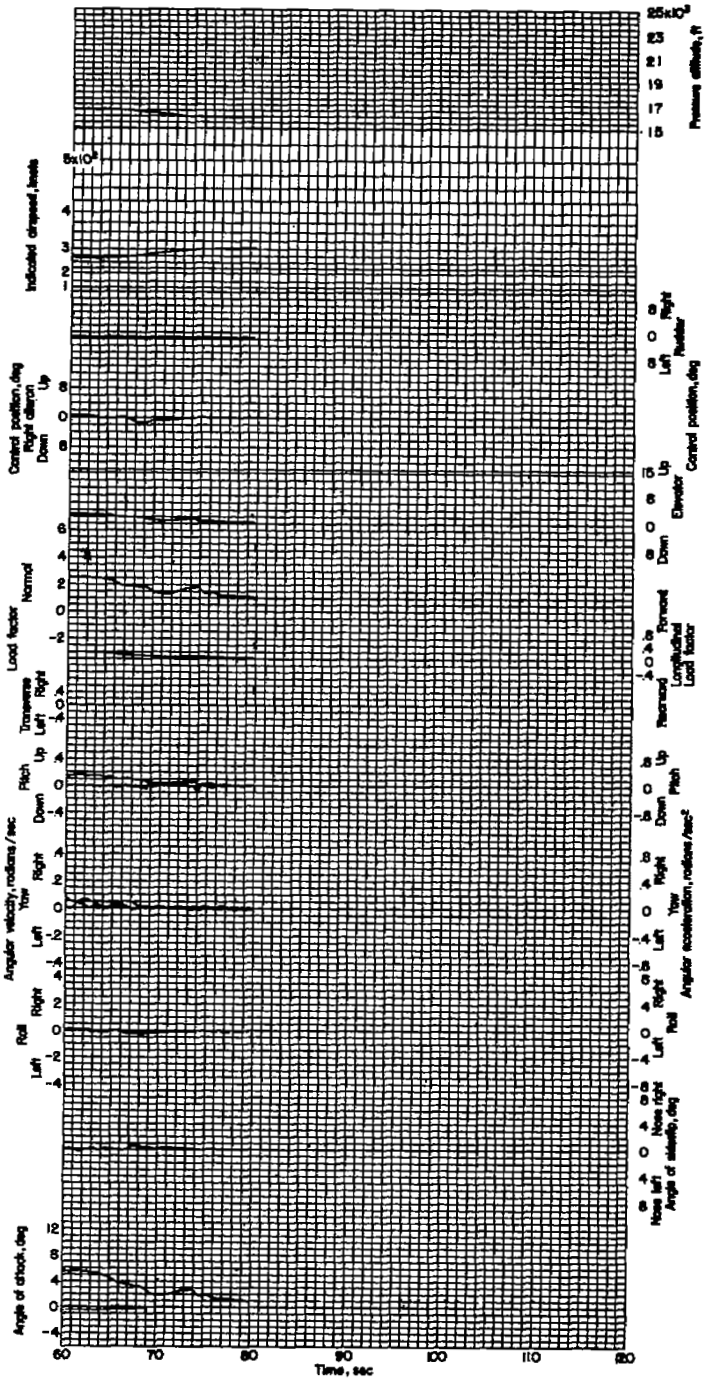
[redacted]



(a)

Figure 233.- Loop followed by right and left aileron roll. Airplane weight, 15,900 pounds; center of gravity at 24.1 percent M.A.C.; flight 2.

[redacted]



(b)

Figure 233.- Concluded.

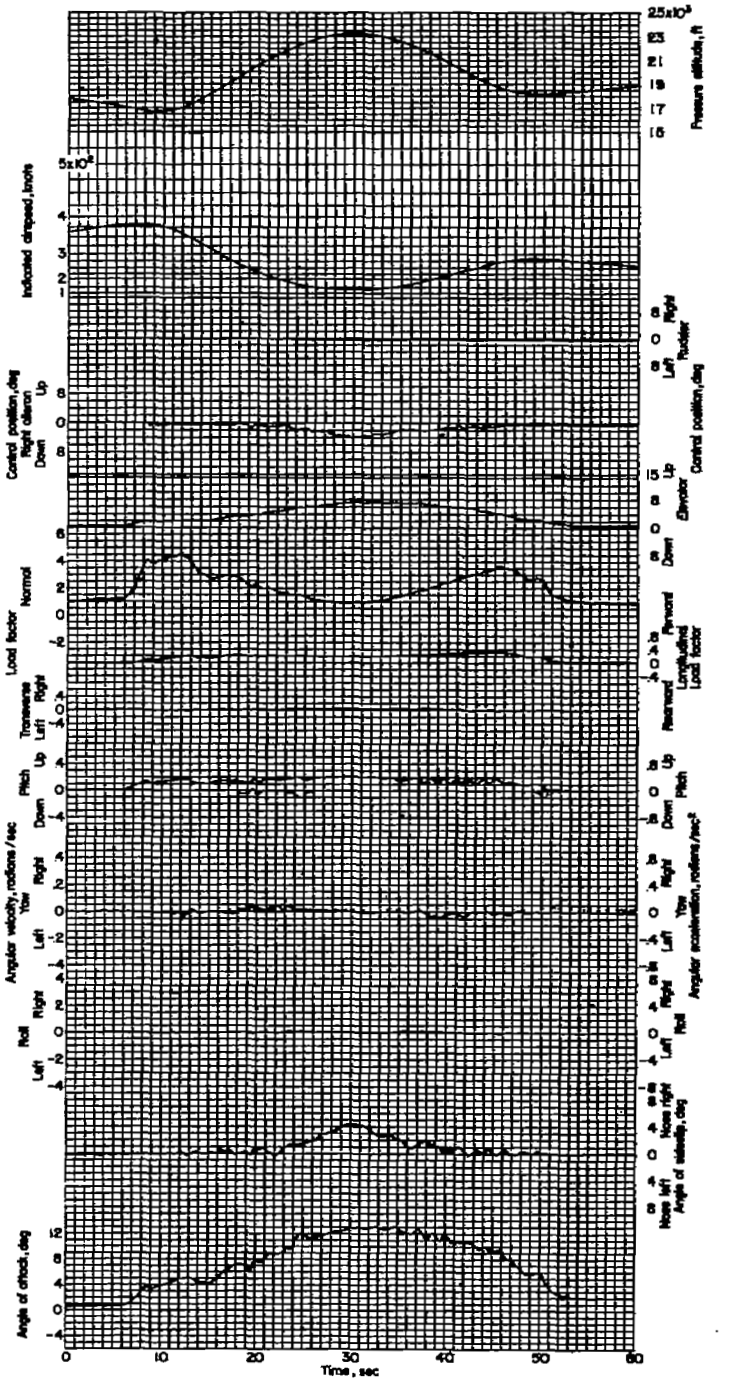
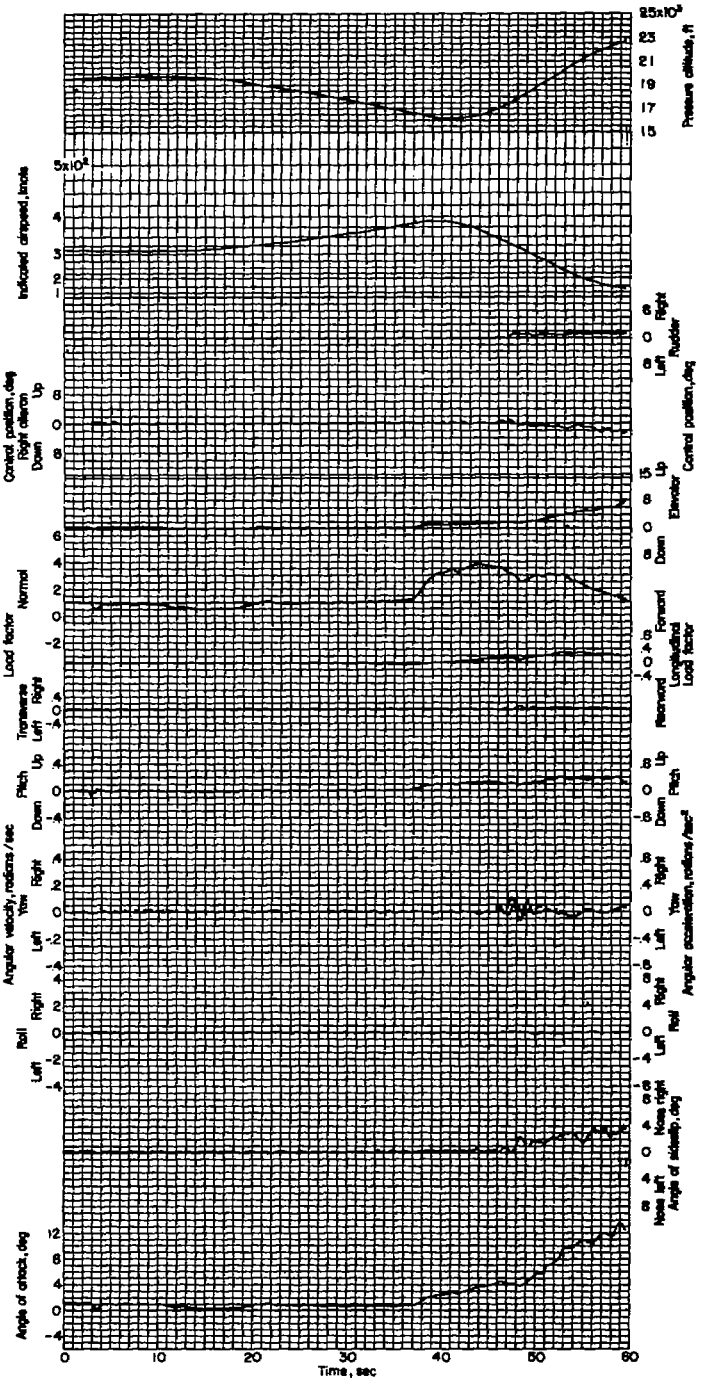


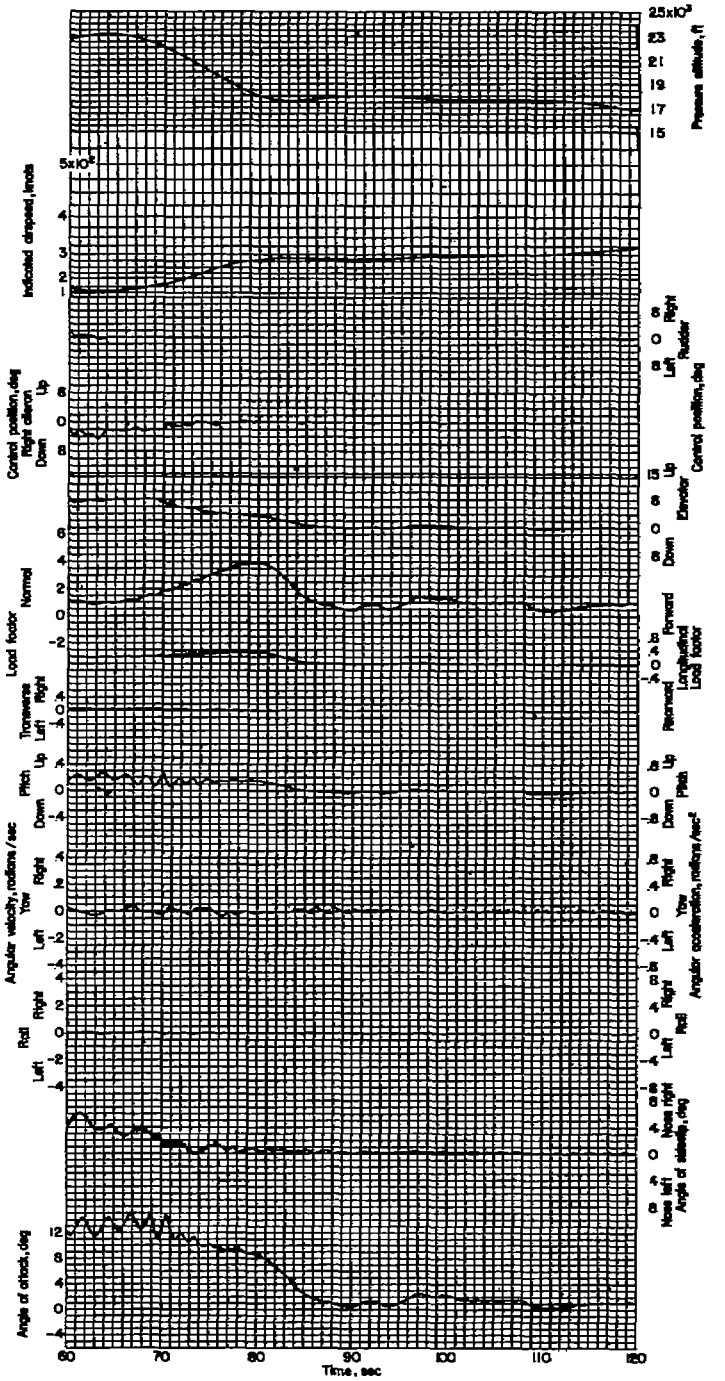
Figure 234.- Loop. Airplane weight, 15,910 pounds; center of gravity at 24.1 percent M.A.C.; flight 3.



(a)

Figure 235.- Loop. Airplane weight, 15,350 pounds; center of gravity at 23.9 percent M.A.C.; flight 3.

[redacted]



(b)

Figure 235.- Concluded.

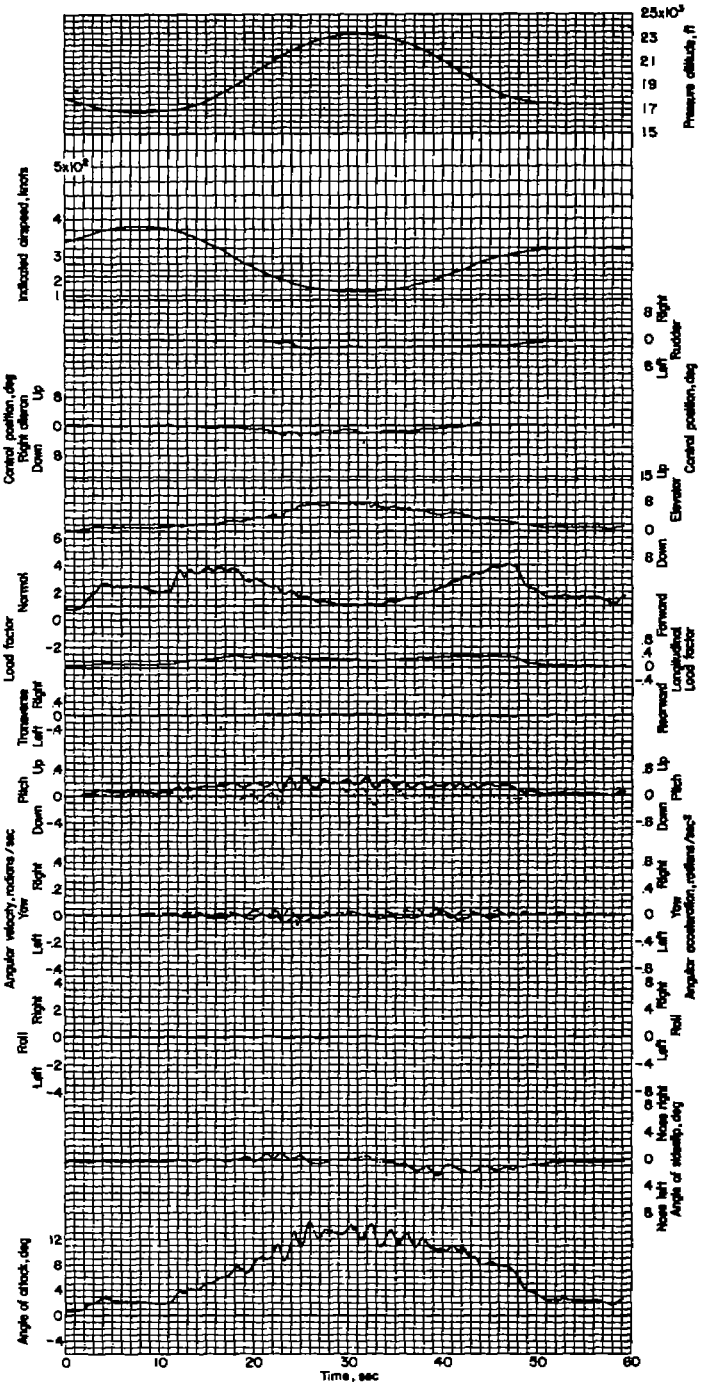
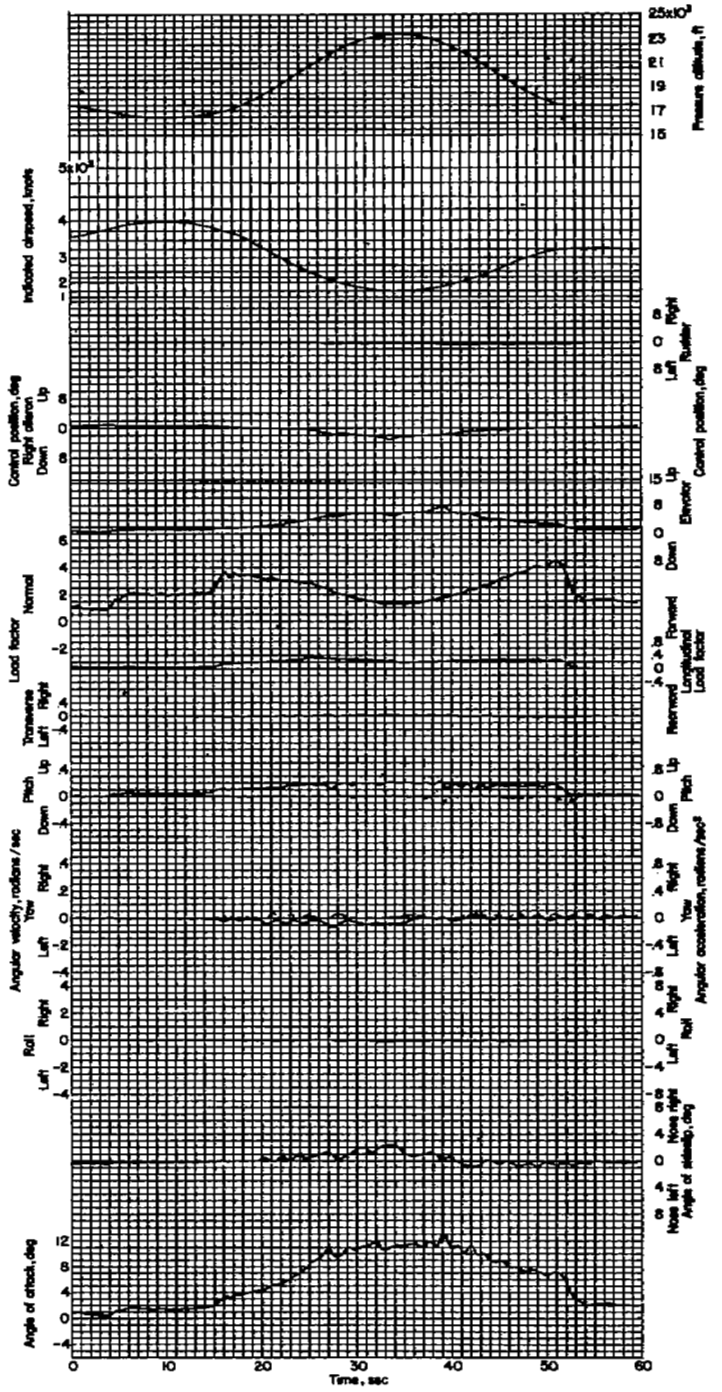


Figure 236.- Loop. Airplane weight, 16,040 pounds; center of gravity at 24.1 percent M.A.C.; flight 10.

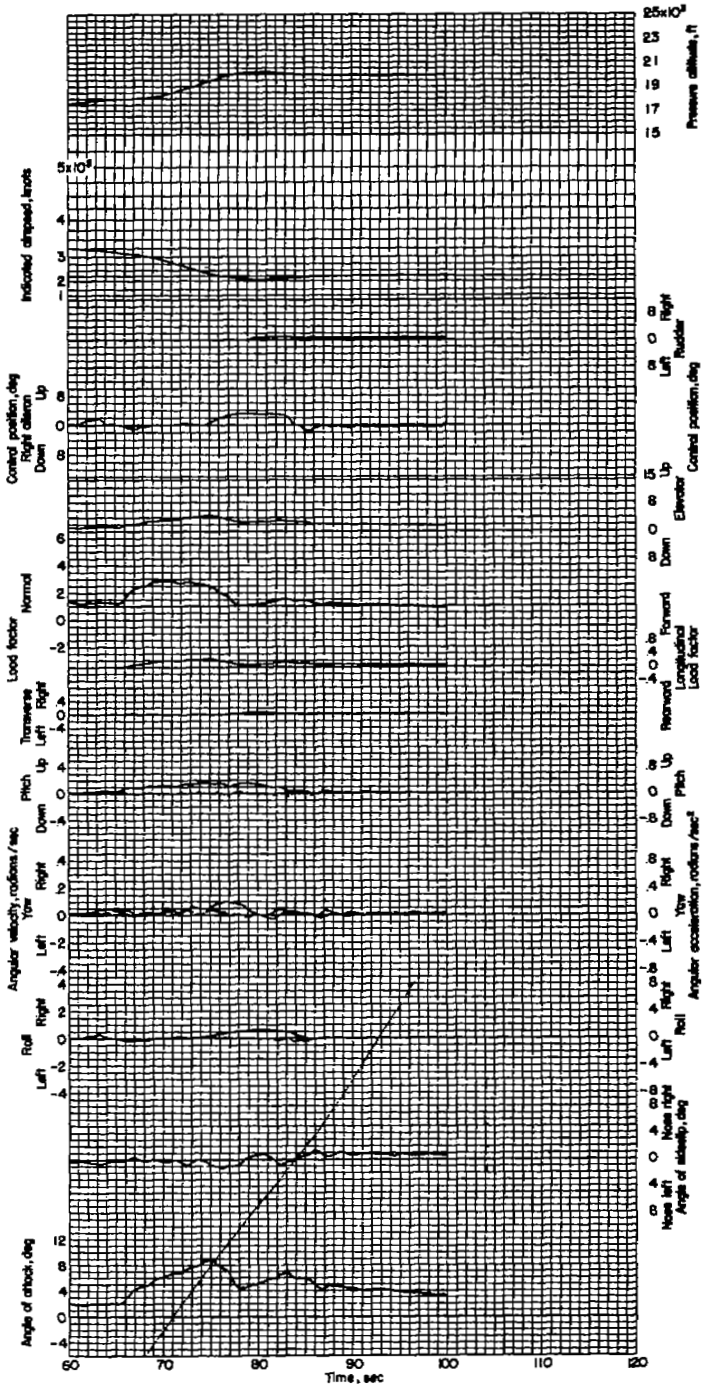
[redacted]



(a)

Figure 237.- Loop followed by chandelle with three-quarter right-roll recovery. Airplane weight, 15,890 pounds; center of gravity at 24.1 percent M.A.C.; flight 10.

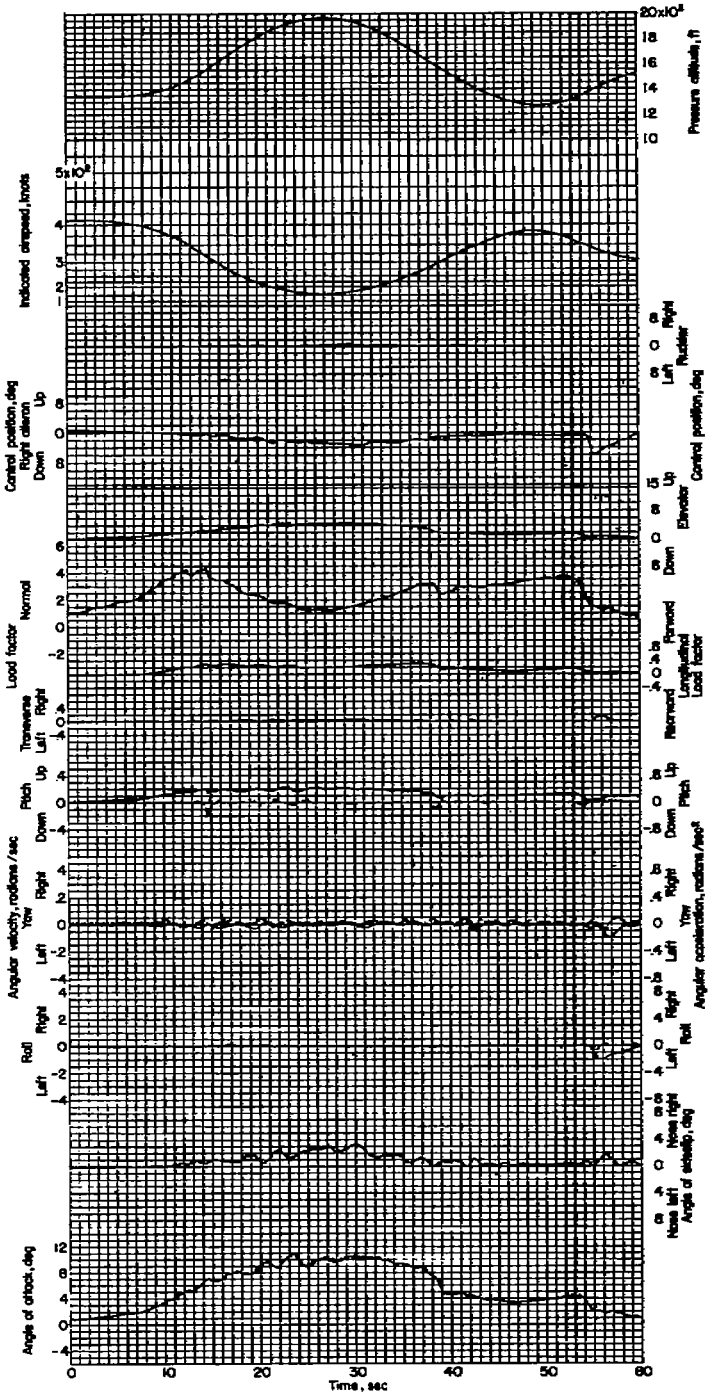
[redacted]



(b)

Figure 237.- Concluded.

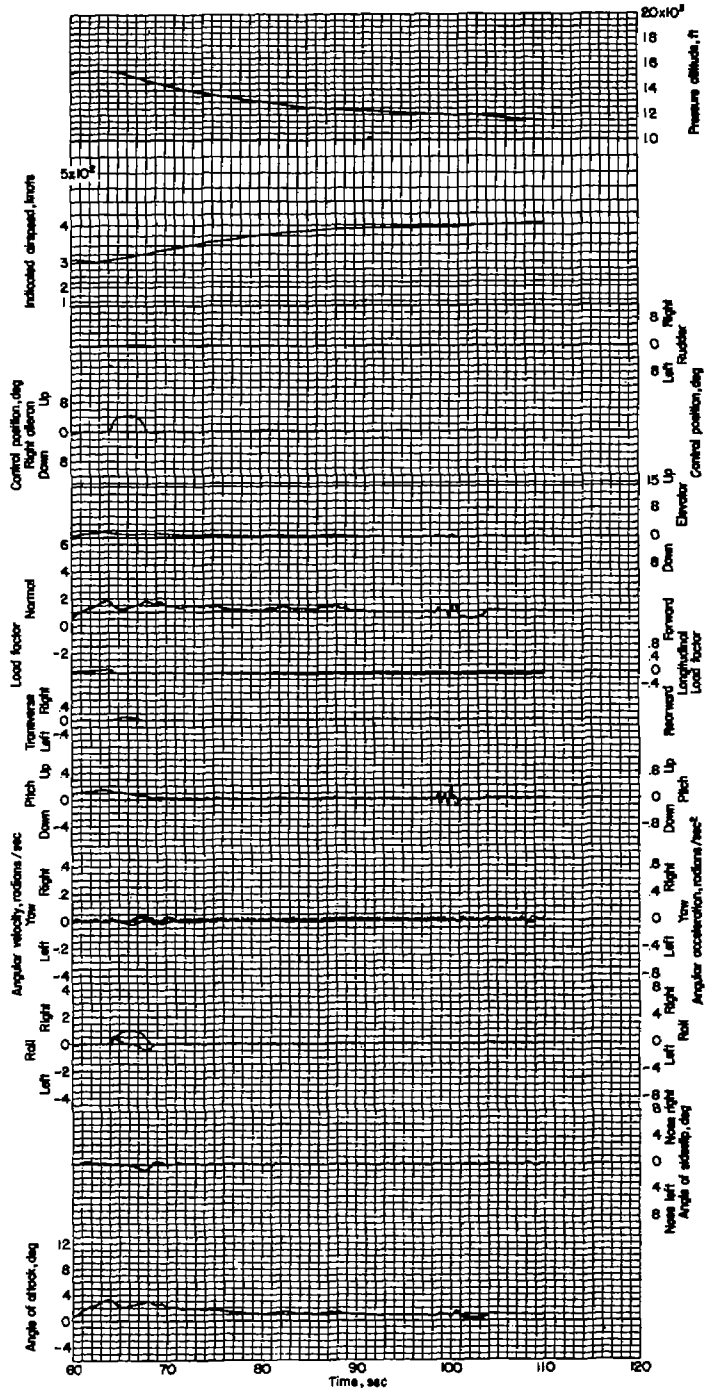
[redacted]



(a)

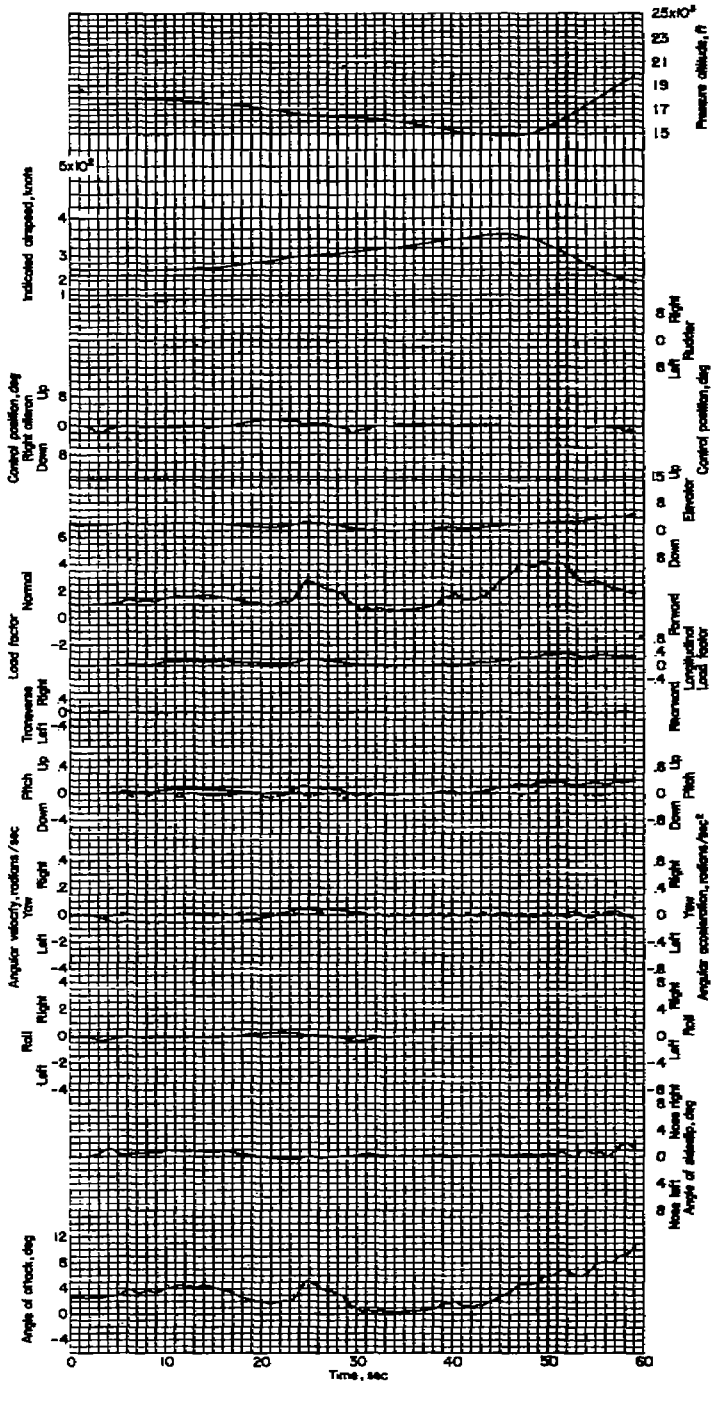
Figure 238.- Loop followed by vertical recovery. Airplane weight, 16,220 pounds; center of gravity at 24.3 percent M.A.C.; flight 11.

[redacted]



(b)

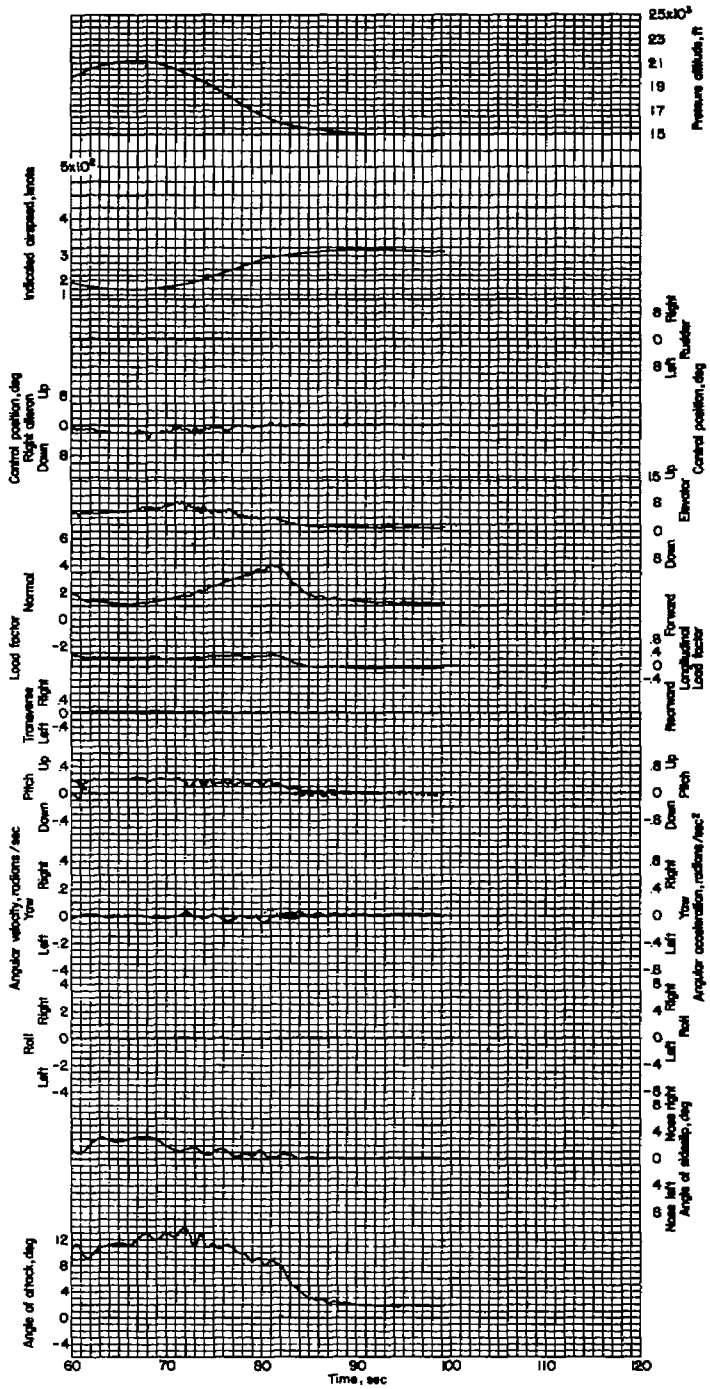
Figure 238.- Concluded.



(a)

Figure 239.- Left and right turn followed by loop. Airplane weight, 16,180 pounds; center of gravity at 24.2 percent M.A.C.; flight 12.

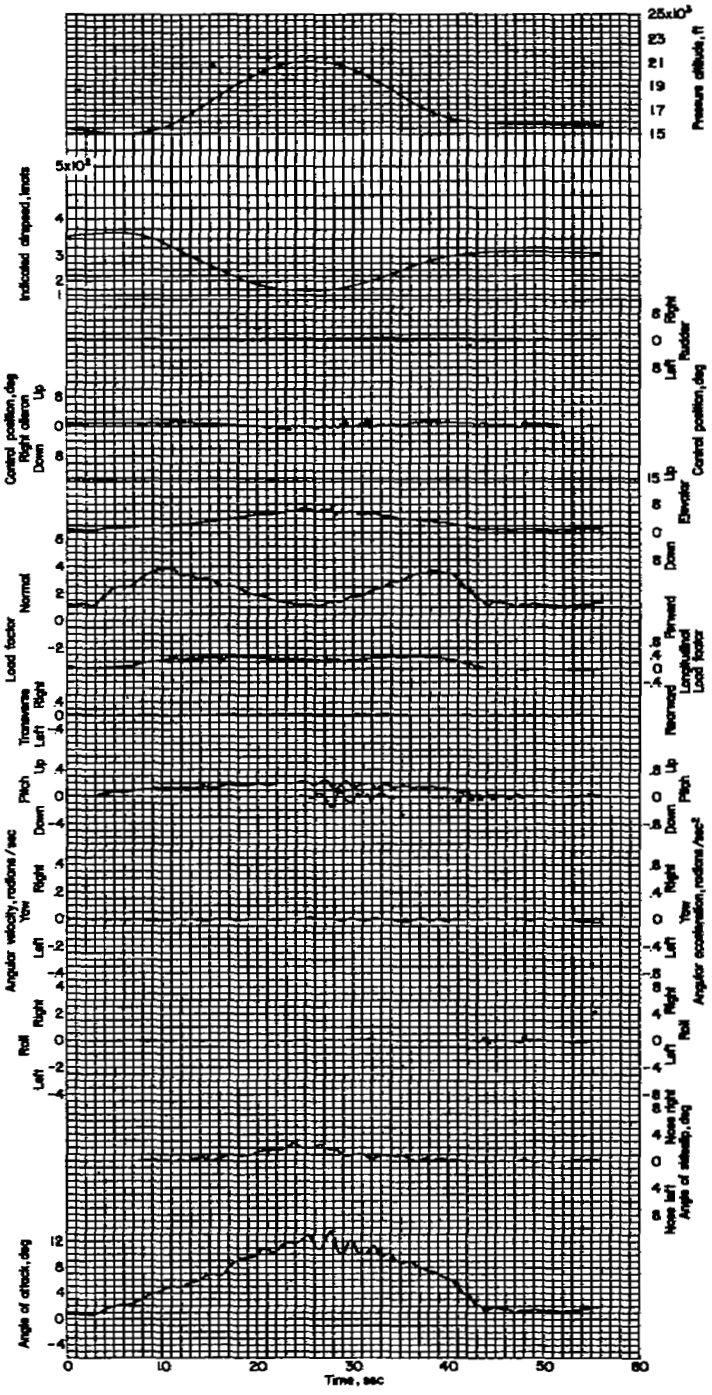
[redacted]



(b)

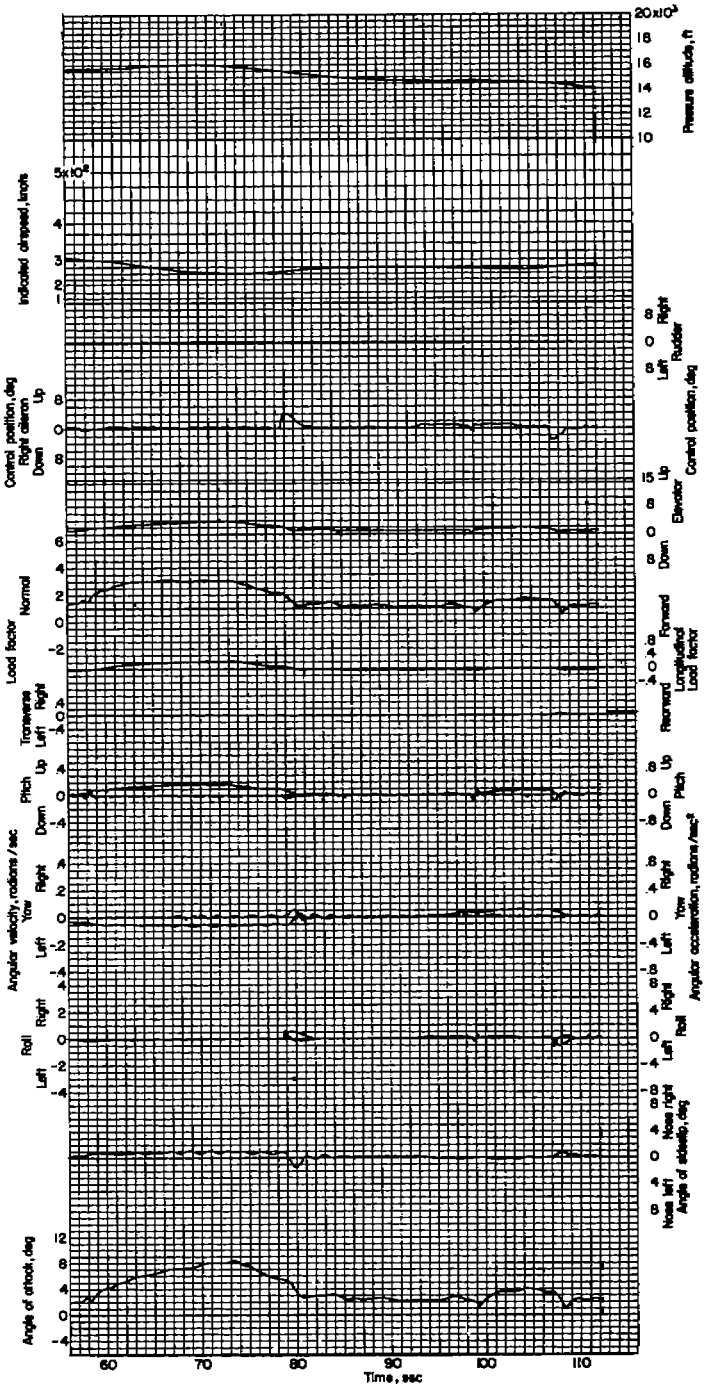
Figure 239.- Concluded.

[redacted]



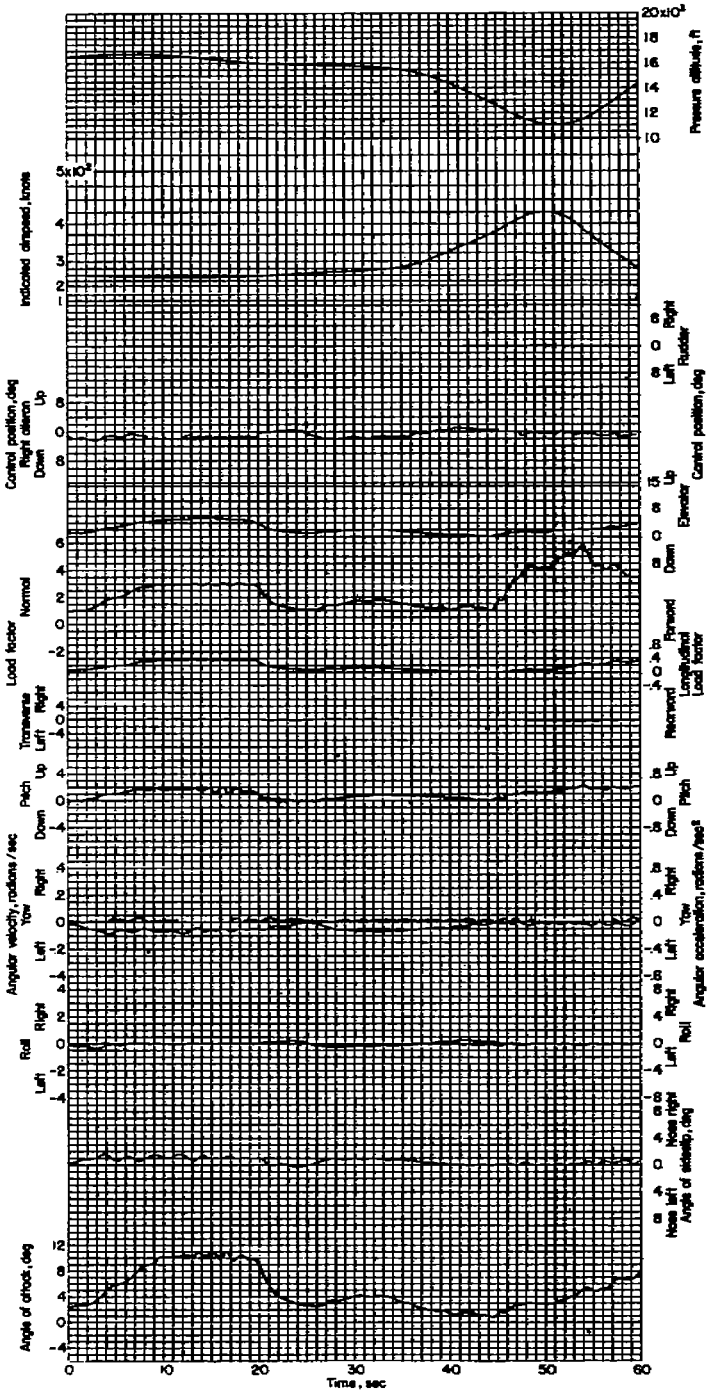
(a)

Figure 240.- Loop followed by left and right turn. Airplane weight, 14,840 pounds; center of gravity at 24.6 percent M.A.C.; flight 12. (Note: In this fig. only, time scale should be multiplied by 1.07.)



(b)

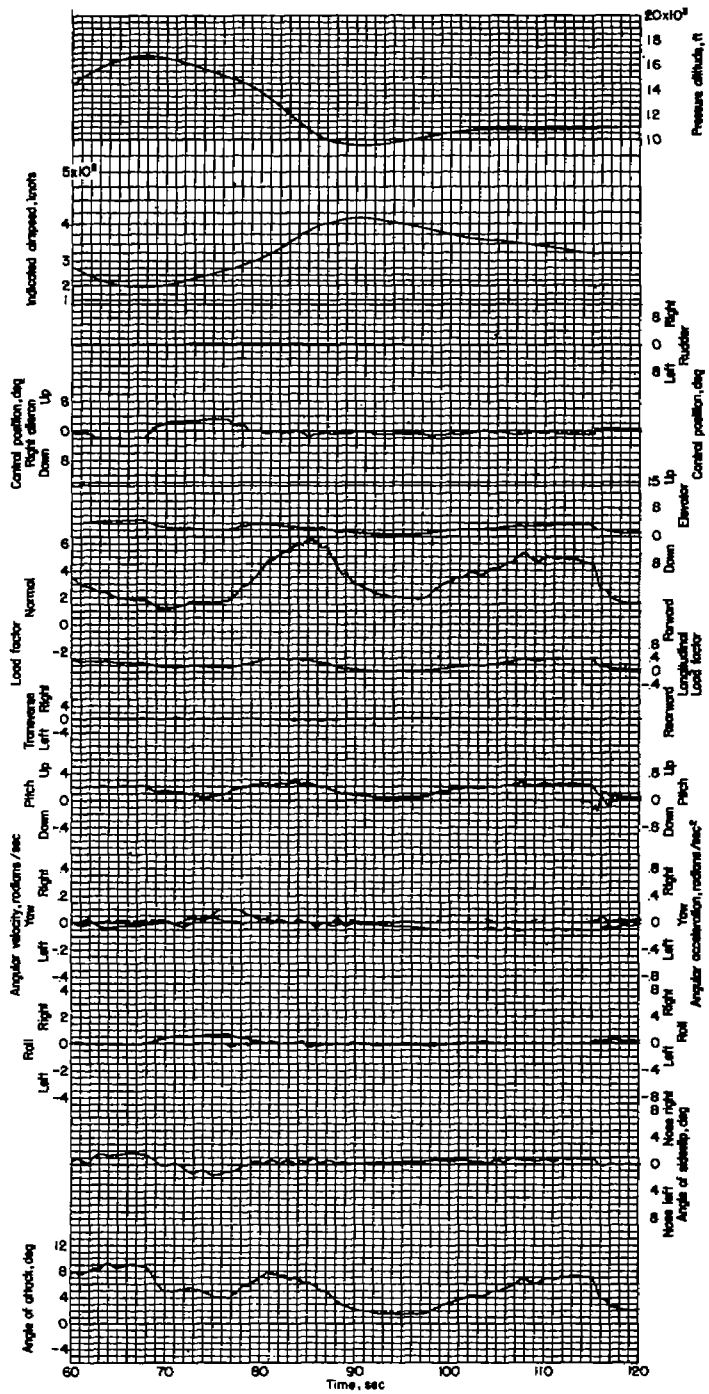
Figure 240.- Concluded.



(a)

Figure 241.- Left turn and dive into loop, with right aileron roll at top, followed by left turn. Airplane weight, 16,040 pounds; center of gravity at 24.1 percent M.A.C.; flight 13.

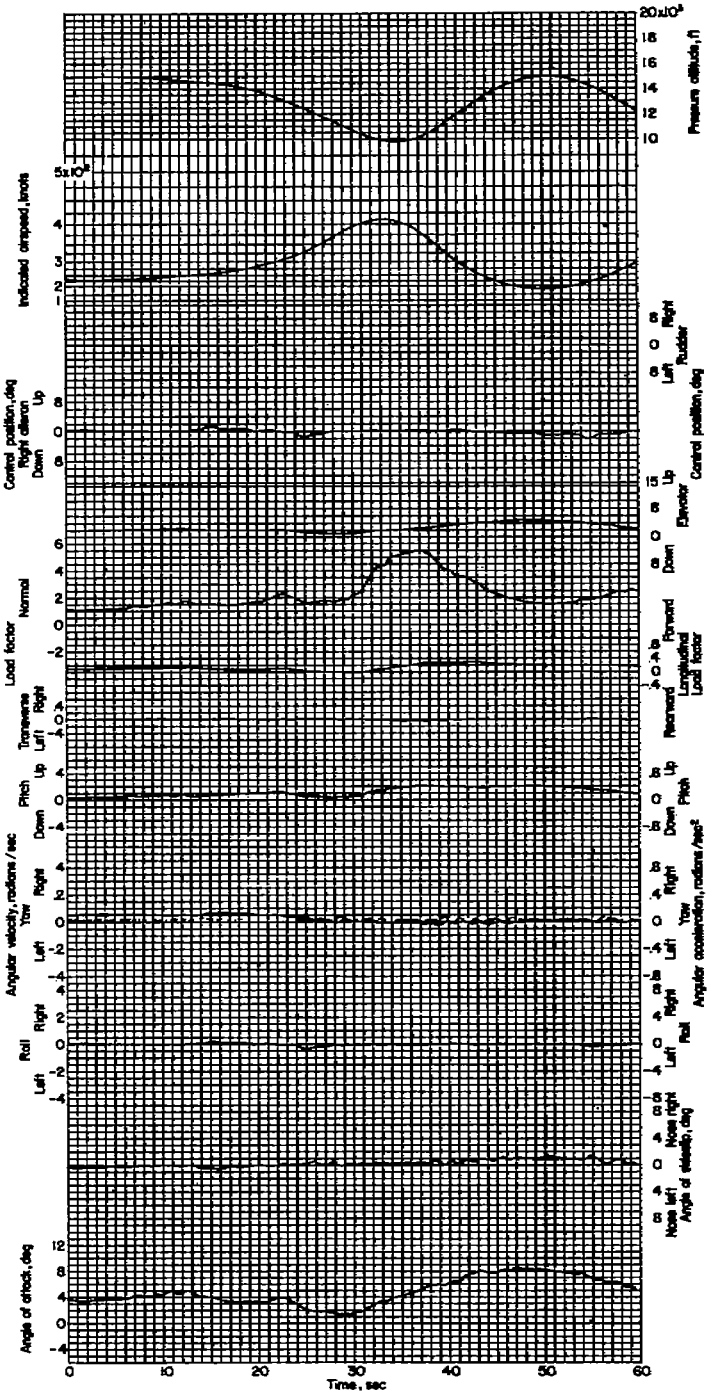
[redacted]



(b)

Figure 241.- Concluded.

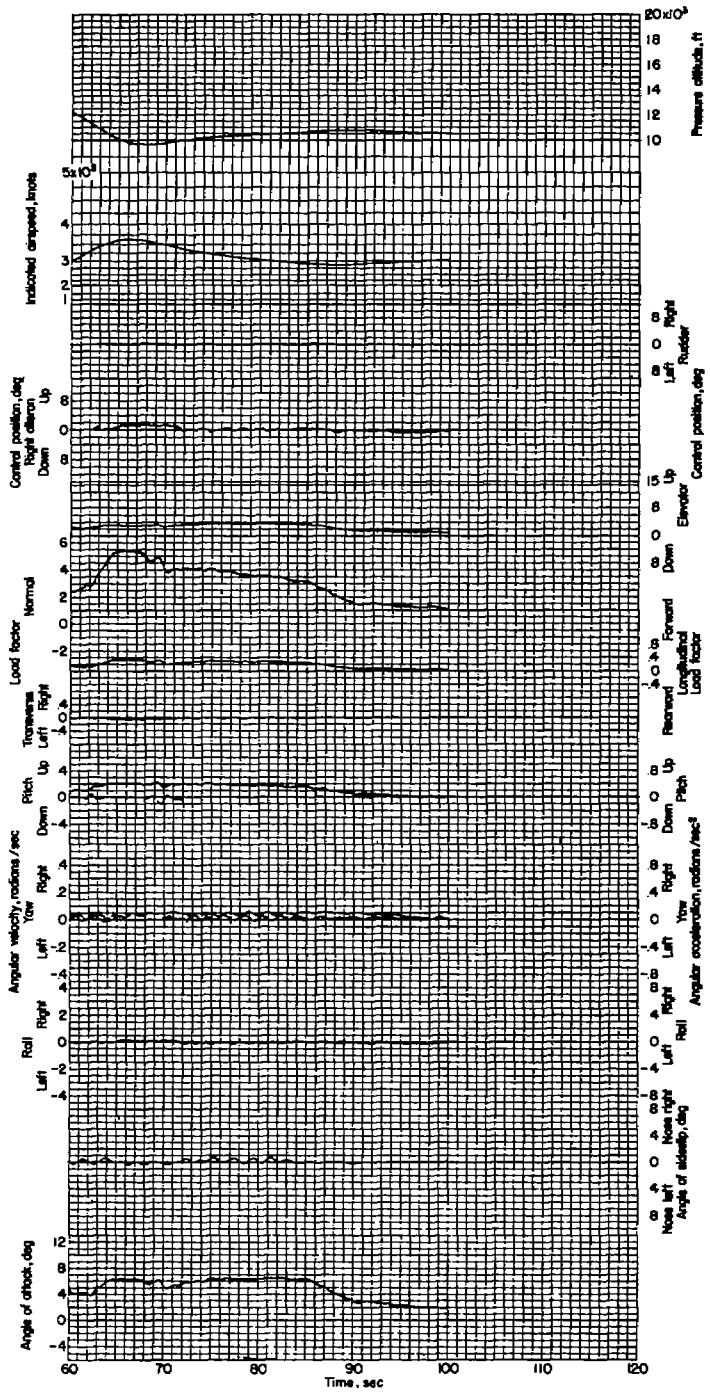
[redacted]



(a)

Figure 242.- Diving right turn into loop followed by right turn. Airplane weight, 15,690 pounds; center of gravity at 23.9 percent M.A.C.; flight 13.

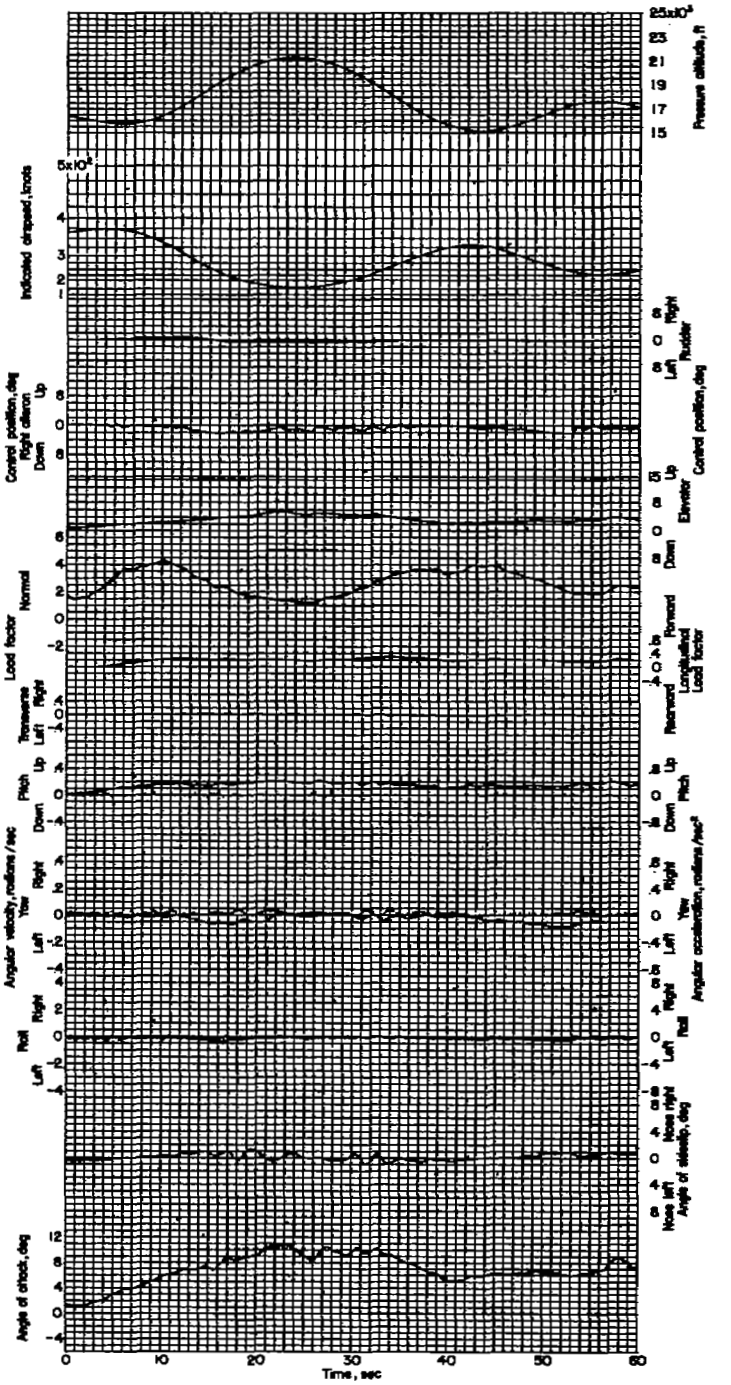
[redacted]



(b)

Figure 242.- Concluded.

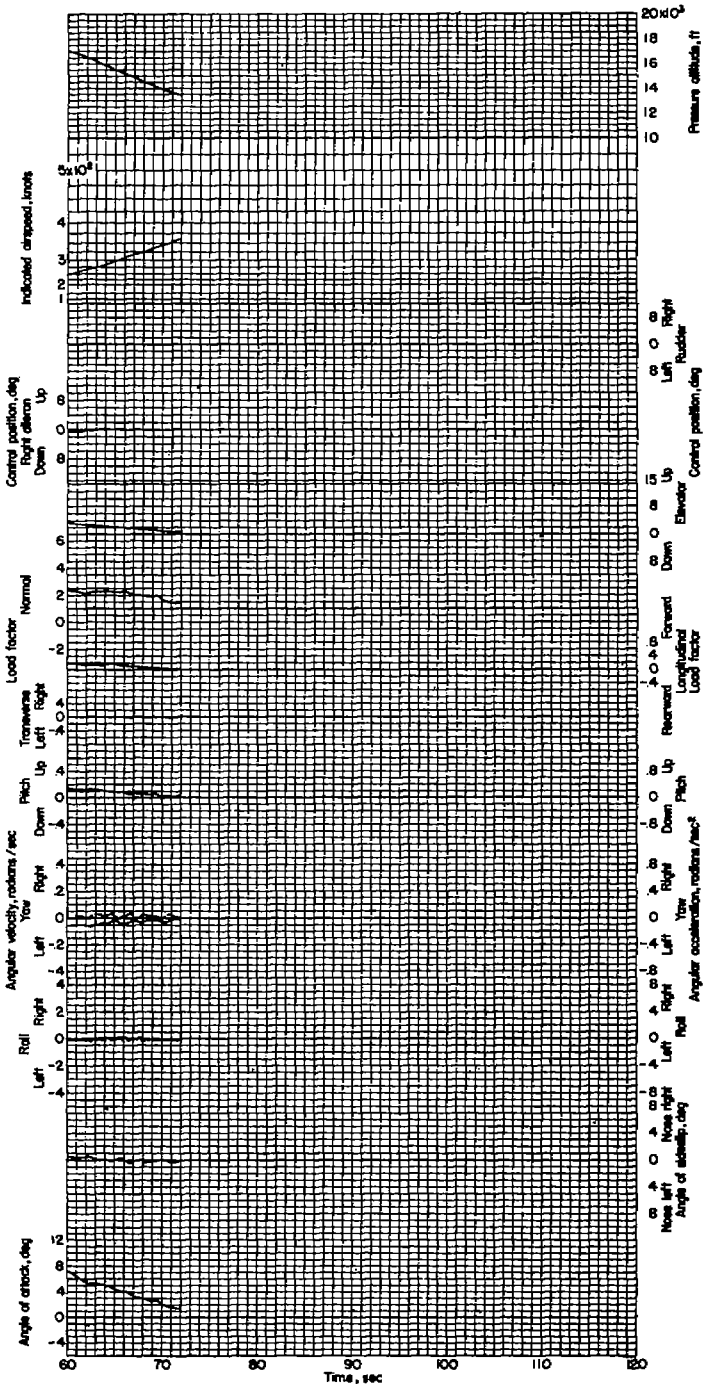
[redacted]



(a)

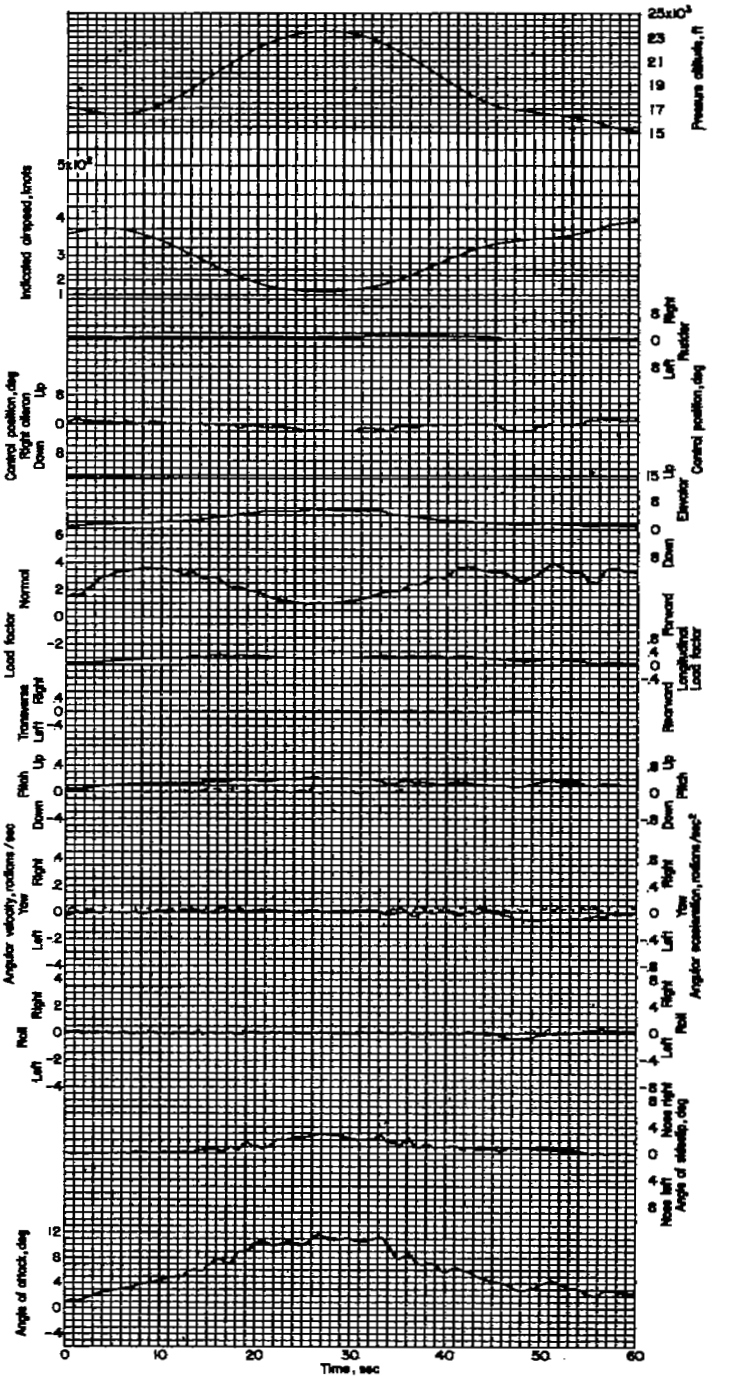
Figure 243.- Loop followed by wing-over. Airplane weight, 16,310 pounds; center of gravity at 24.3 percent M.A.C.; flight 14.

[redacted]



(b)

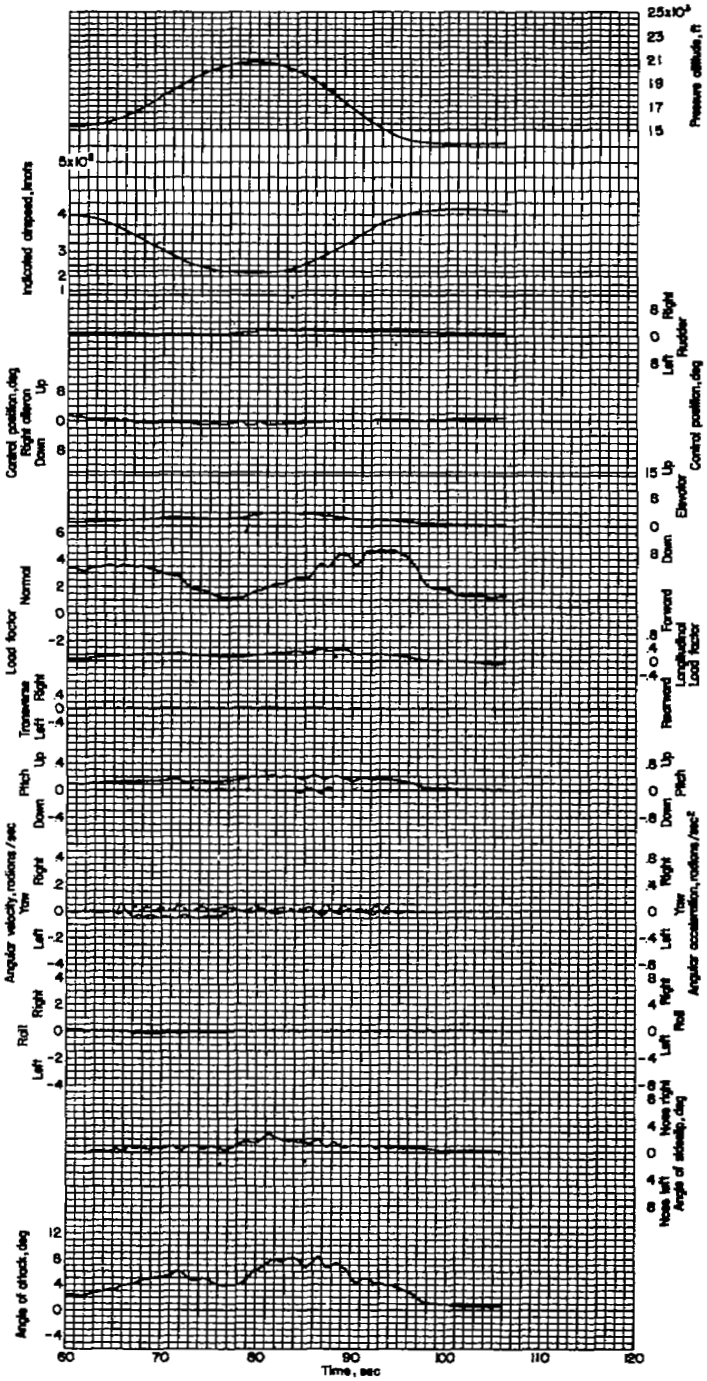
Figure 243.- Concluded.



(a)

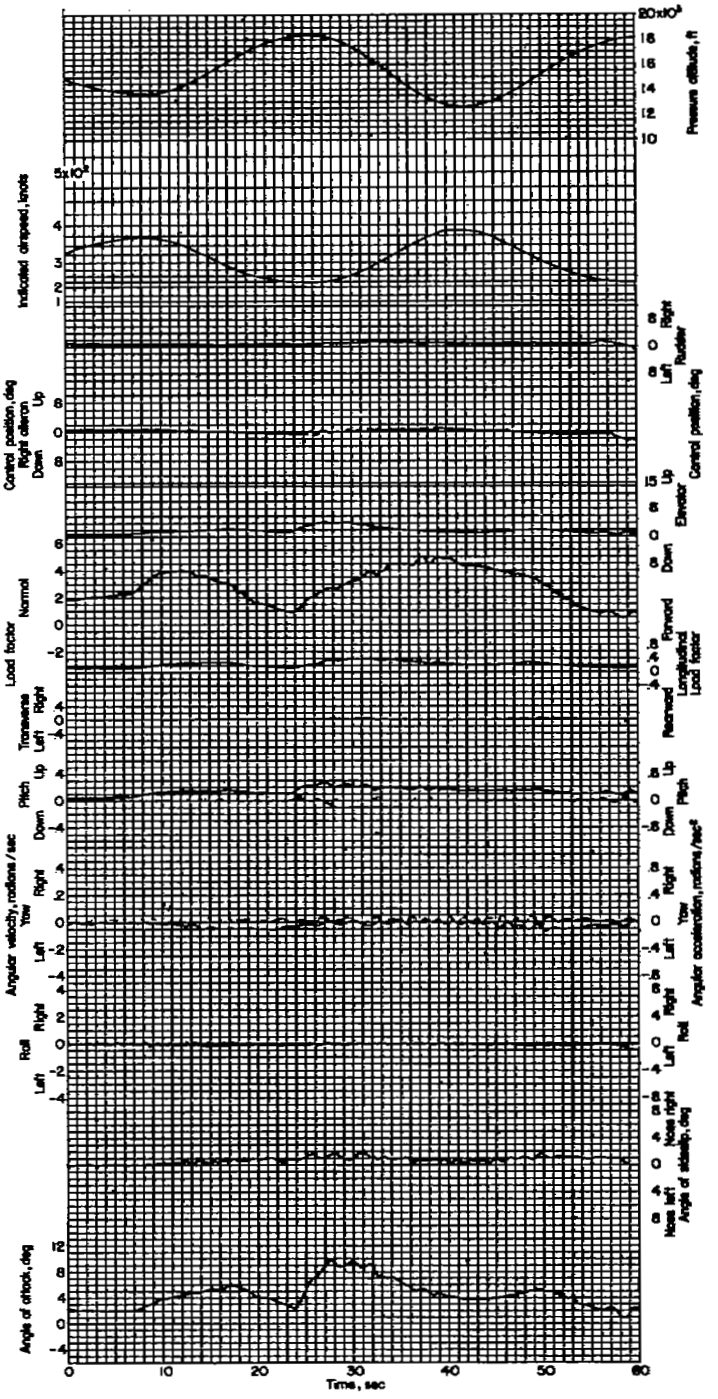
Figure 244.- Two loops. Airplane weight, 15,600 pounds; center of gravity at 23.9 percent M.A.C.; flight 14.

[redacted]



(b)

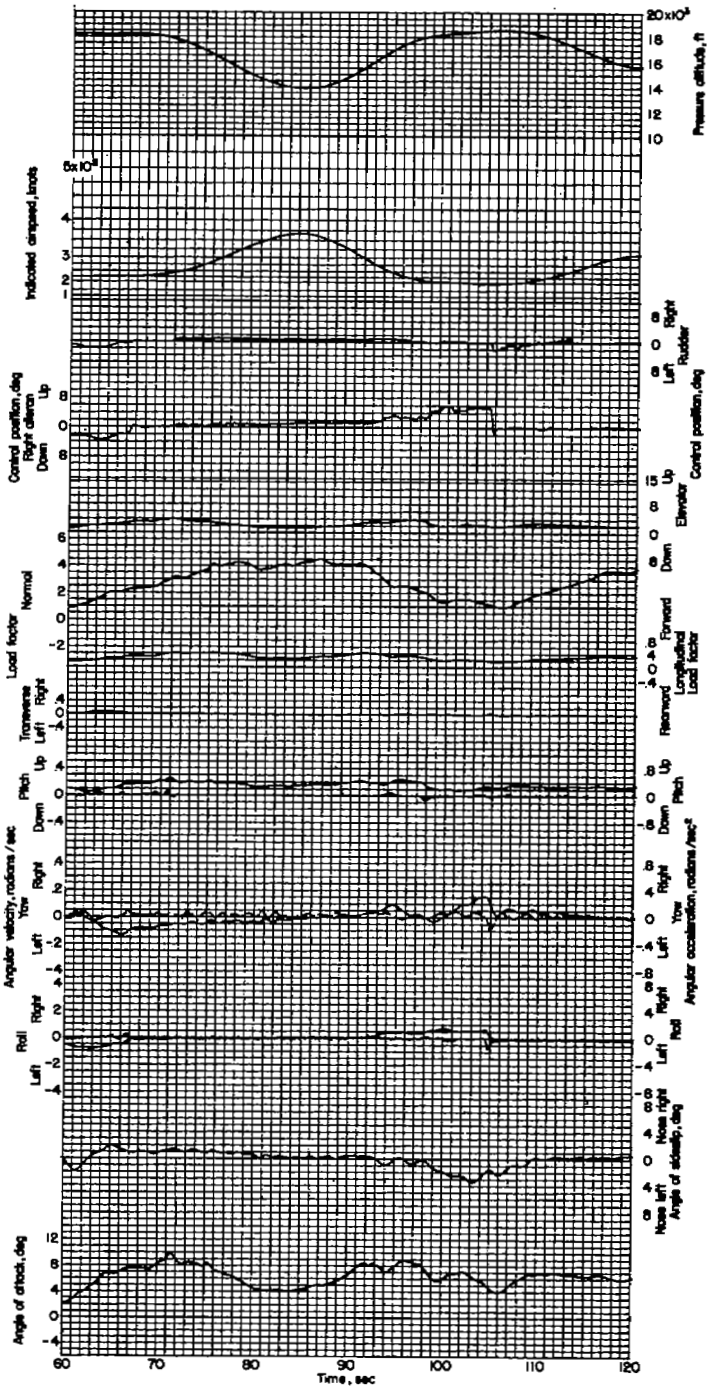
Figure 244.- Concluded.



(a)

Figure 245.- Loop and Immelman followed by split-S into loop with right aileron roll at top. Airplane weight, 15,150 pounds; center of gravity at 24.1 percent M.A.C.; flight 14.

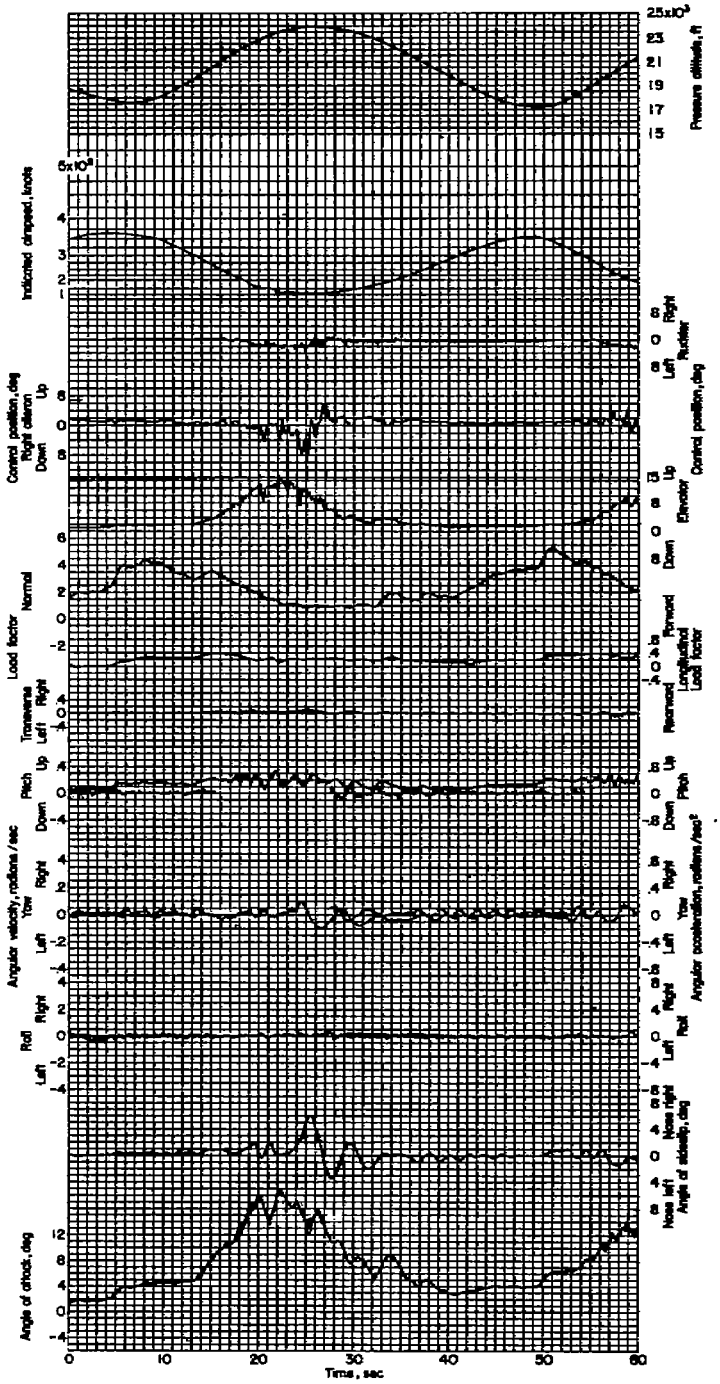
[redacted]



(b)

Figure 245.- Concluded.

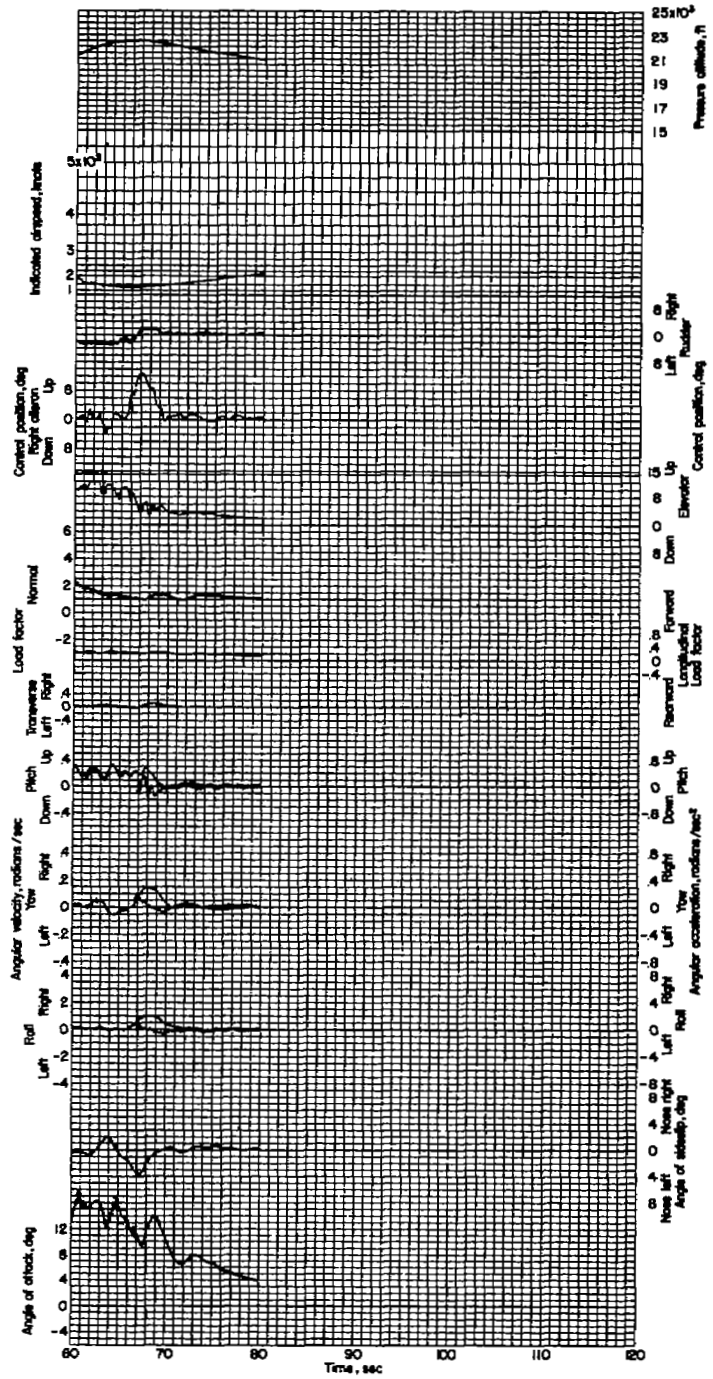
[redacted]



(a)

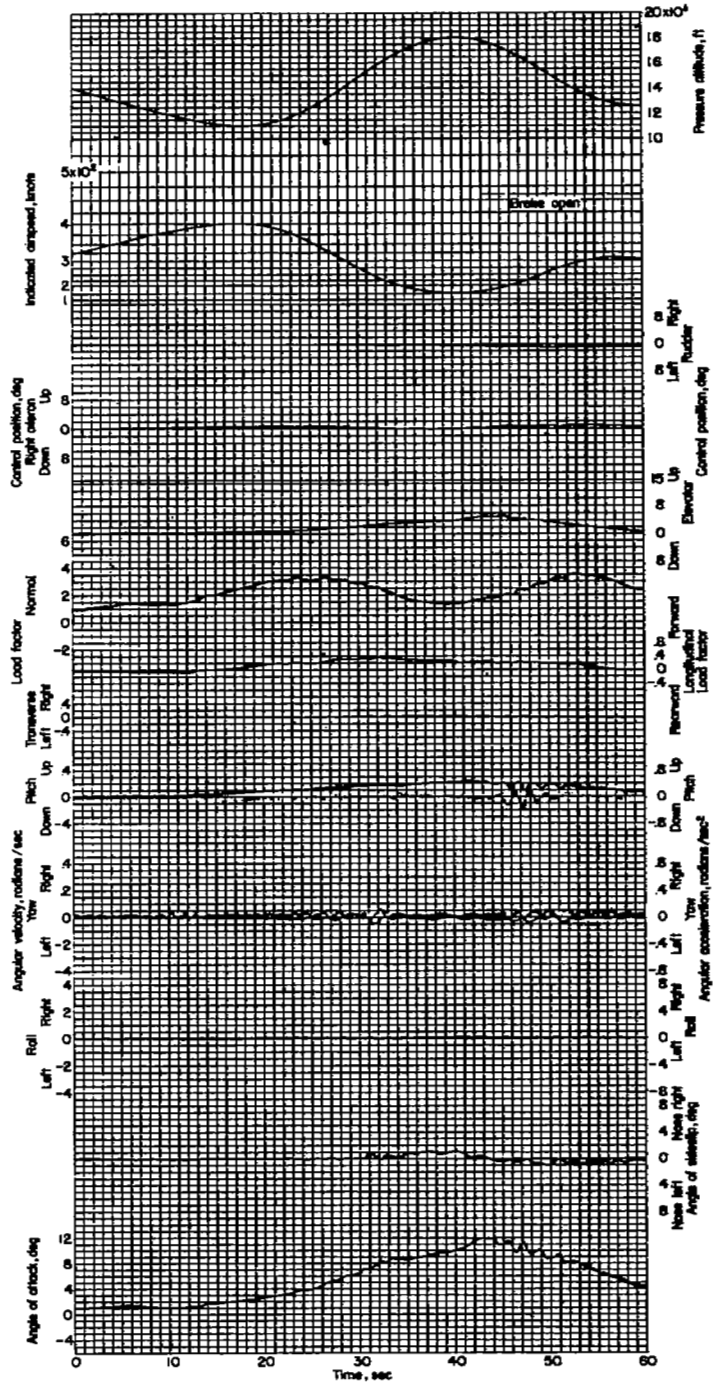
Figure 246.- Loop with right-quarter-roll recovery followed by Immelman. Airplane weight, 15,230 pounds; center of gravity at 24.0 percent M.A.C.; flight 18.

[redacted]



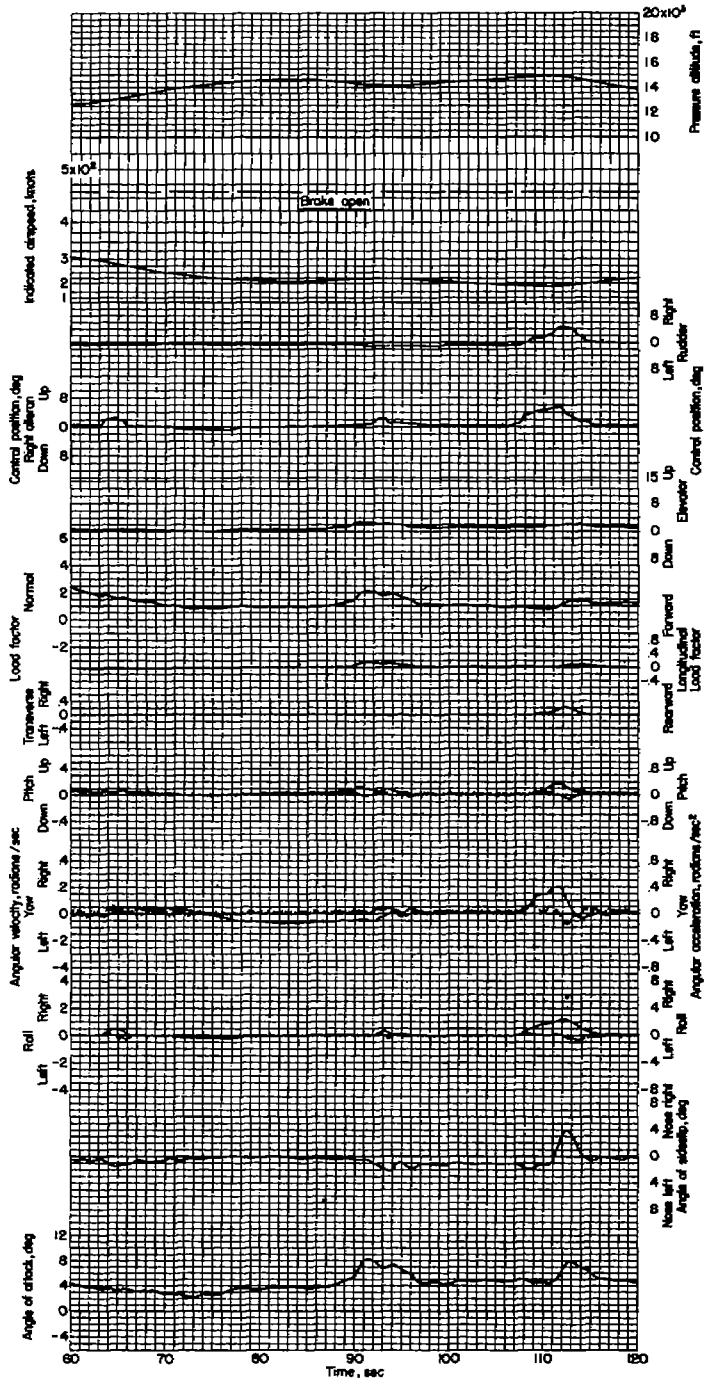
(b)

Figure 246.- Concluded.



(a)

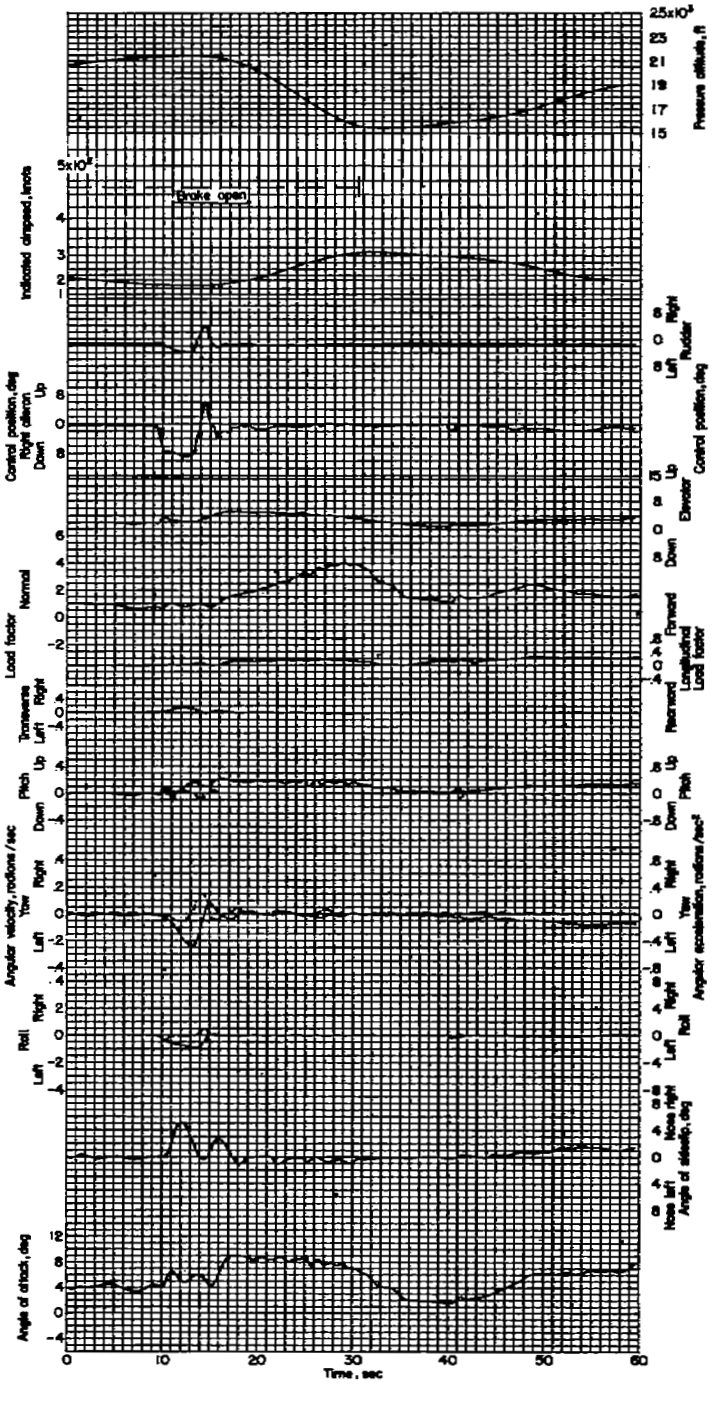
Figure 247.- Loop followed by right and left turn and right aileron roll. Airplane weight, 14,500 pounds; center of gravity at 24.2 percent M.A.C.; flight 19.



(b)

Figure 247.- Concluded.

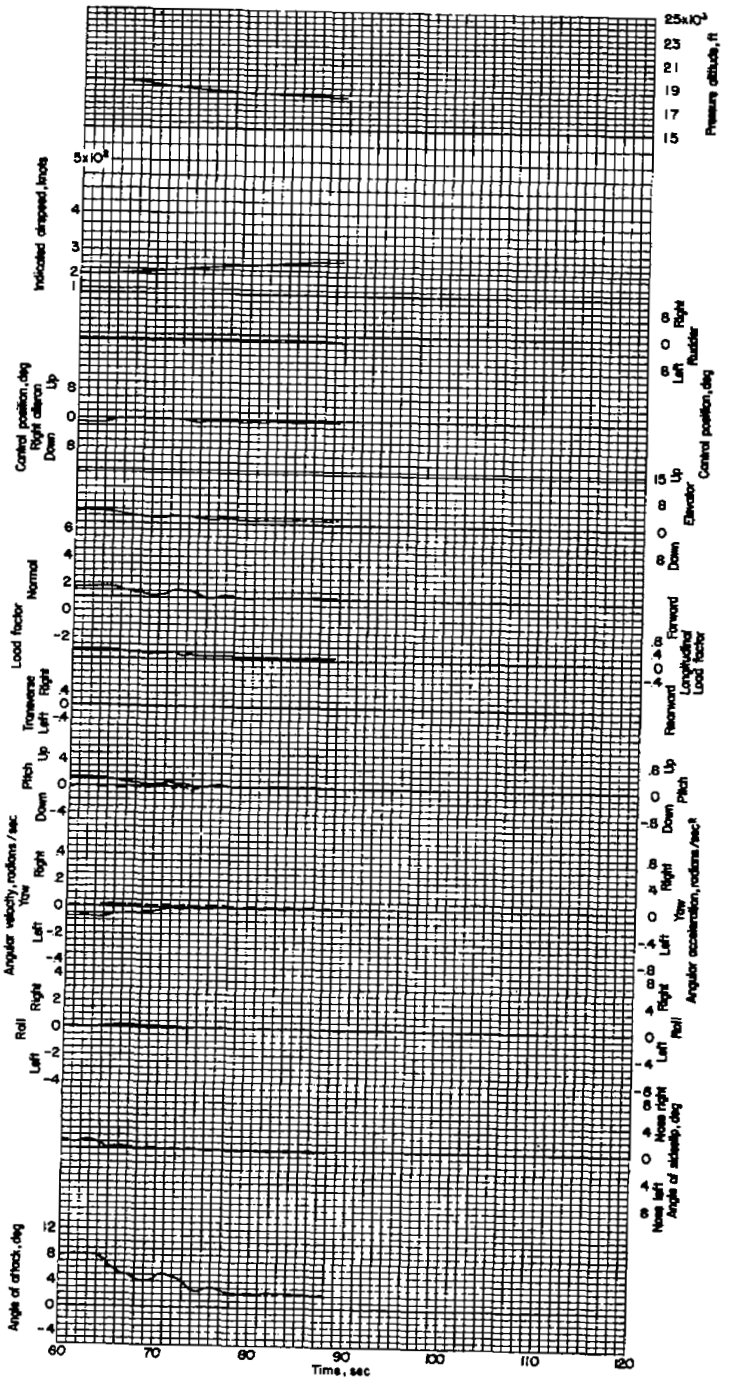
[redacted]



(a)

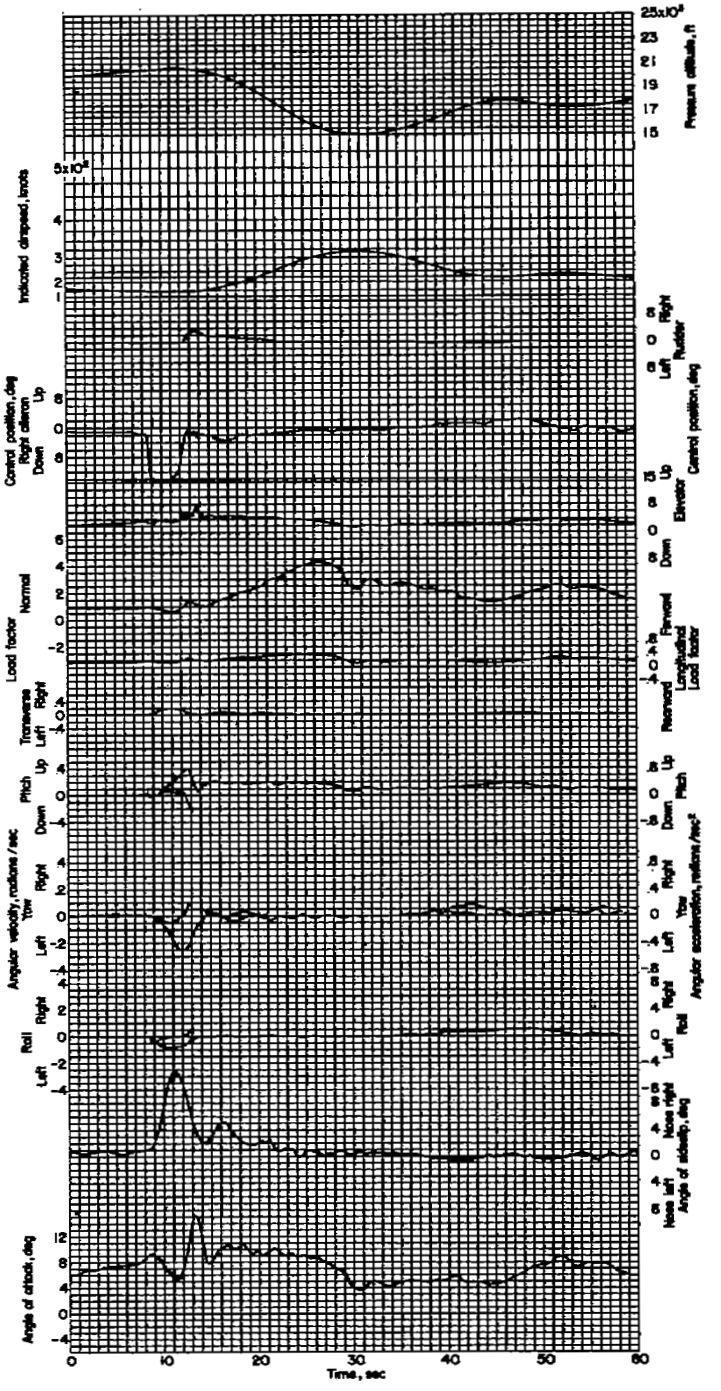
Figure 248.- Split-S followed by wing-over. Airplane weight, 16,740 pounds; center of gravity at 24.5 percent M.A.C.; flight 2.

[redacted]



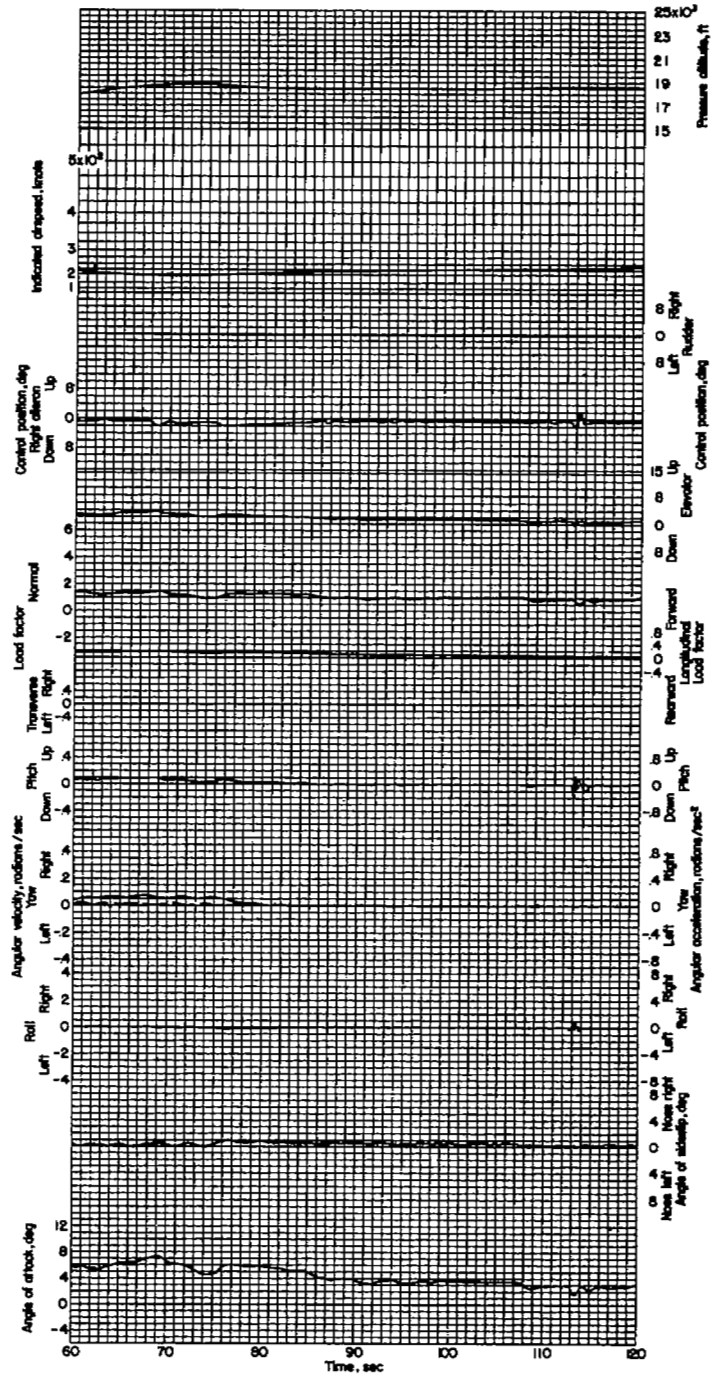
(b)

Figure 248.- Concluded.



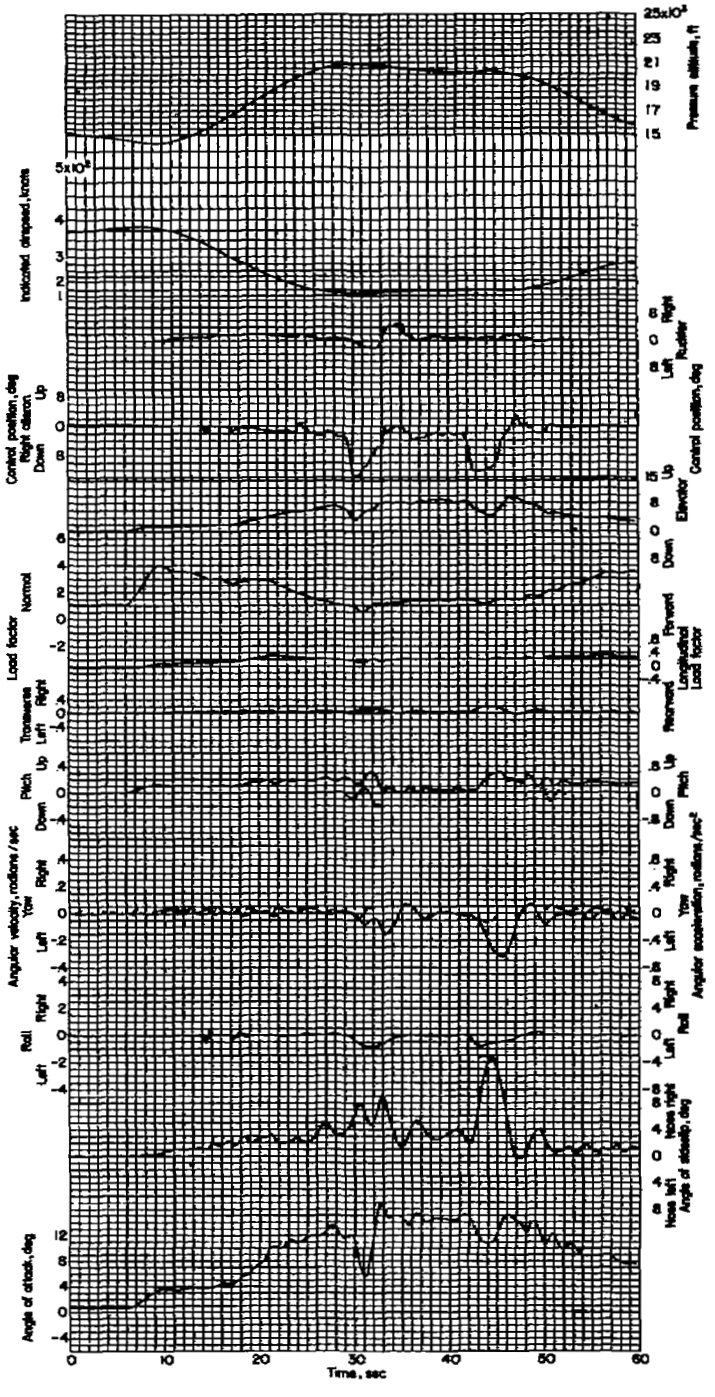
(a)

Figure 249.- Split-S followed by right barrel roll and right turn. Airplane weight, 16,220 pounds; center of gravity at 24.3 percent M.A.C.; flight 3.



(b)

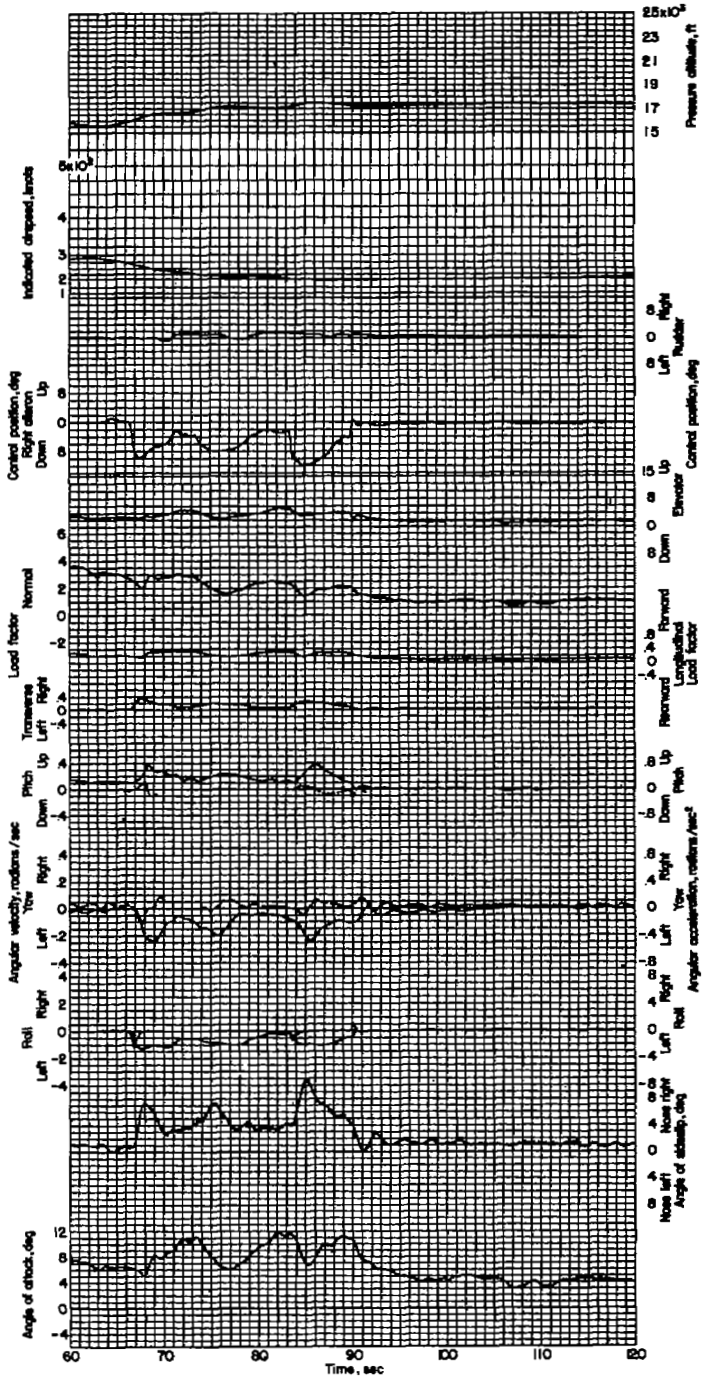
Figure 249.- Concluded.



(a)

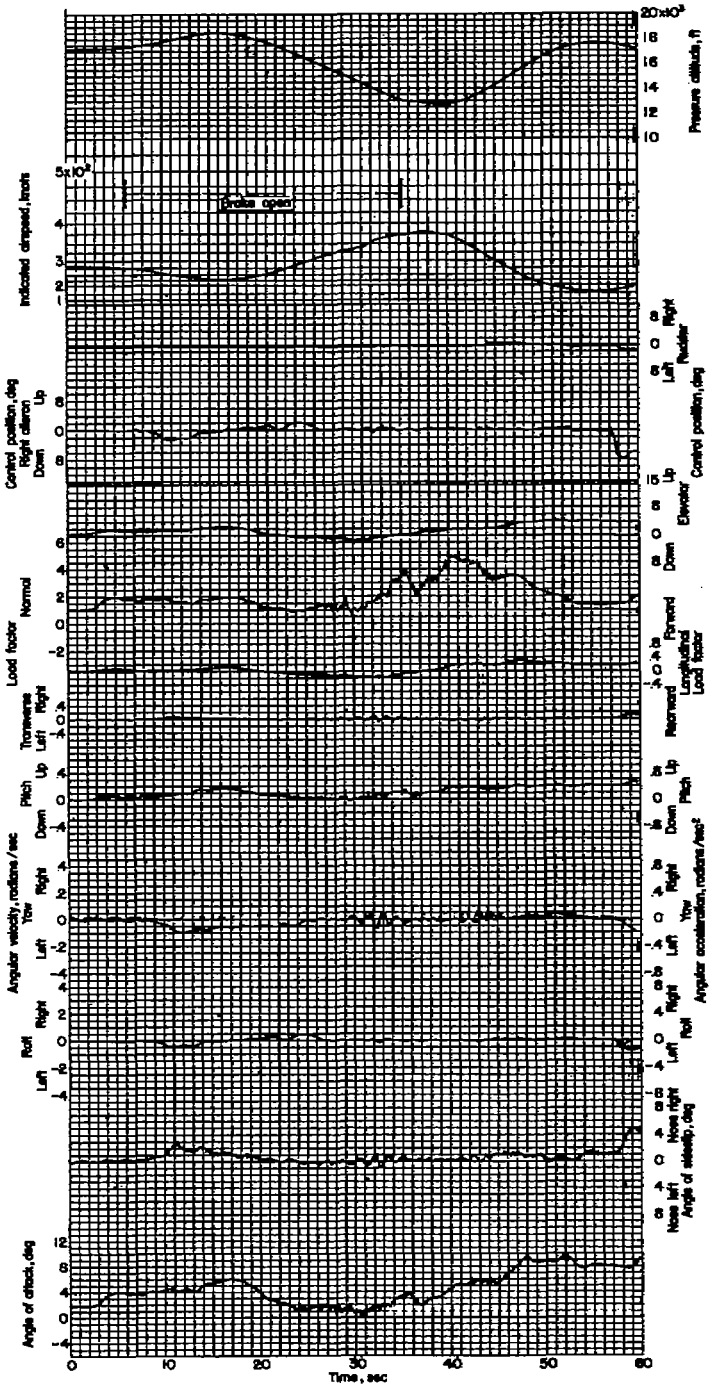
Figure 250.- Immelman followed by split-S and three left barrel rolls. Airplane weight, 15,250 pounds; center of gravity at 24.0 percent M.A.C.; flight 3.

[redacted]



(b)

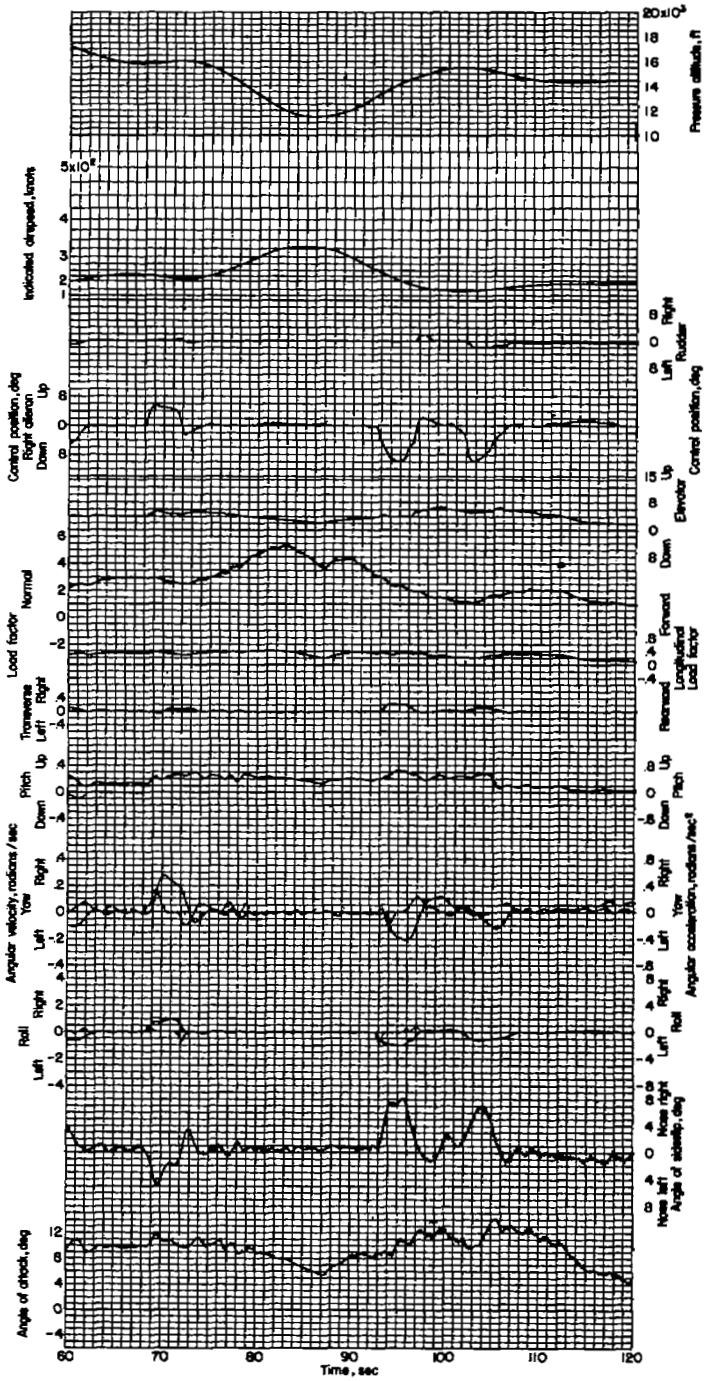
Figure 250.- Concluded.



(a)

Figure 251.- Peel-off into dive and pull-up into Immelman followed by split-S and vertical recovery. Airplane weight, 14,940 pounds; center of gravity at 24.4 percent M.A.C.; flight 3.

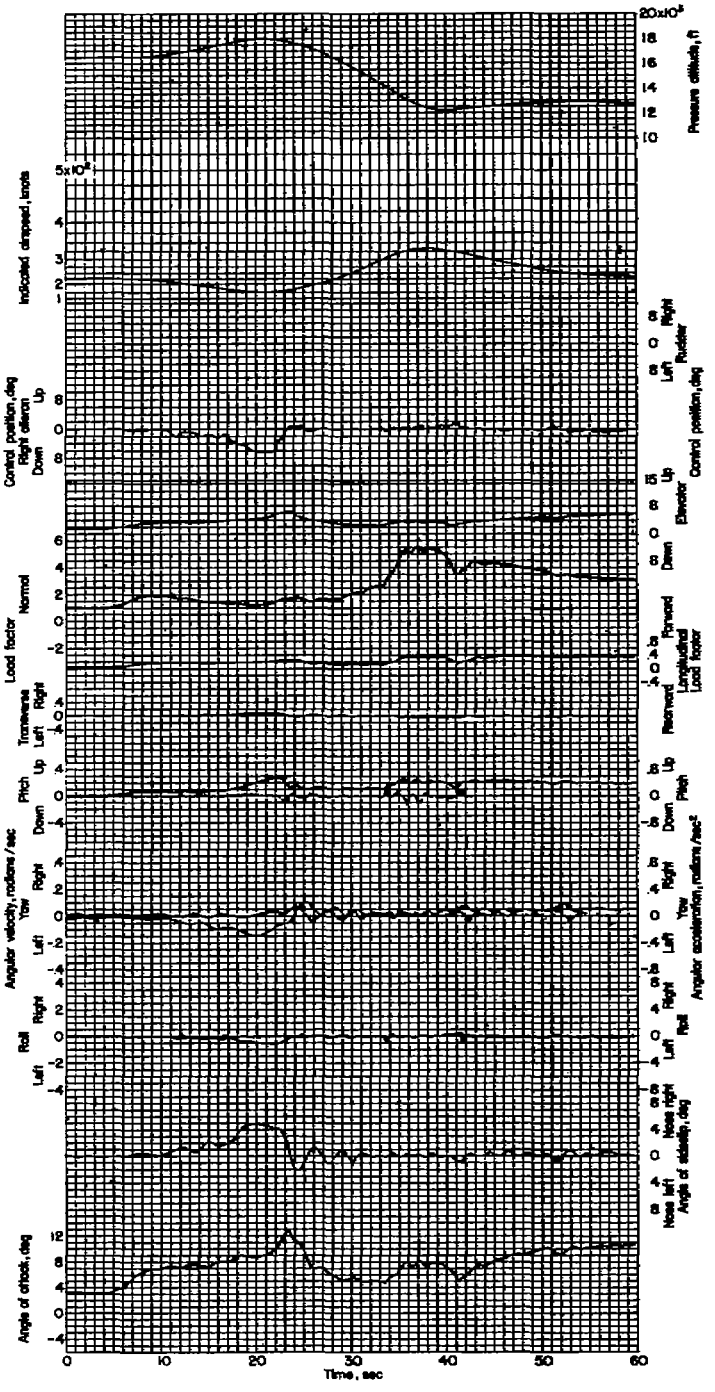
[redacted]



(b)

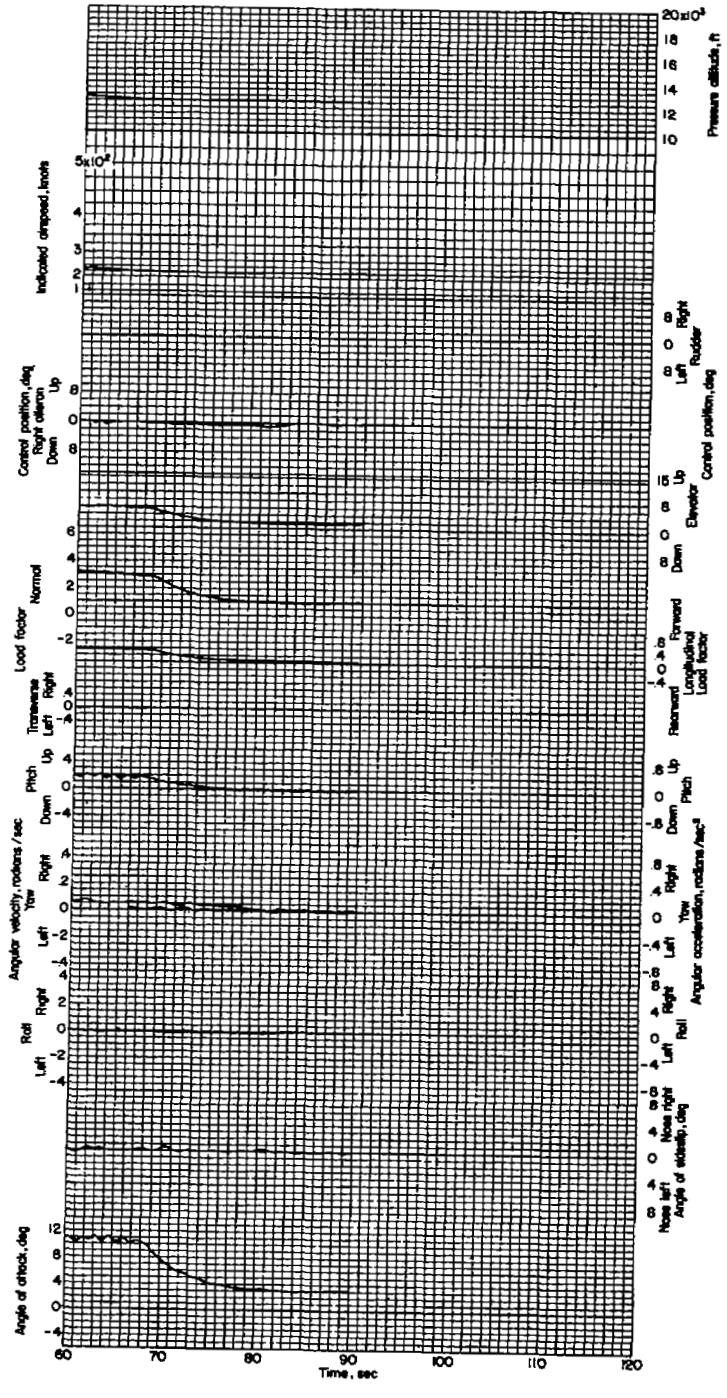
Figure 251.- Concluded.

[redacted]



(a)

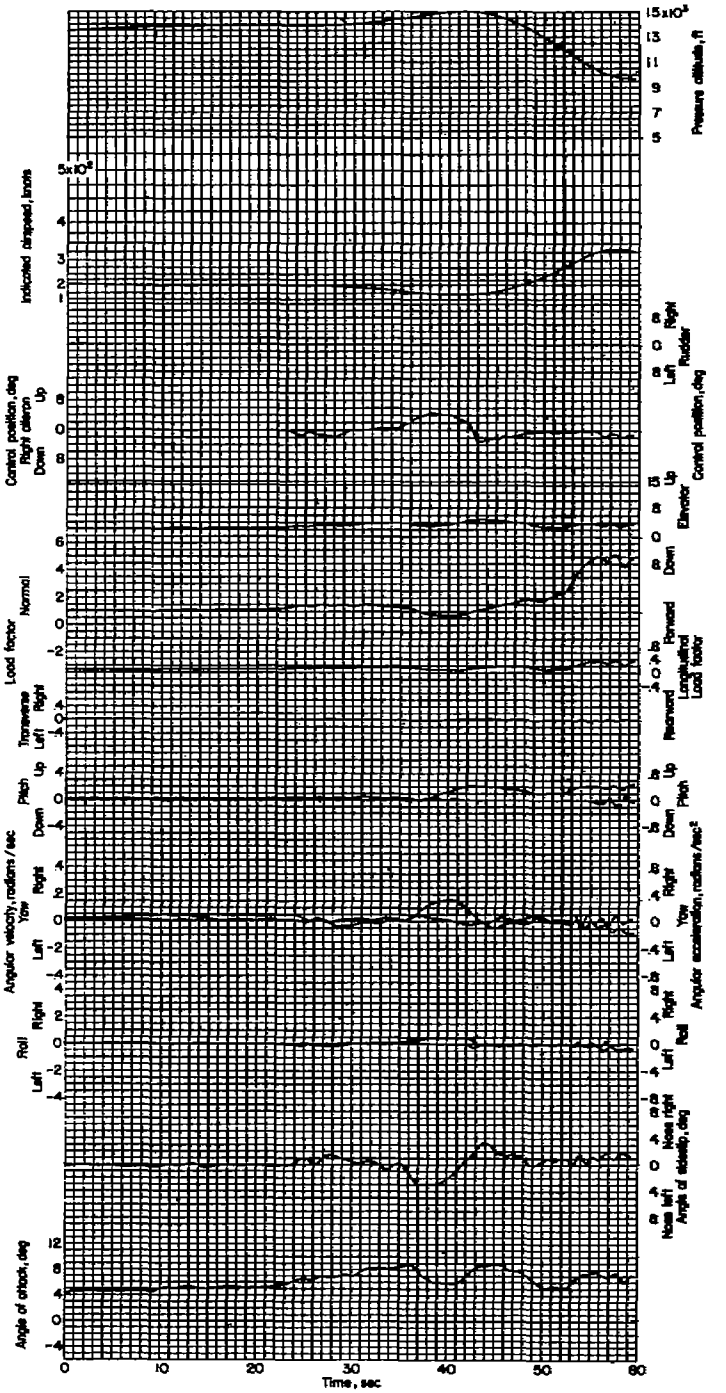
Figure 252.- Split-S into right turn. Airplane weight, 15,430 pounds; center of gravity at 23.8 percent M.A.C.; flight 13.



(b)

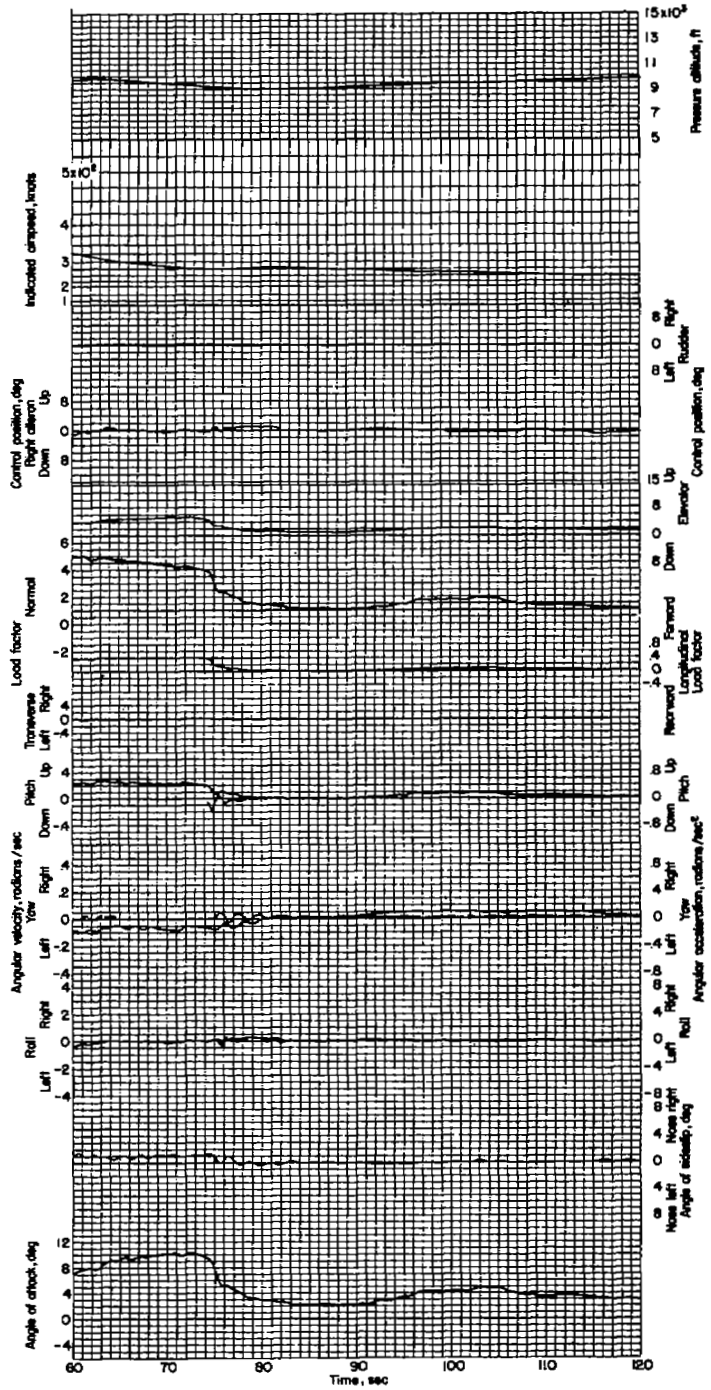
Figure 252.- Concluded.

[redacted]



(a)

Figure 253.- Split-S into left and right turn. Airplane weight, 15,330 pounds; center of gravity at 23.9 percent M.A.C.; flight 13.



(b)

Figure 253.- Concluded.

[redacted]

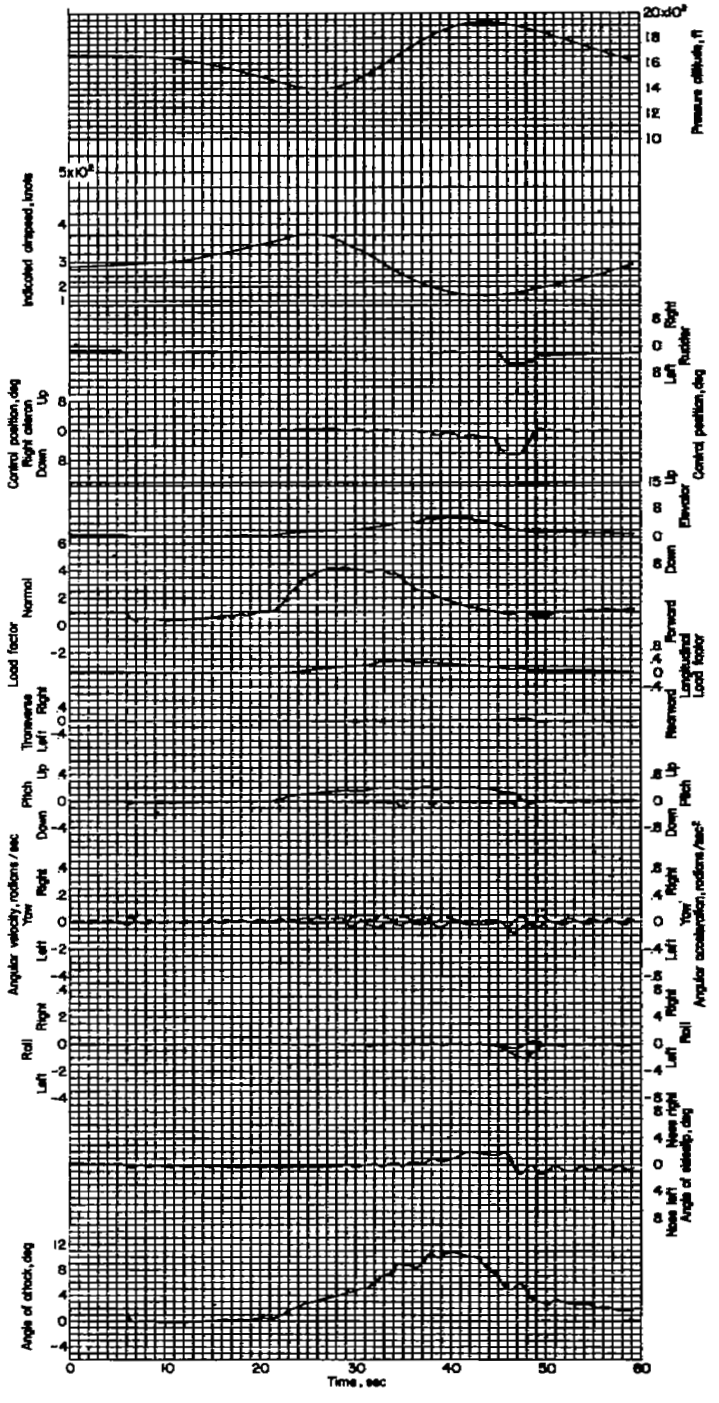
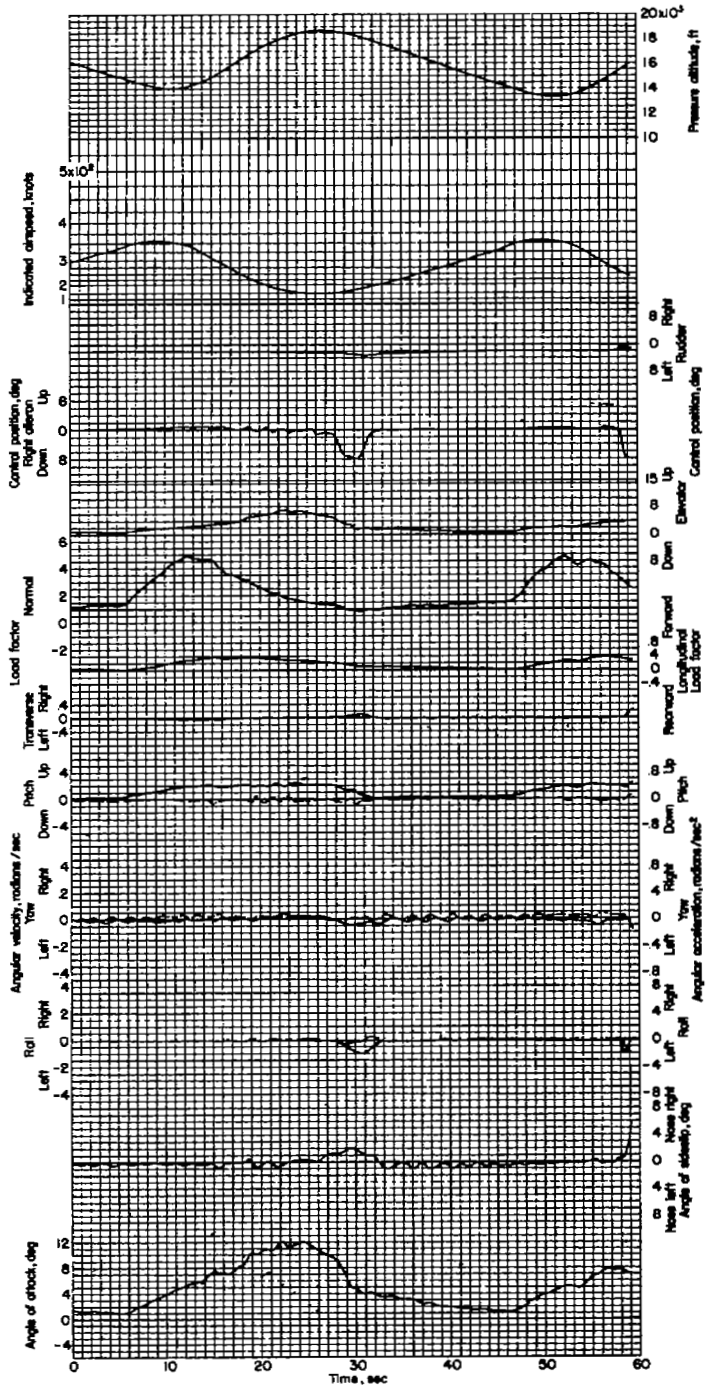


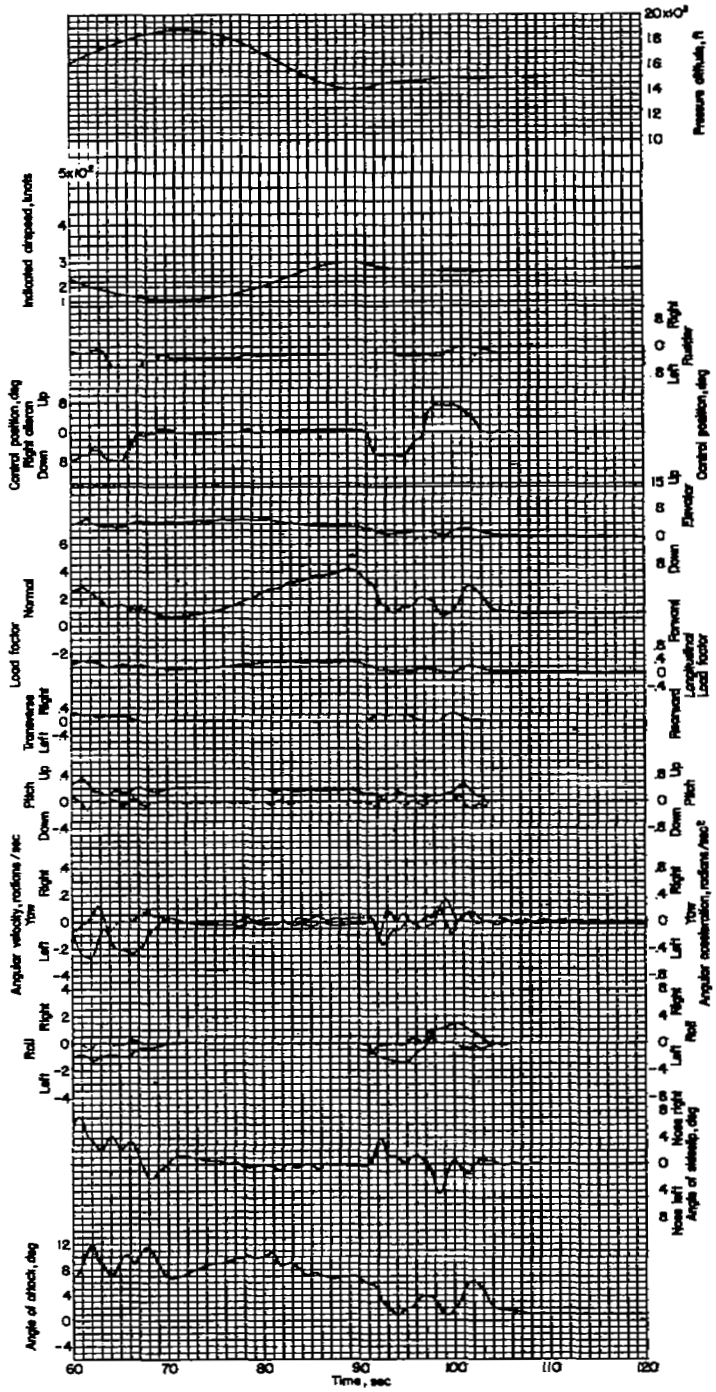
Figure 254.- One-half Cuban eight. Airplane weight, 15,760 pounds; center of gravity at 24.0 percent M.A.C.; flight 2.



(a)

Figure 255.- One-half Cuban eight followed by one and one-quarter climbing left aileron rolls into half-loop followed by left and right aileron roll. Airplane weight, 15,700 pounds; center of gravity at 24.0 percent M.A.C.; flight 2.

[redacted]



(b)

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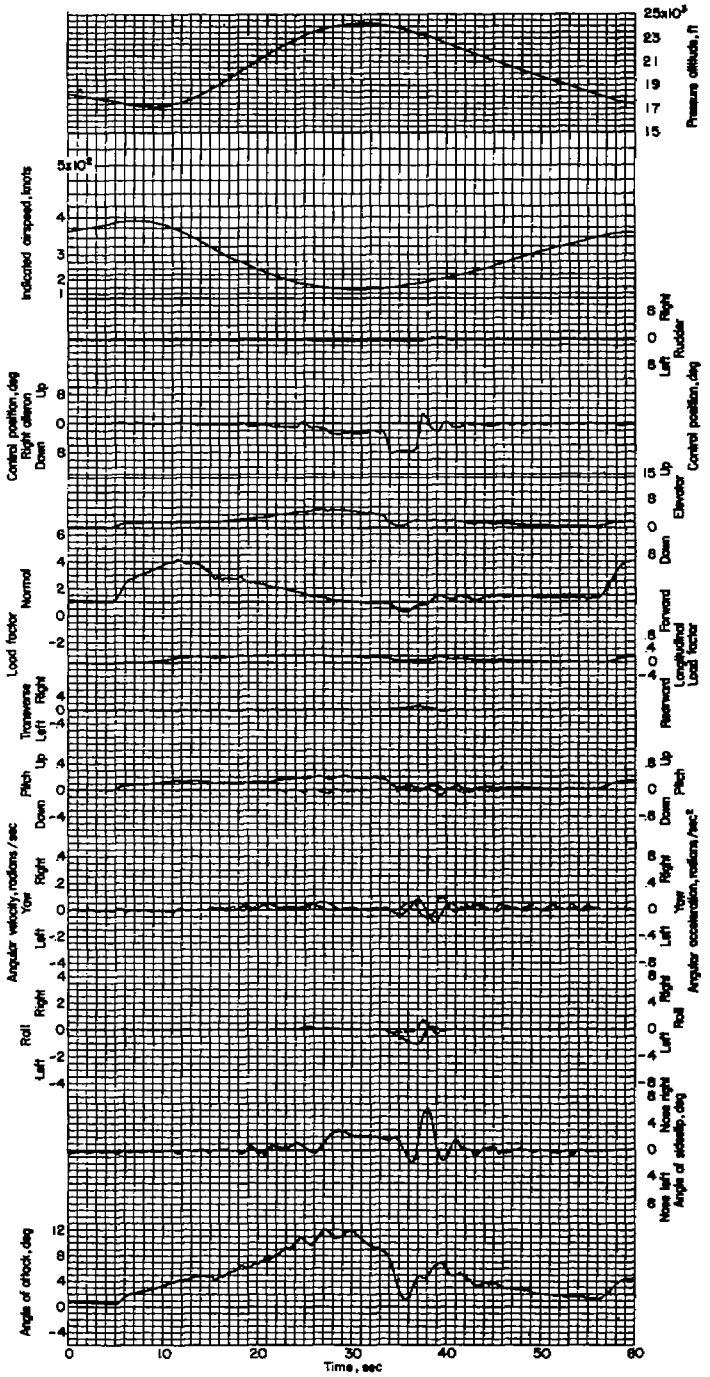
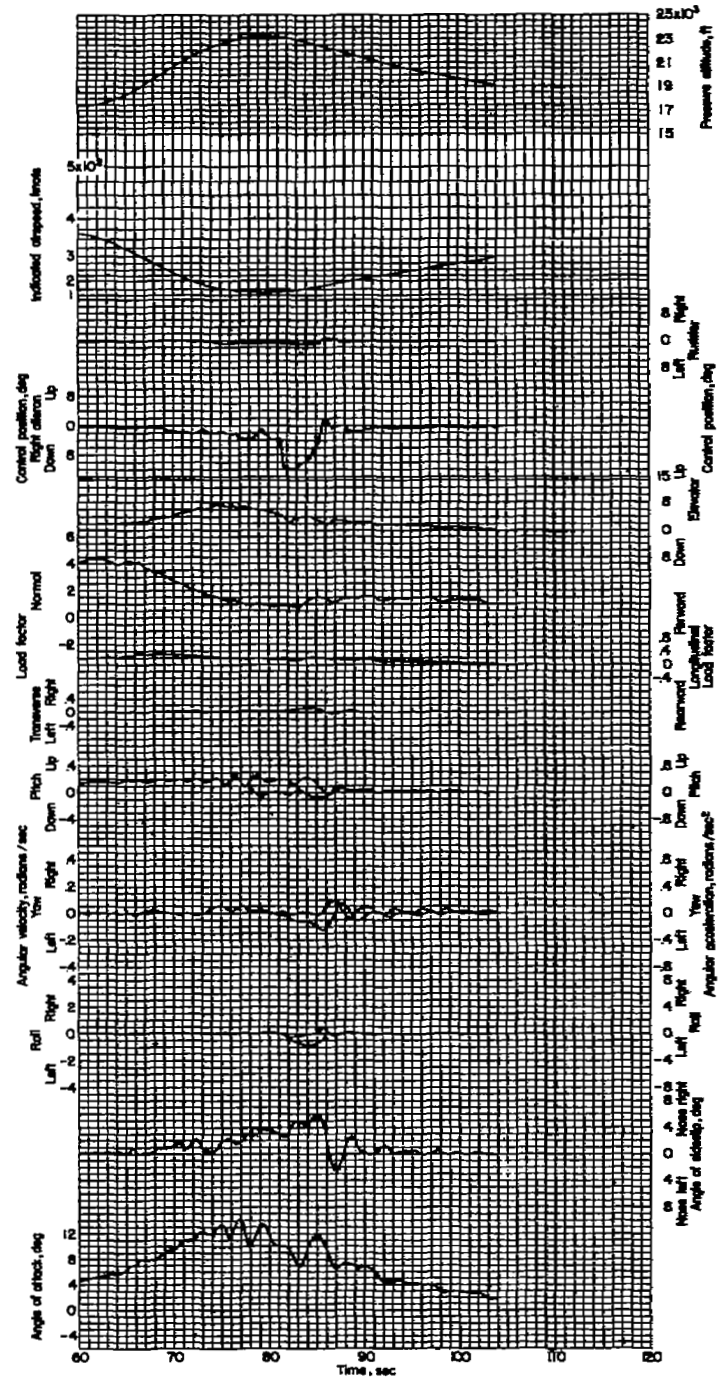
Figure 255.- Concluded.



(a)

Figure 256.- Cuban eight. Airplane weight, 16,390 pounds; center of gravity at 24.3 percent M.A.C.; flight 3.



(b)

Figure 256.- Concluded.

[redacted]

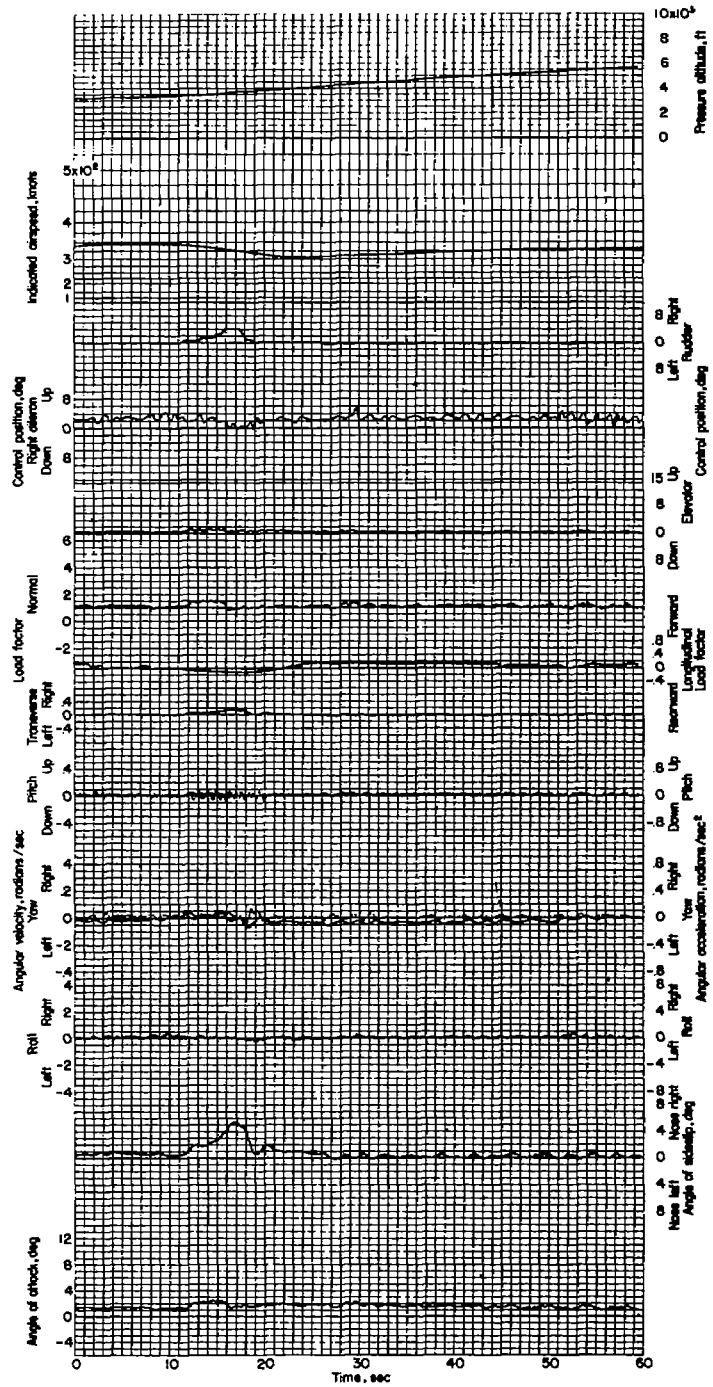
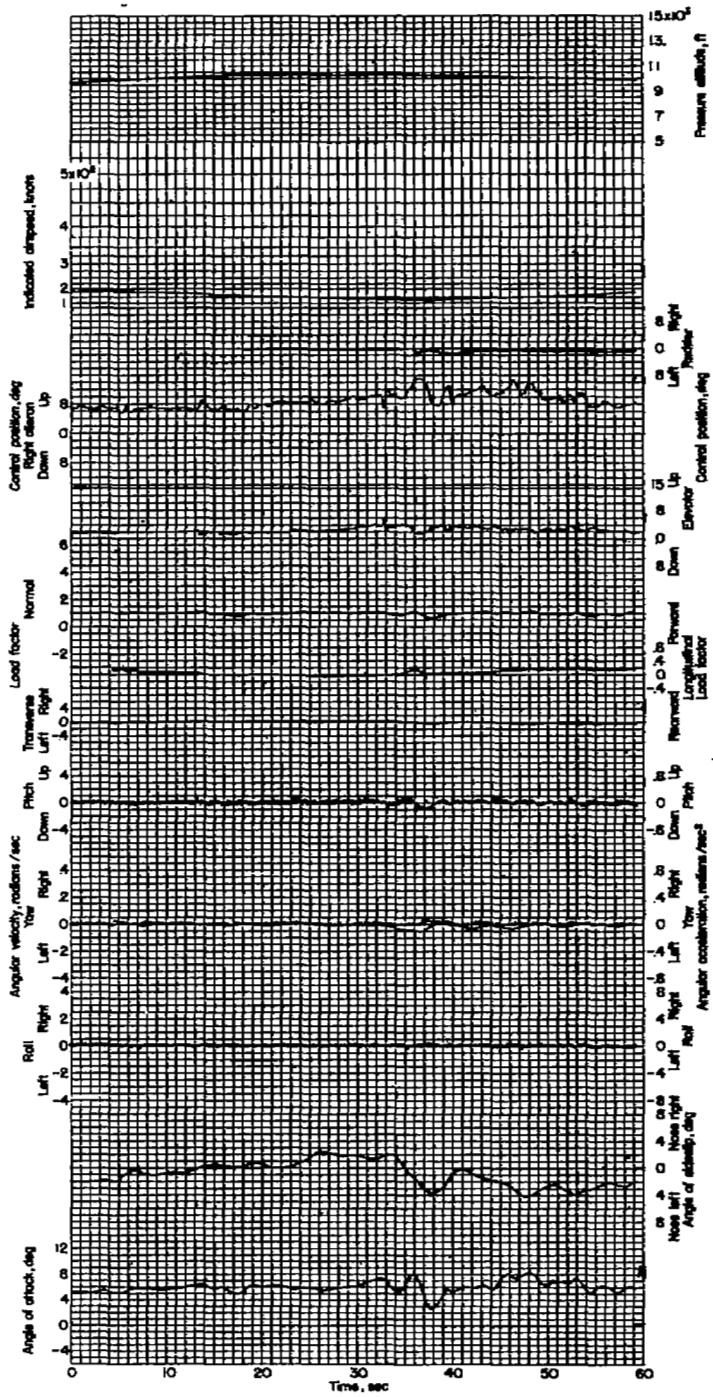
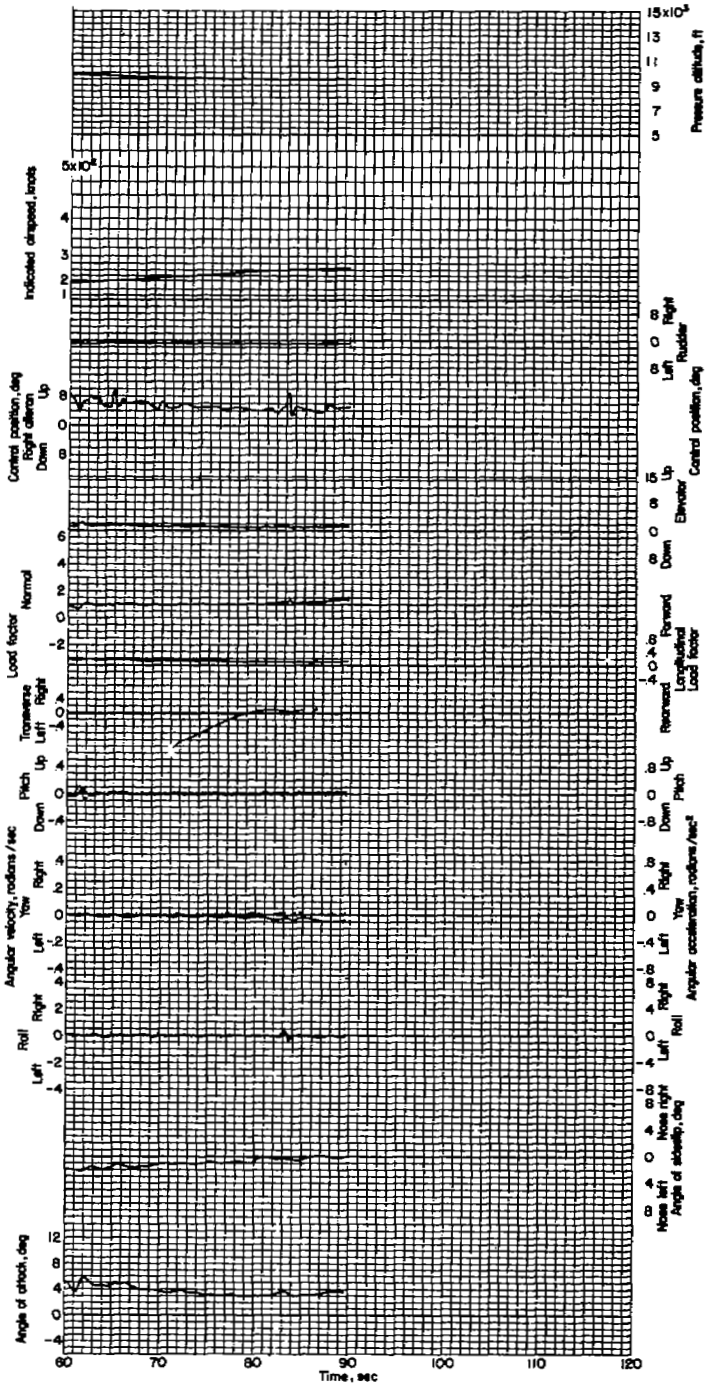


Figure 257.- Left sideslip. Airplane weight, 17,150 pounds; center of gravity at 24.7 percent M.A.C.; flight 4.



(a)

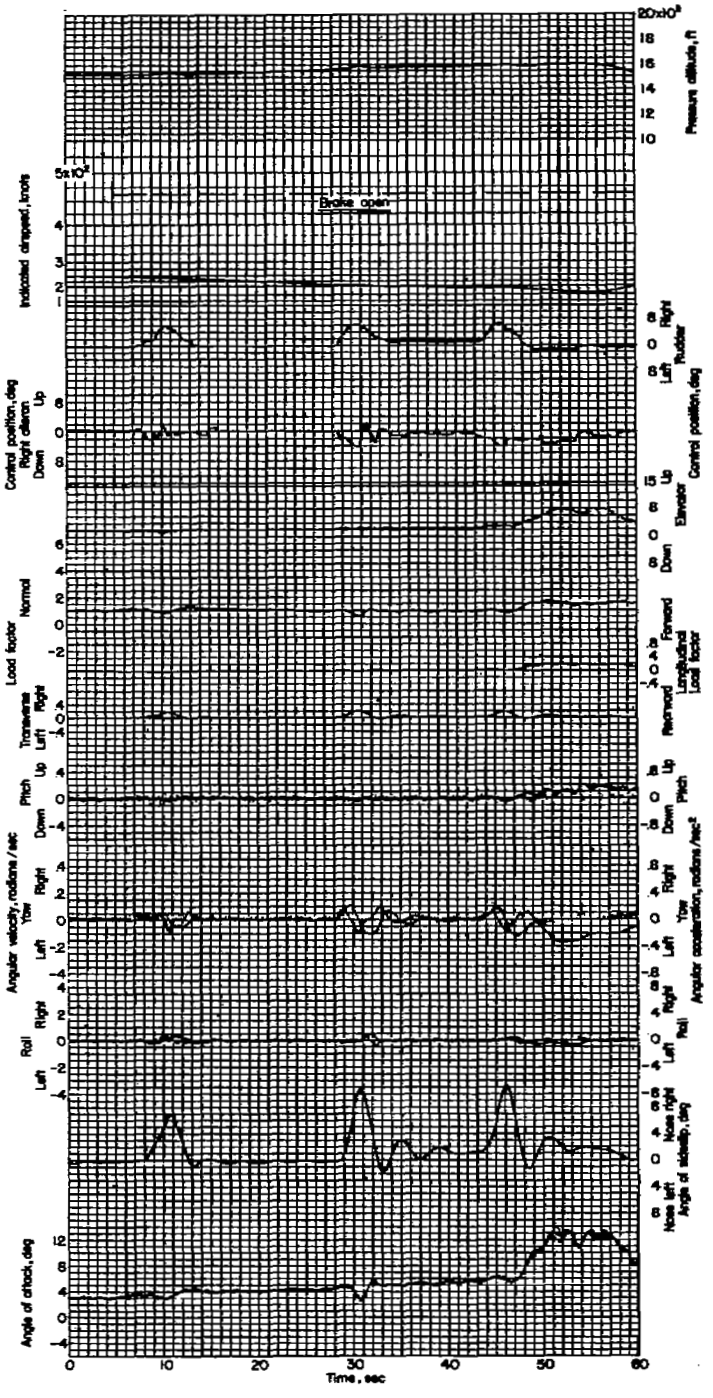
Figure 258.- Sideslip. Airplane weight, 16,380 pounds; center of gravity at 25.1 percent M.A.C.; flight 4.



(b)

Figure 258.- Concluded.

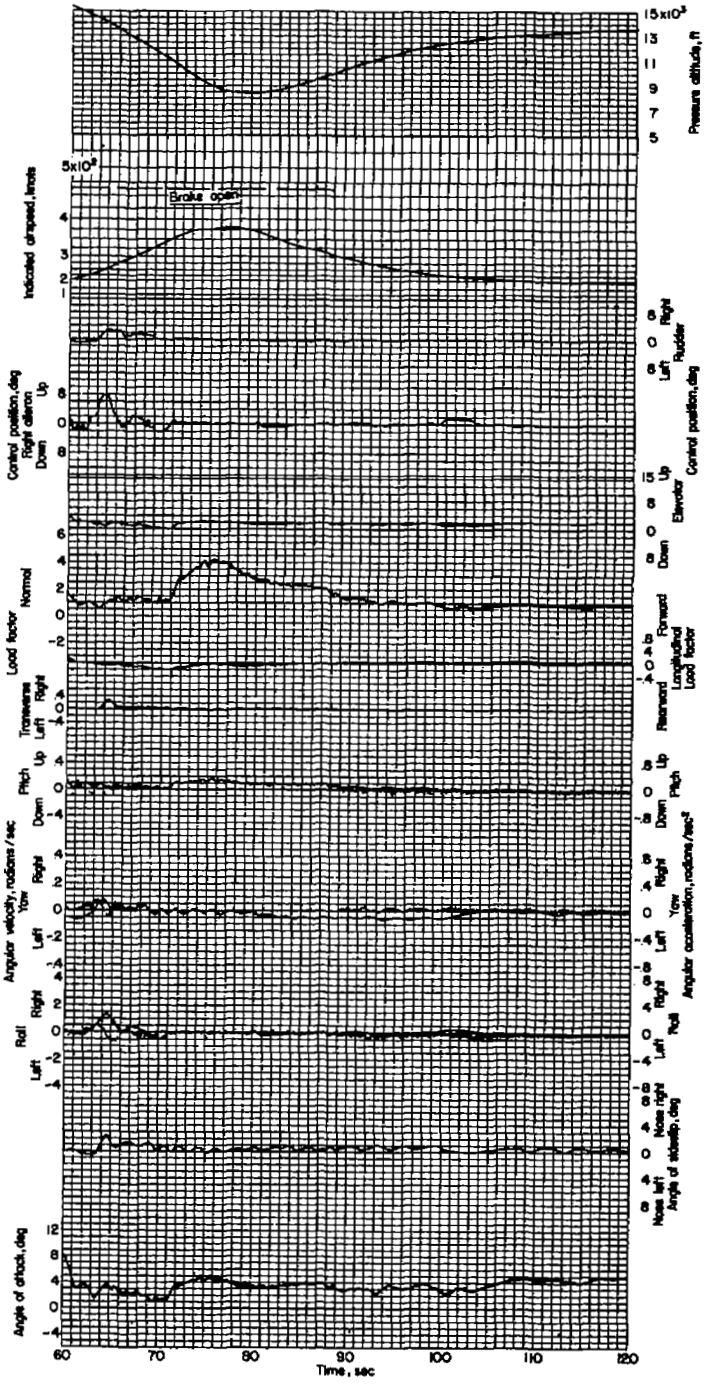
[redacted]



(a)

Figure 259.- Three left sideslips followed by peel-off into dive-bombing run. Airplane weight, 16,490 pounds; center of gravity at 24.4 percent M.A.C.; flight 18.

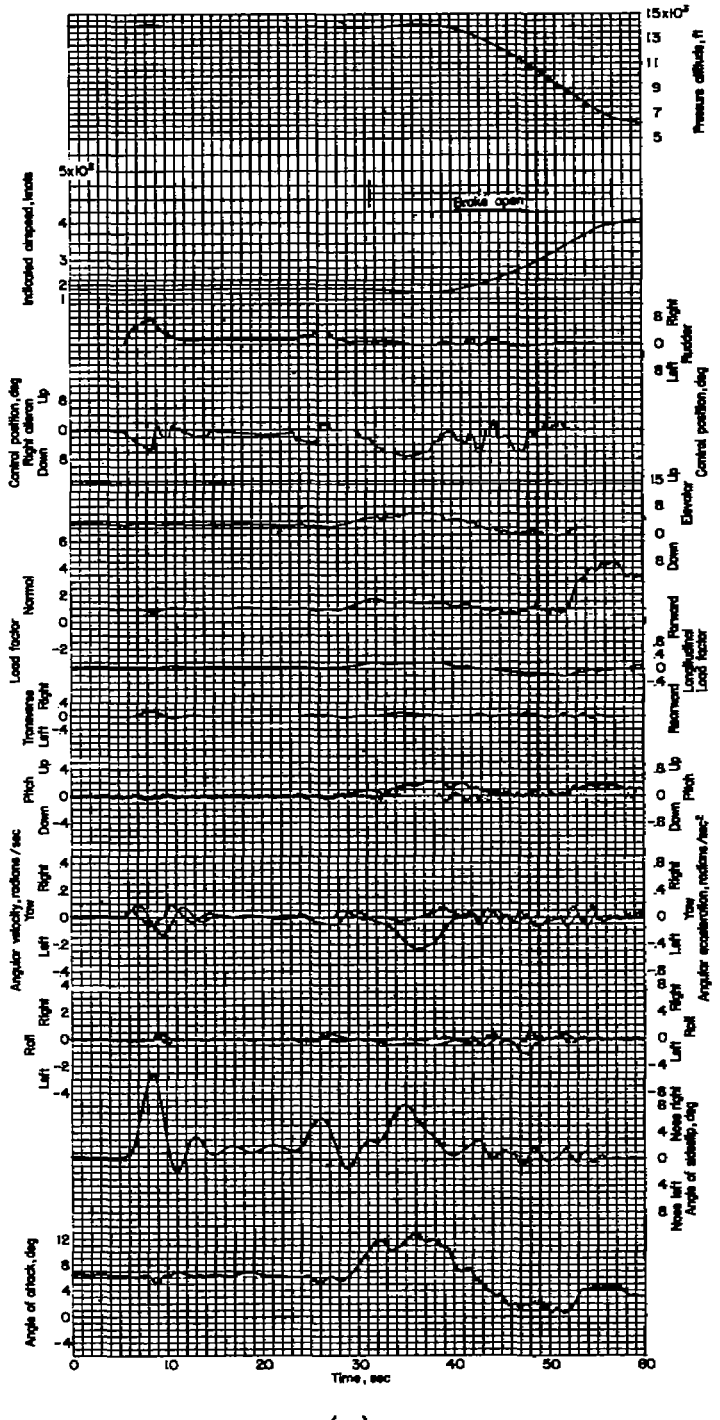
[redacted]



(b)

Figure 259.- Concluded.

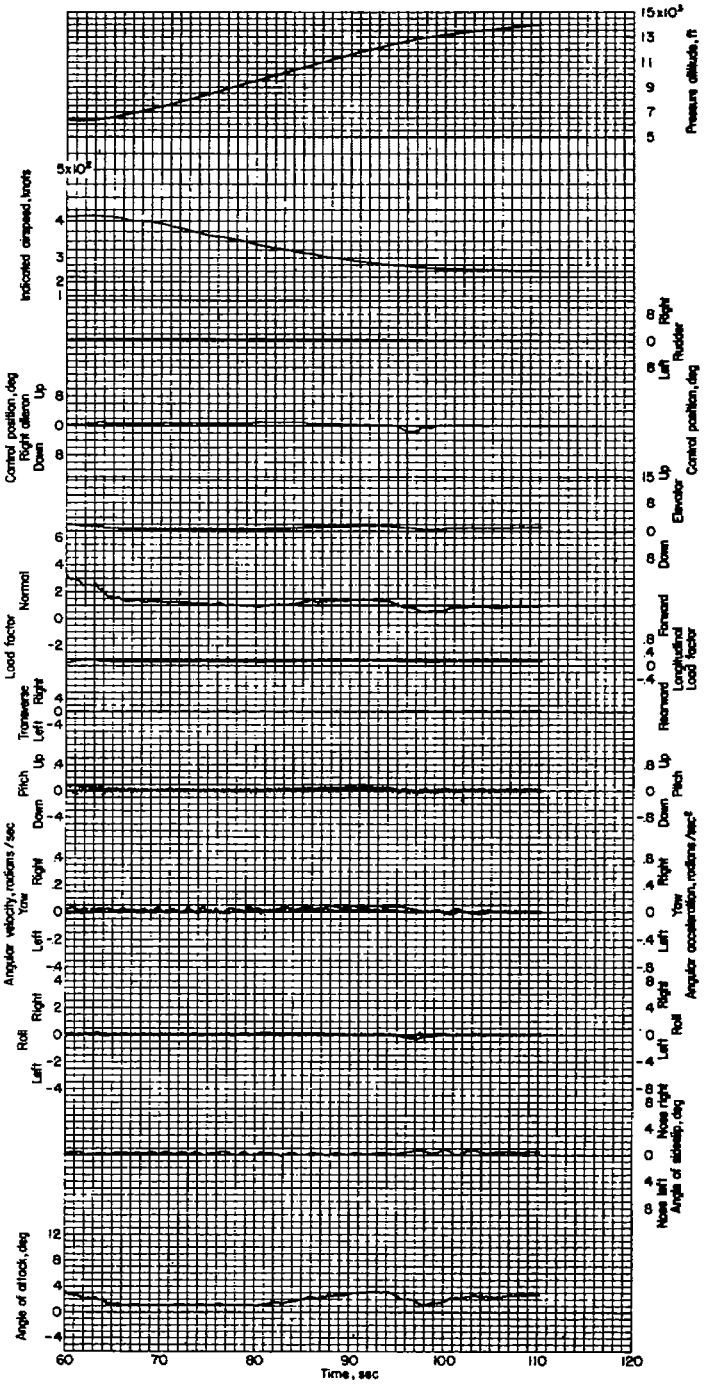
[redacted]



(a)

Figure 260.- Left sideslip followed by peel-off into dive-bombing run. Airplane weight, 16,360 pounds; center of gravity at 24.3 percent M.A.C.; flight 18.

[redacted]



(b)

Figure 260.- Concluded.

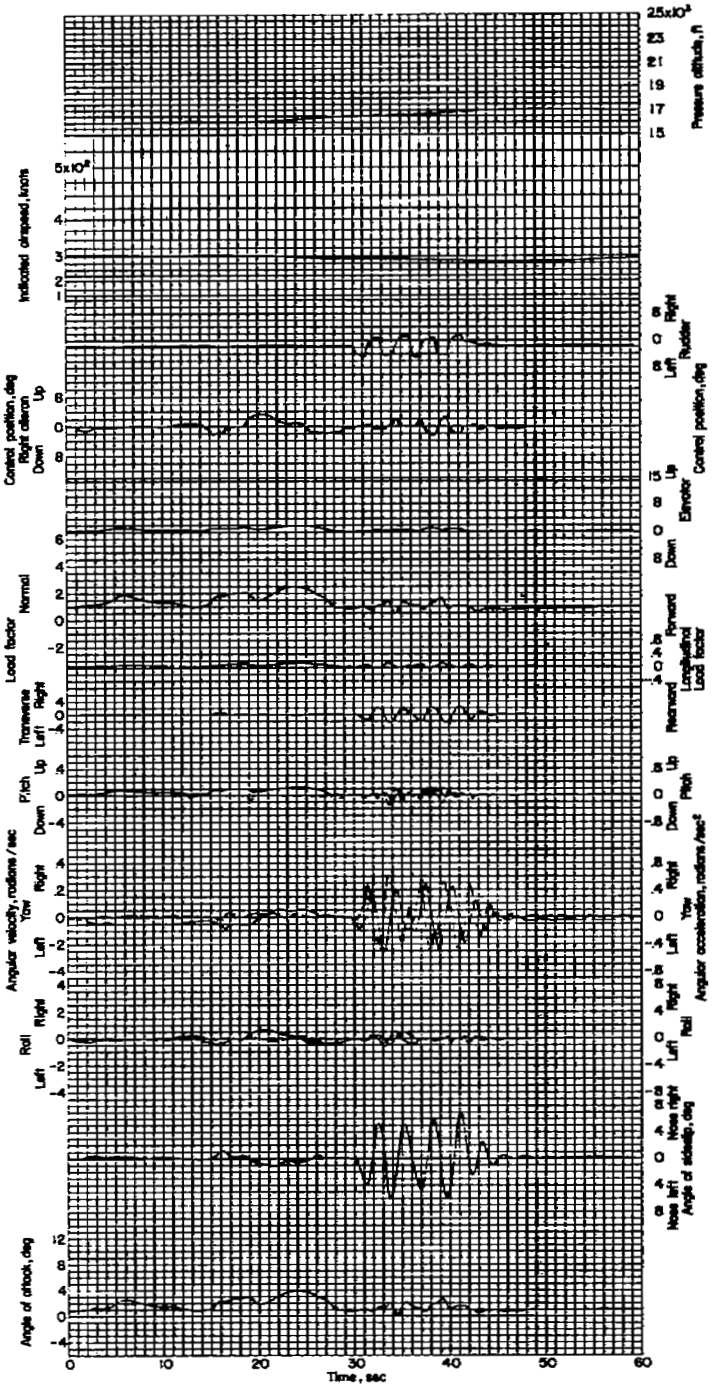


Figure 261.- Fishtails. Airplane weight, 15,860 pounds; center of gravity at 24.0 percent M.A.C.; flight 2.

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[redacted]

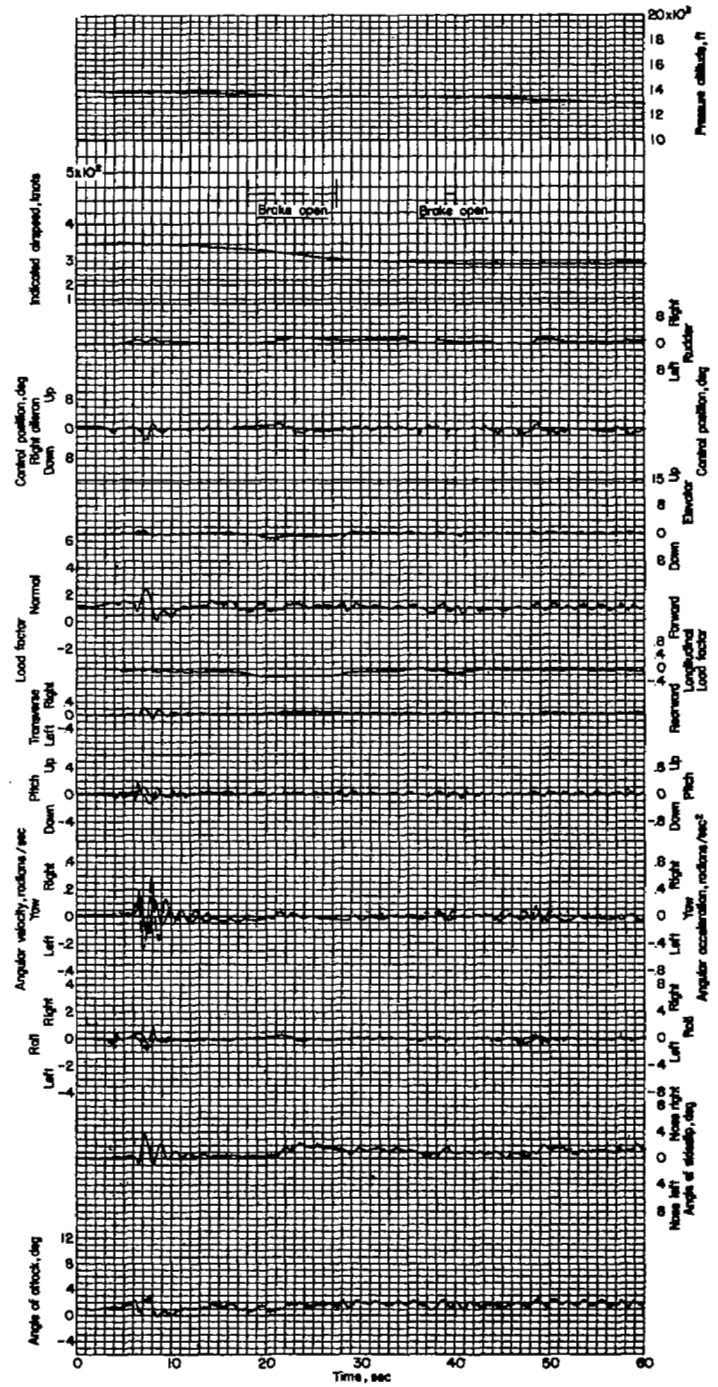


Figure 262.- Fishtails. Airplane weight, 14,080 pounds; center of gravity at 25.6 percent M.A.C.; flight 3.

[redacted]

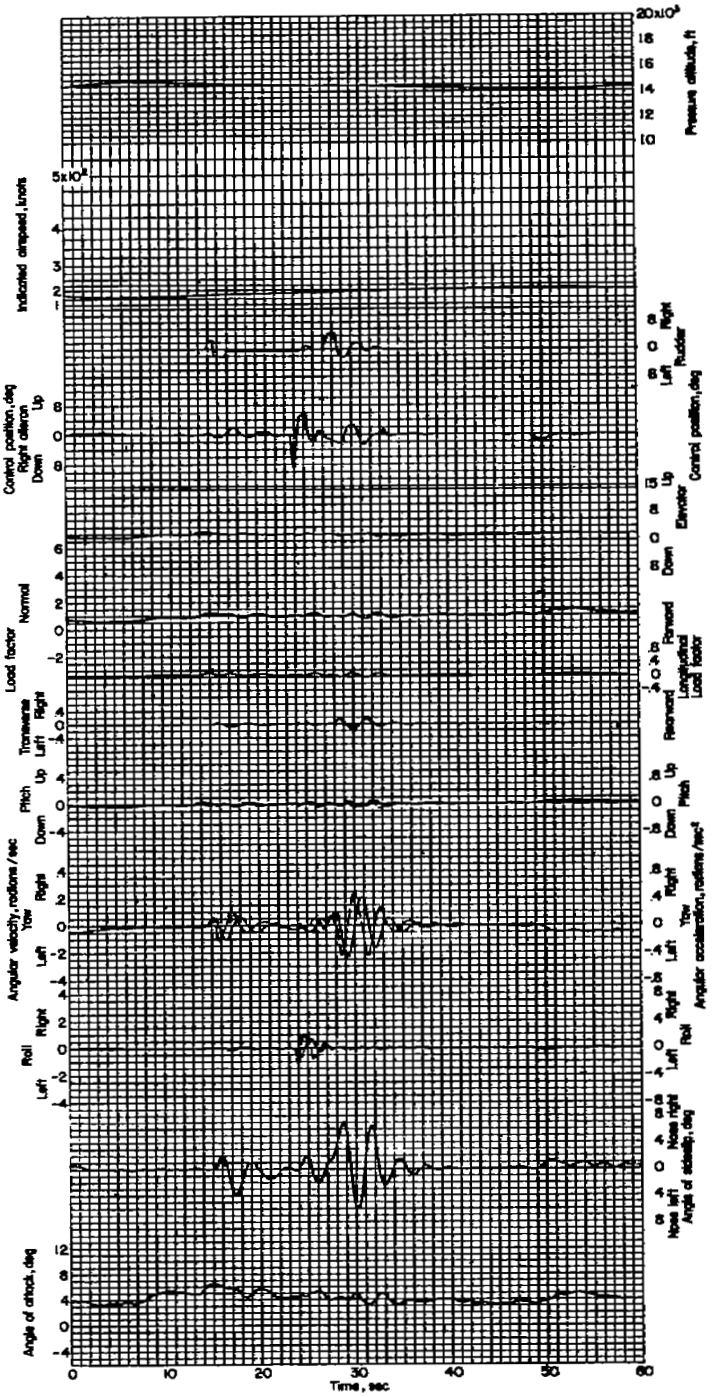
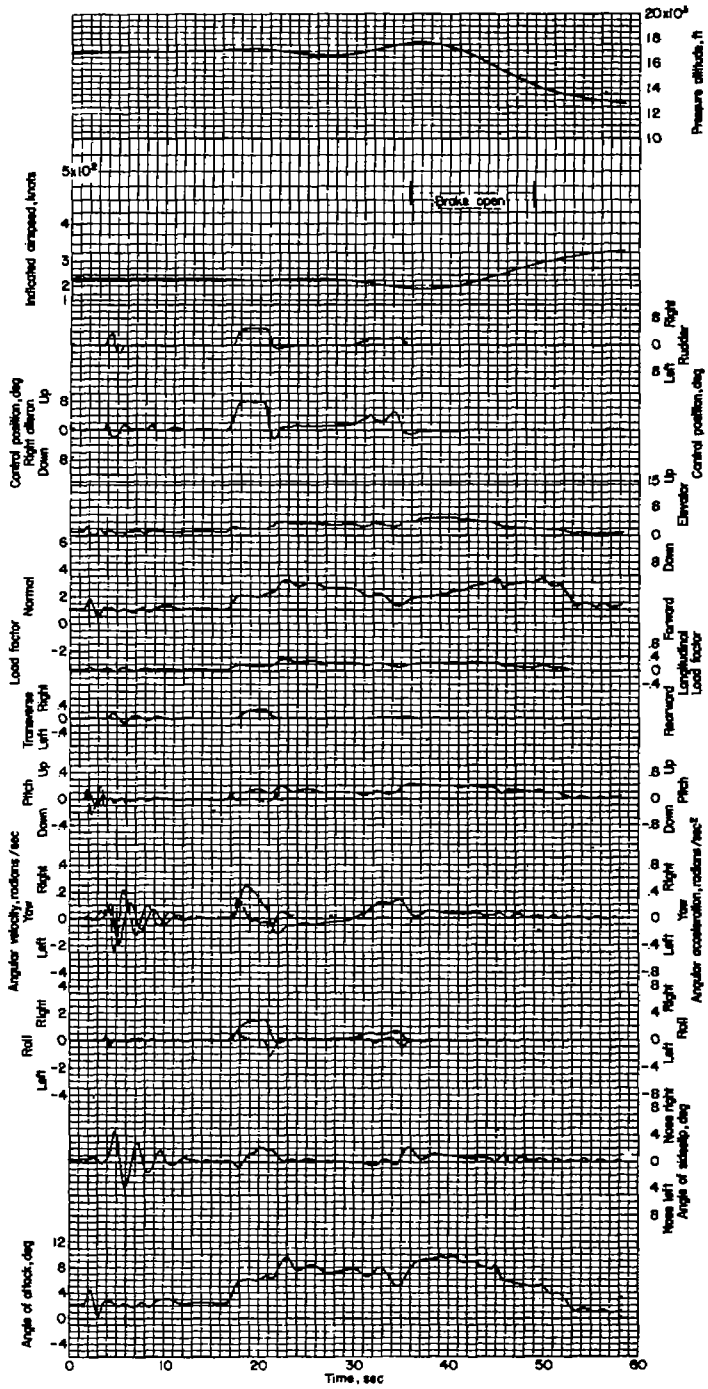


Figure 263.- Fishtails. Airplane weight, 14,250 pounds; center of gravity at 25.4 percent M.A.C.; flight 6.

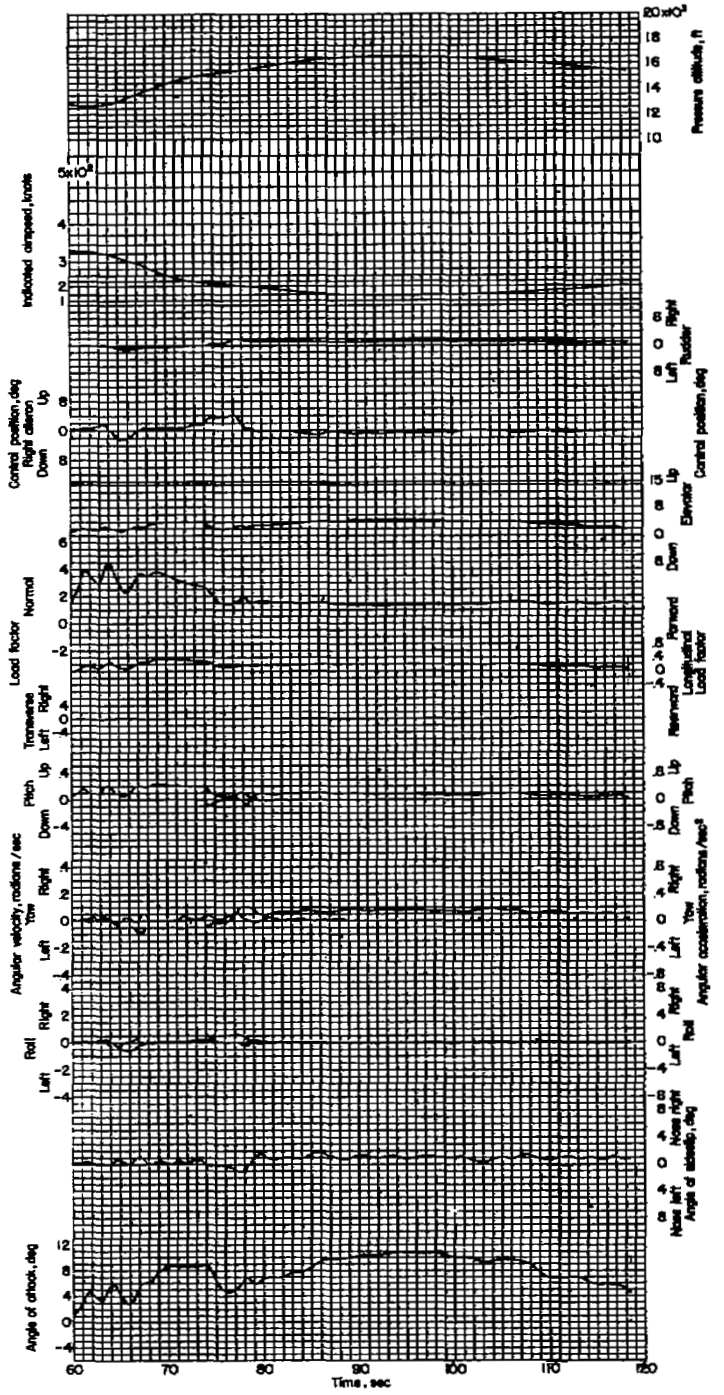
[redacted]



(a)

Figure 264.- Fishtails followed by right aileron roll with peel-off into dive and pull-up into climbing left turn. Airplane weight, 13,960 pounds; center of gravity at 25.8 percent M.A.C.; flight 6.

[redacted]



(b)

Figure 264.- Concluded.

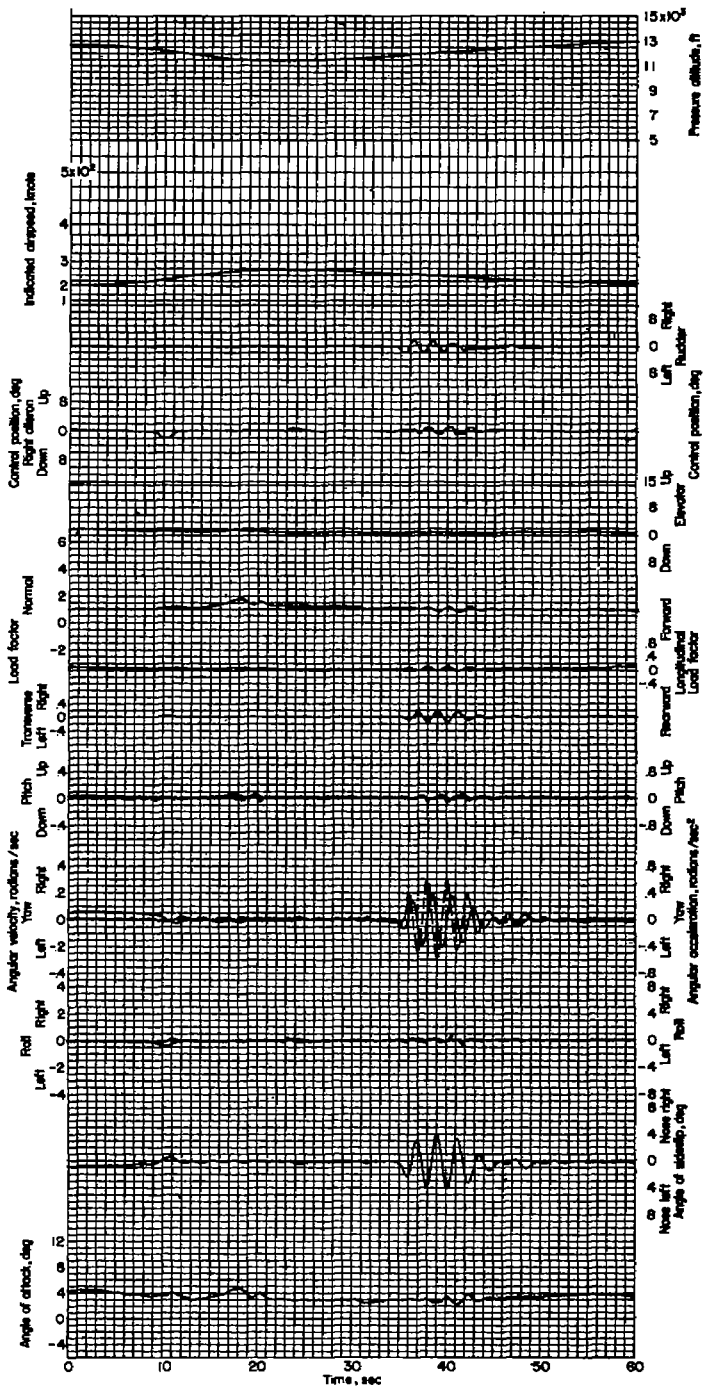
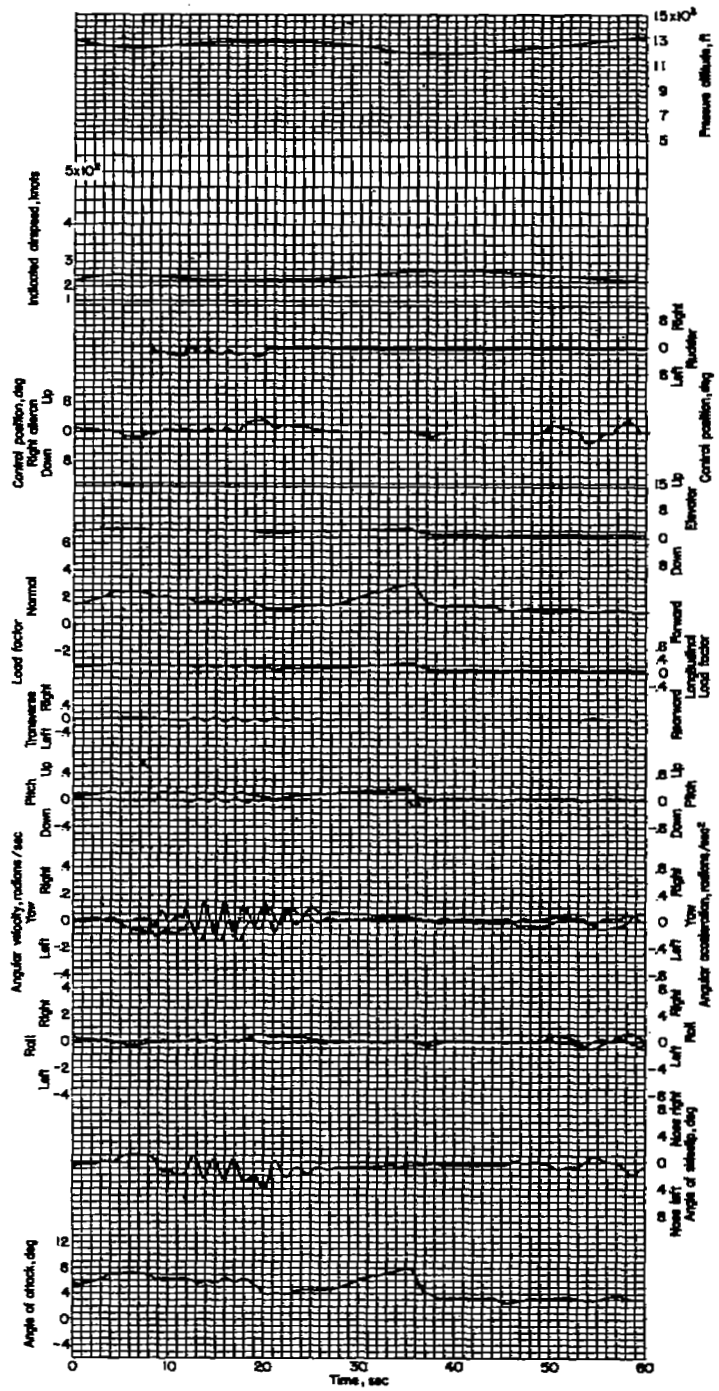


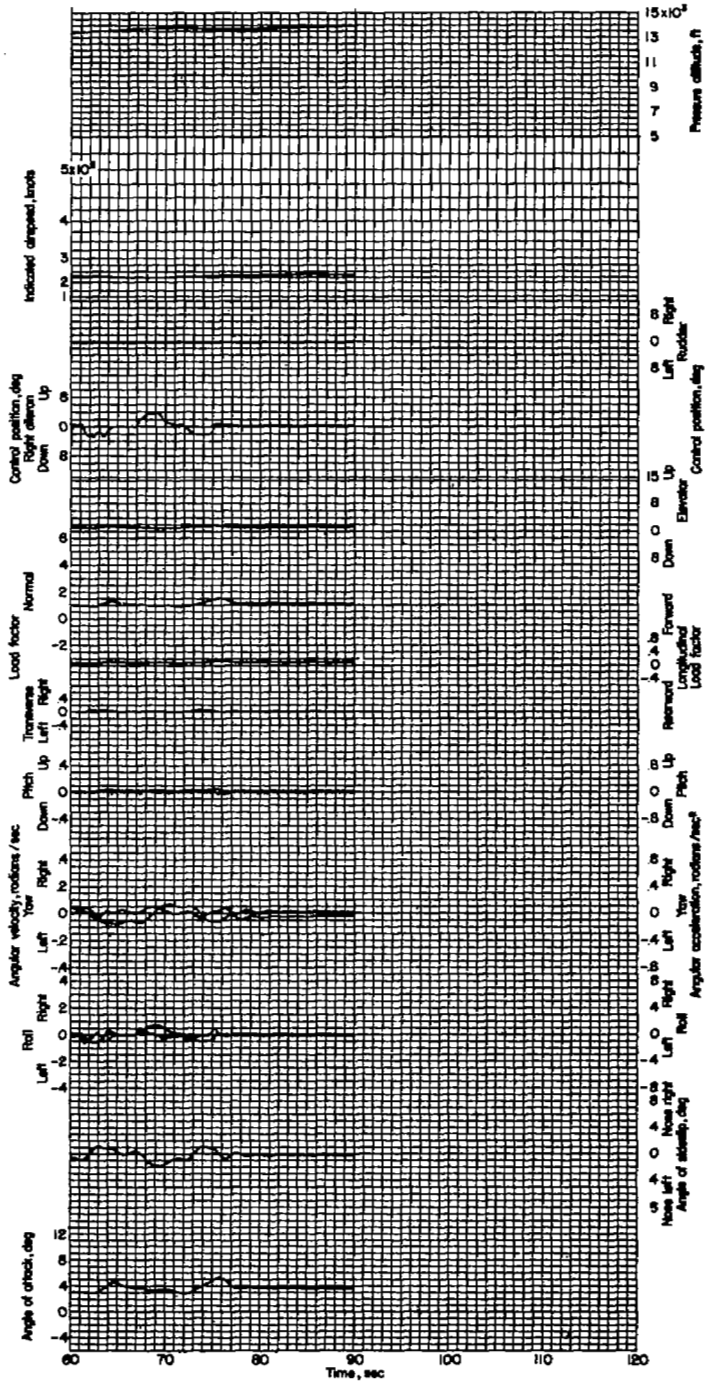
Figure 265.- Fishtails. Airplane weight, 14,450 pounds; center of gravity at 24.2 percent M.A.C.; flight 20.



(a)

Figure 266.- Fishtails while in left turn followed by series of banks. Airplane weight, 14,320 pounds; center of gravity at 24.4 percent M.A.C.; flight 20.

[redacted]



(b)

Figure 266.- Concluded.

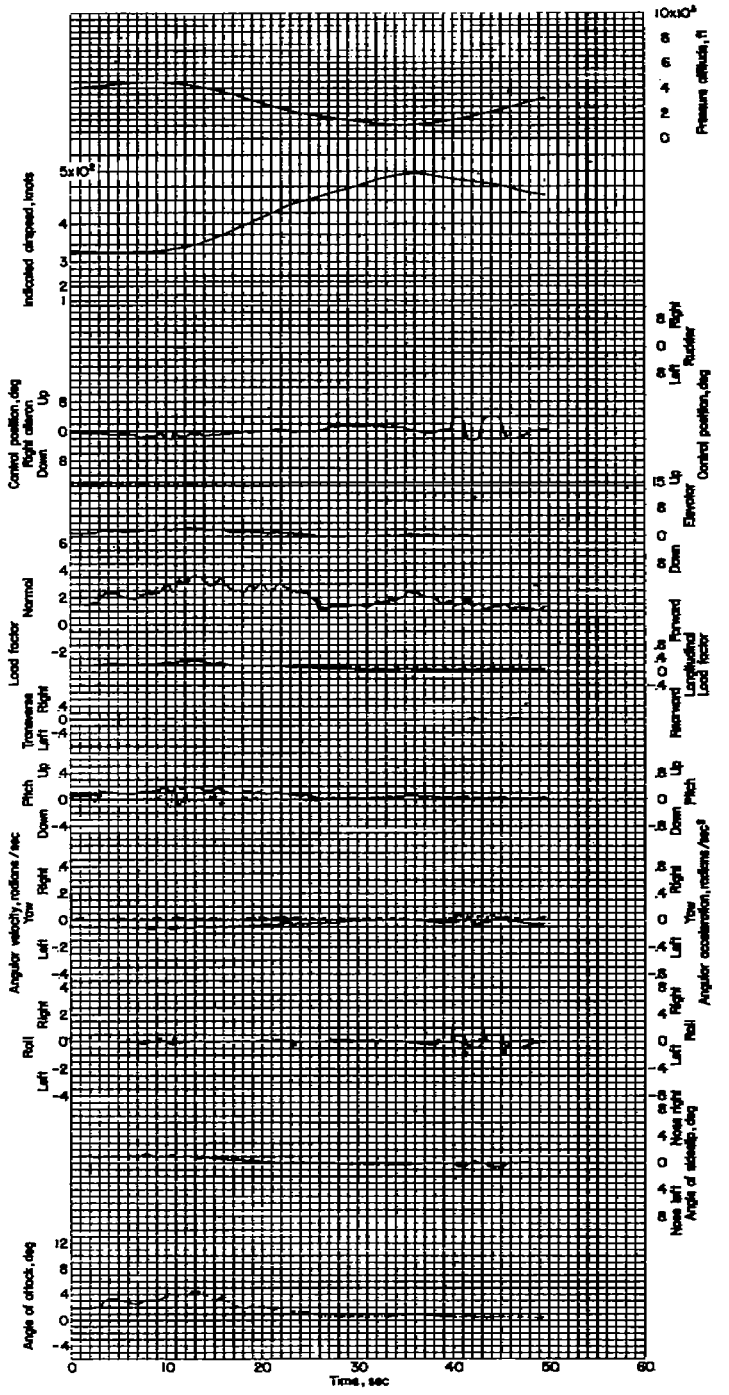
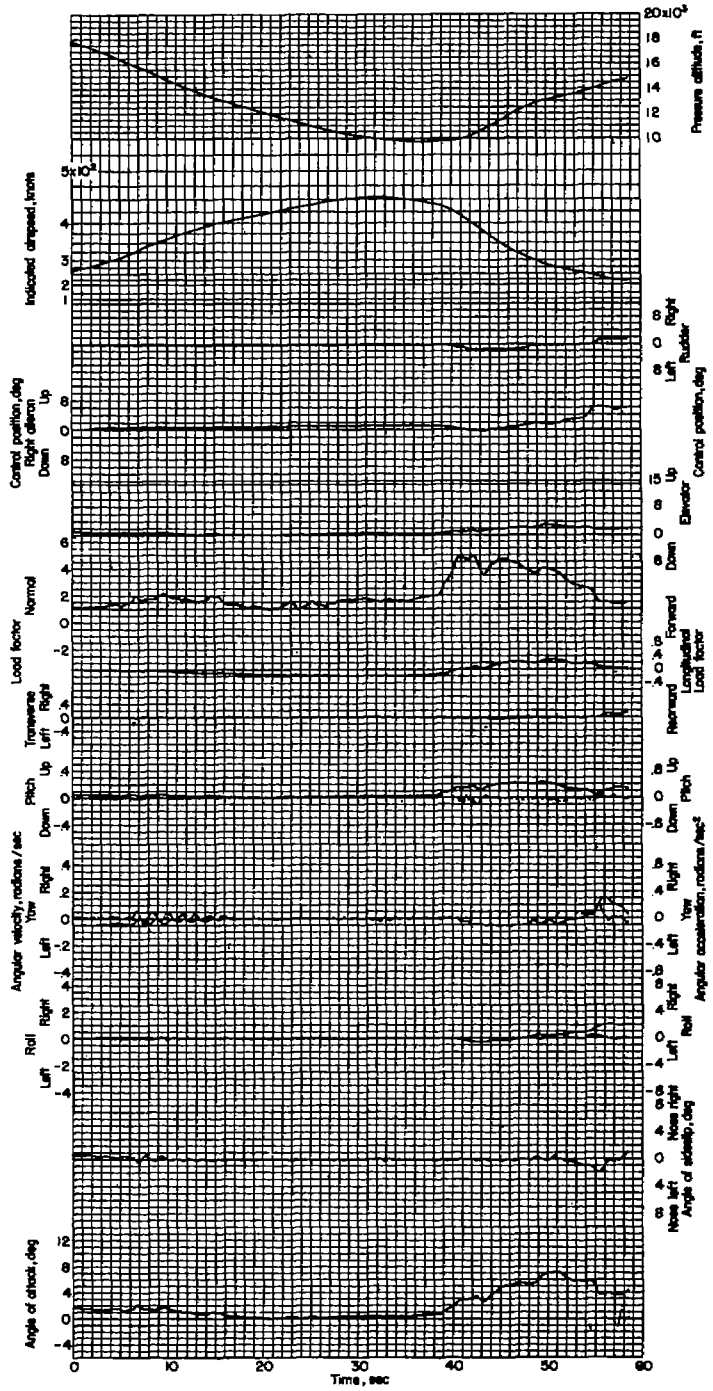


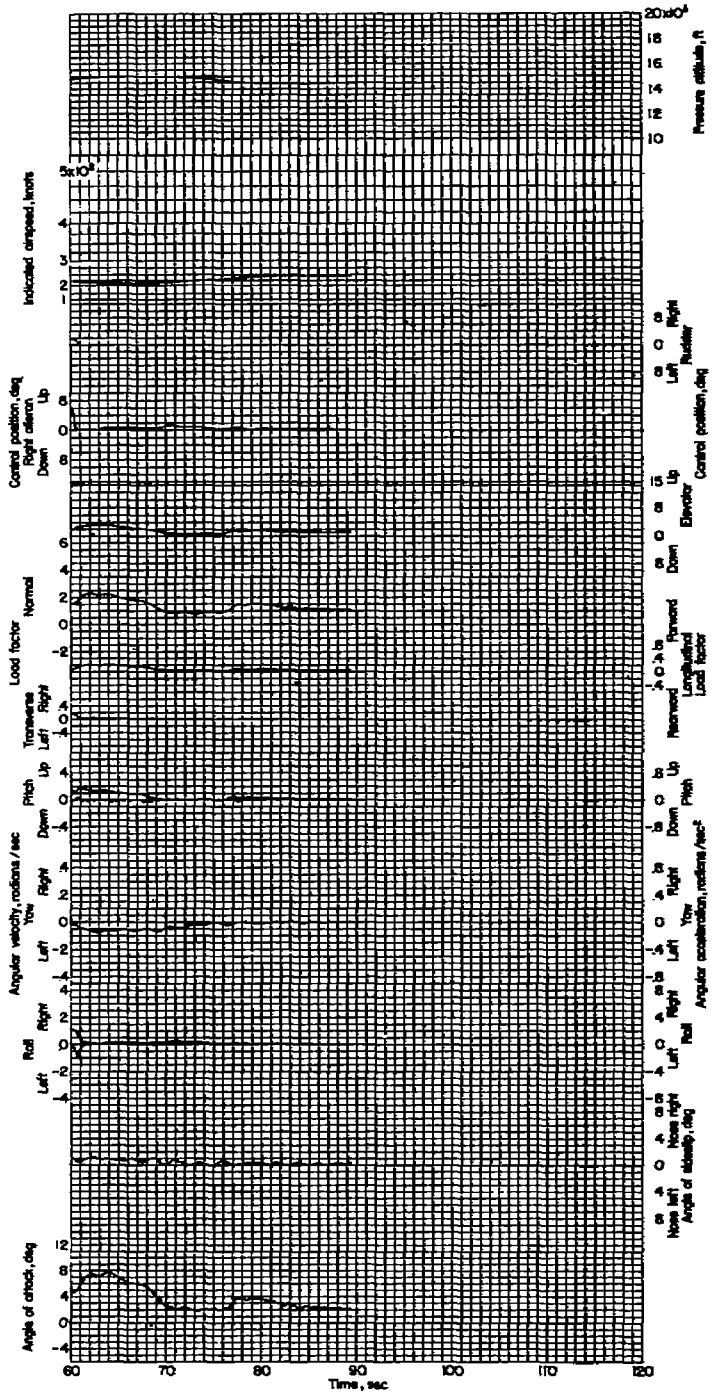
Figure 267.- Shallow dive. Airplane weight, 15,990 pounds; center of gravity at 24.1 percent M.A.C.; flight 5.



(a)

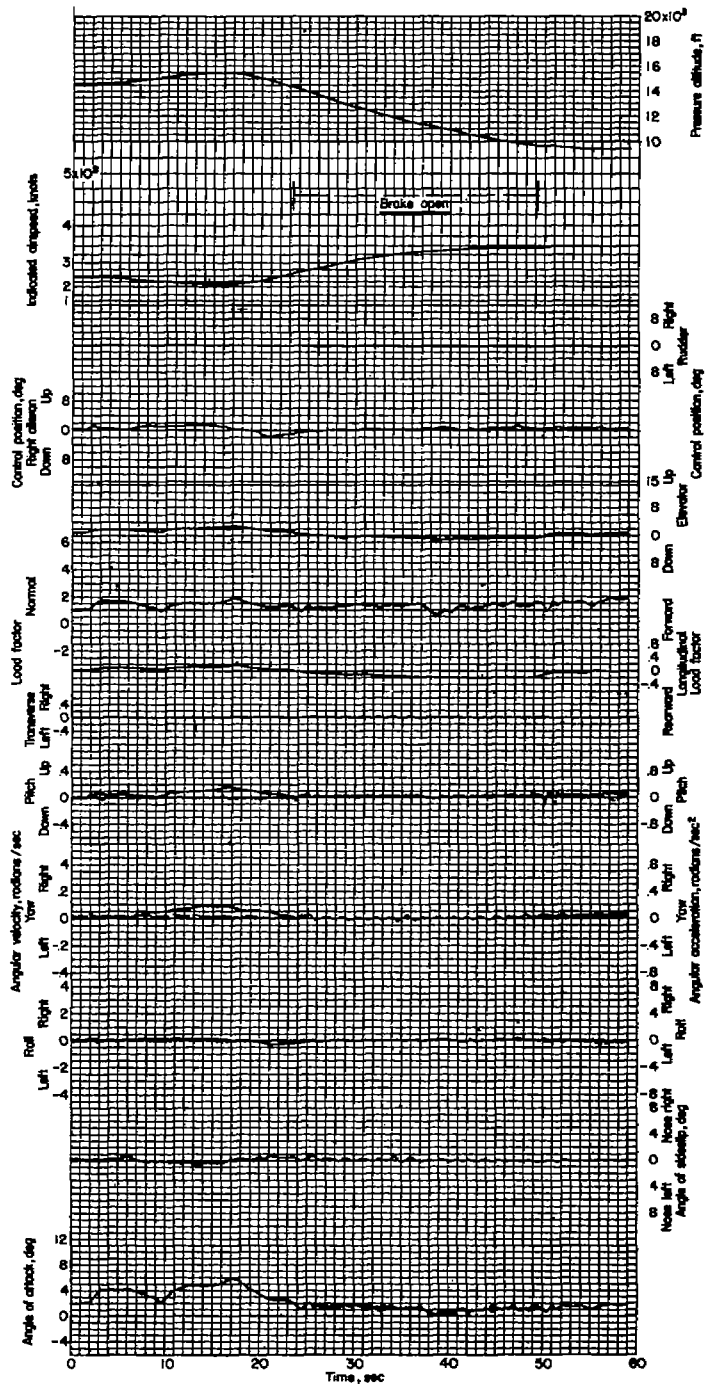
Figure 268.- Dive and pull-up into climbing right aileron roll. Airplane weight, 14,410 pounds; center of gravity at 25.2 percent M.A.C.; flight 6.

[redacted]



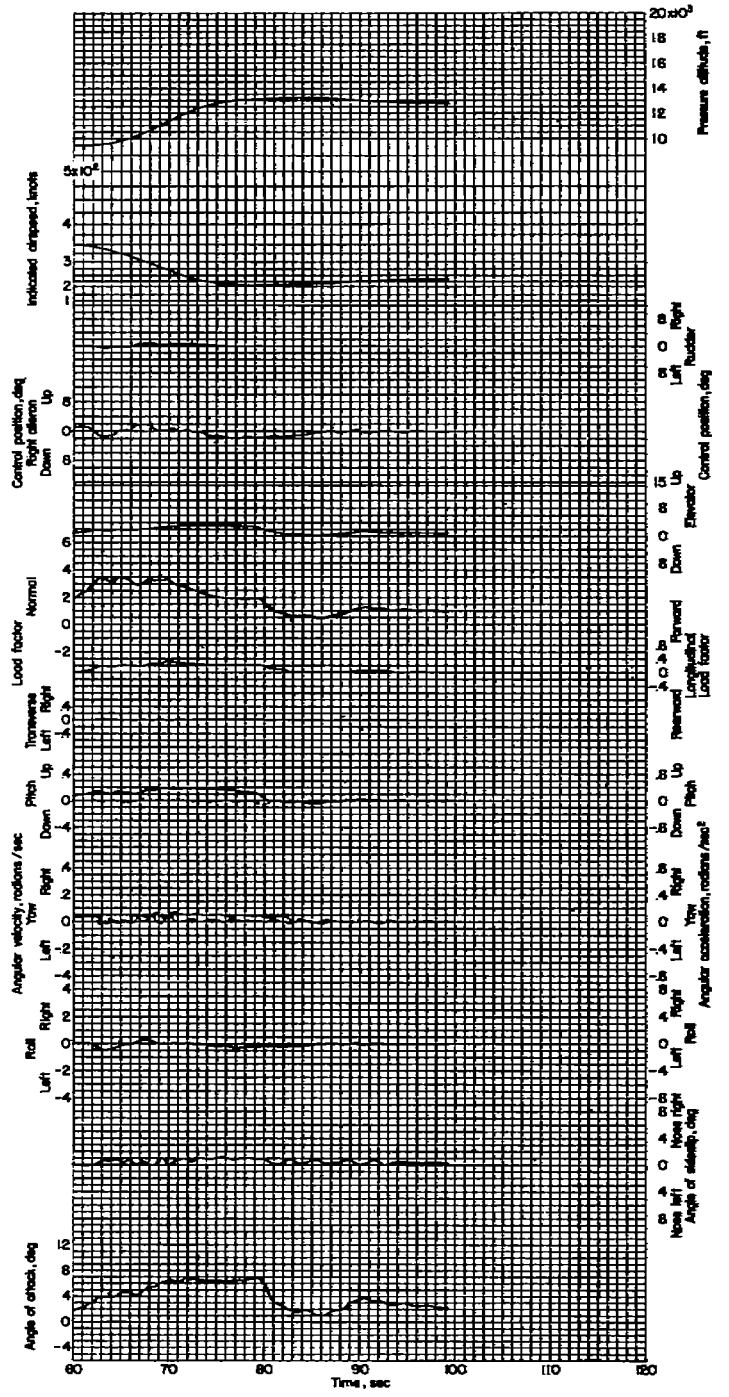
(b)

Figure 268.- Concluded.



(a)

Figure 269.- Shallow dive and pull-out. Airplane weight, 14,330 pounds; center of gravity at 25.3 percent M.A.C.; flight 6.



(b)

Figure 269.- Concluded.

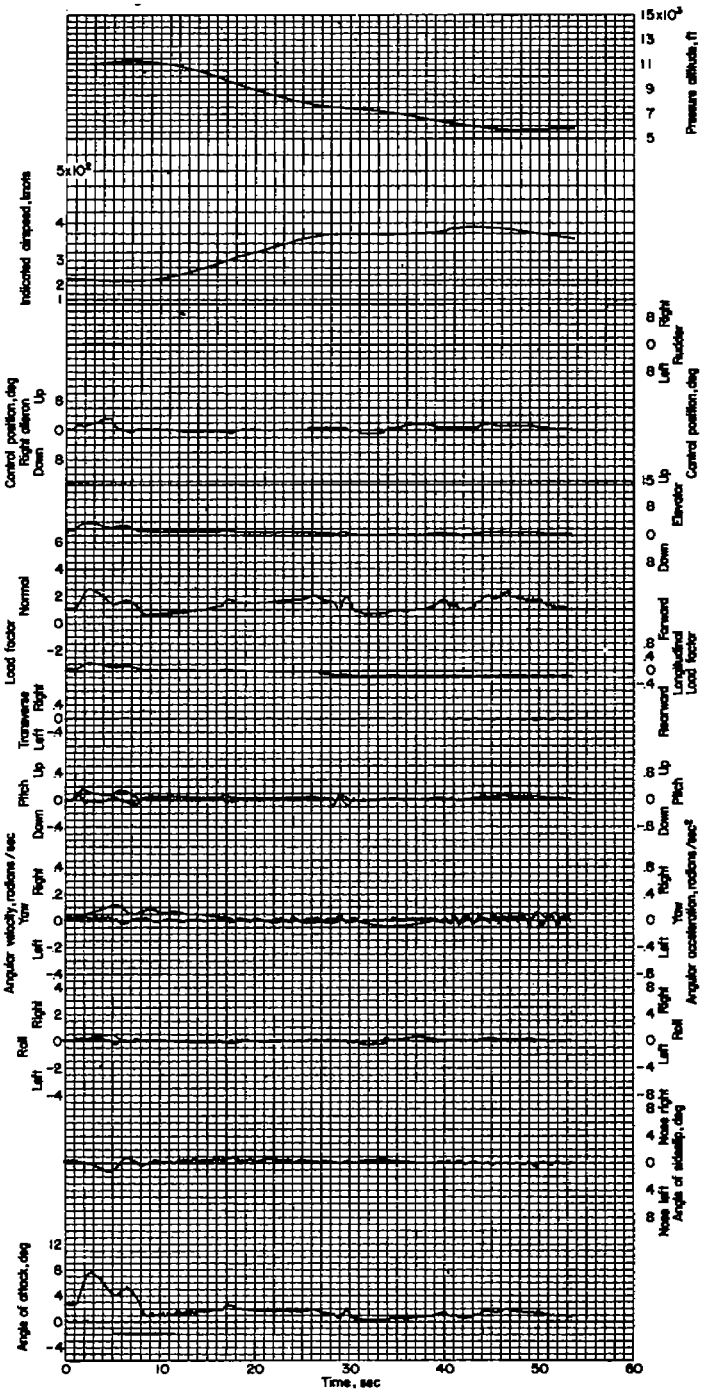


Figure 270.- Peel-off into shallow dive. Airplane weight, 14,460 pounds; center of gravity at 25.1 percent M.A.C.; flight 8.

[redacted]

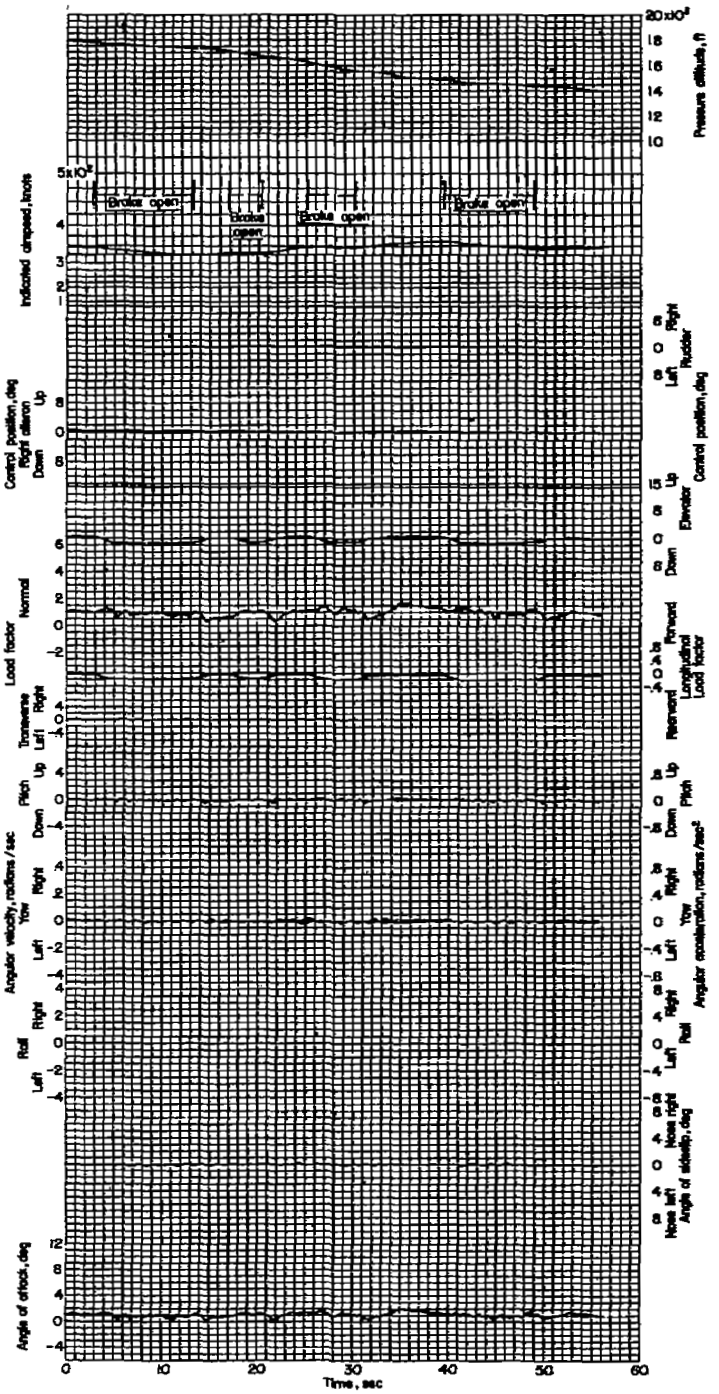


Figure 271.- Shallow dive. Airplane weight, 15,440 pounds; center of gravity at 23.8 percent M.A.C.; flight 10.

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[redacted]

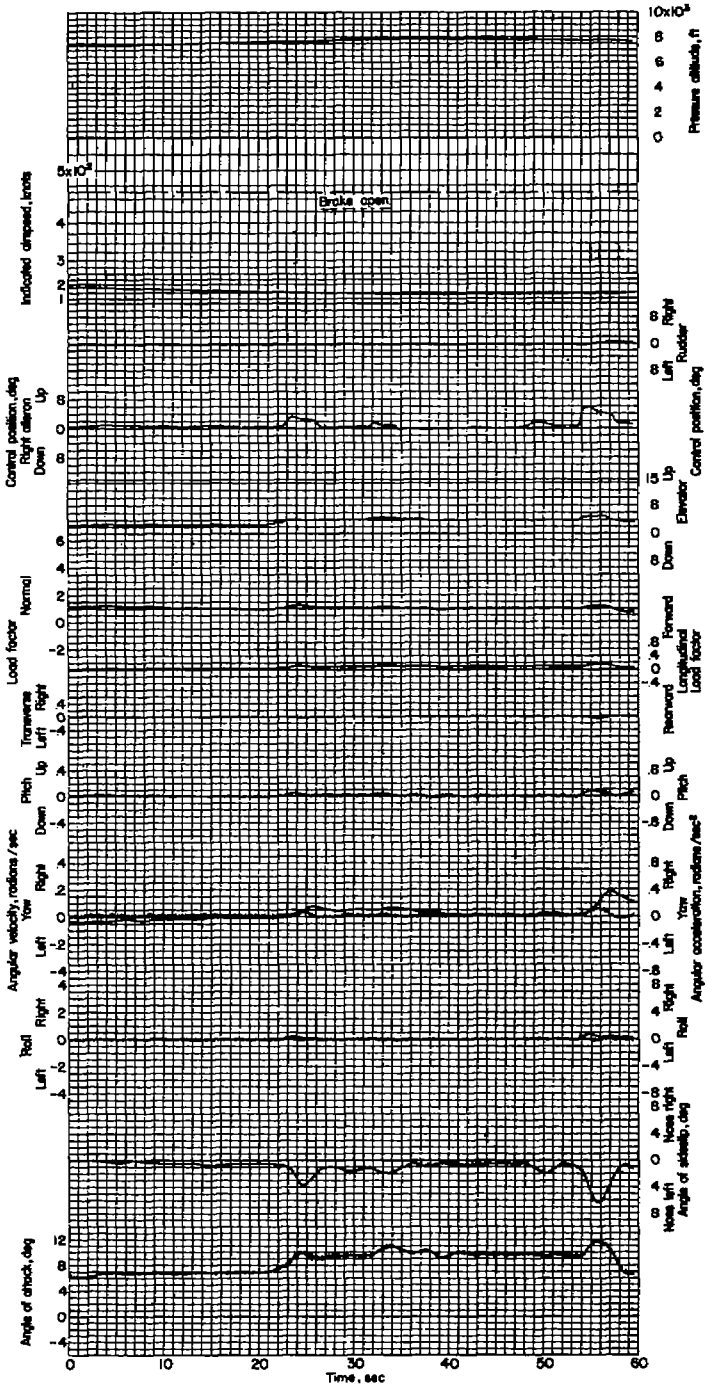
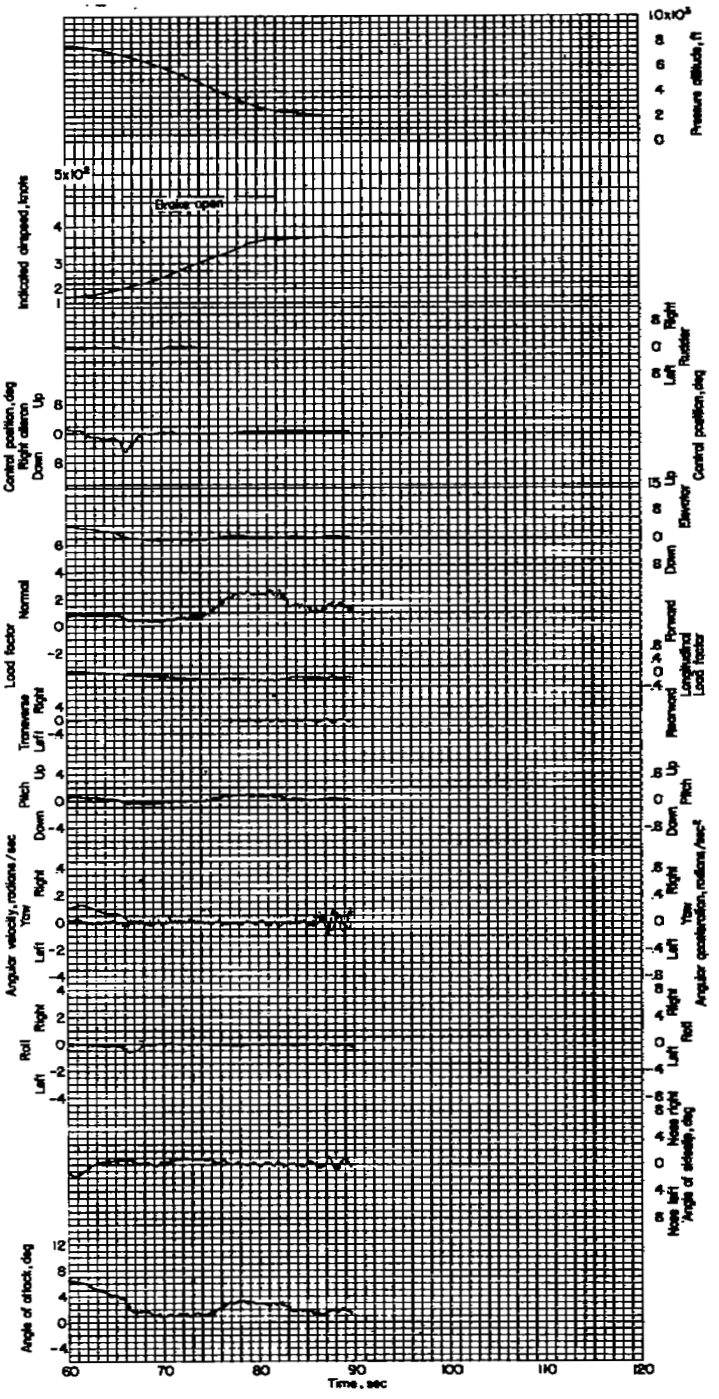


Figure 272.- Left and right turn followed by peel-off into dive. Airplane weight, 14,690 pounds; center of gravity at 24.8 percent M.A.C.; flight 11.

[redacted]



(b)

Figure 272.- Concluded.

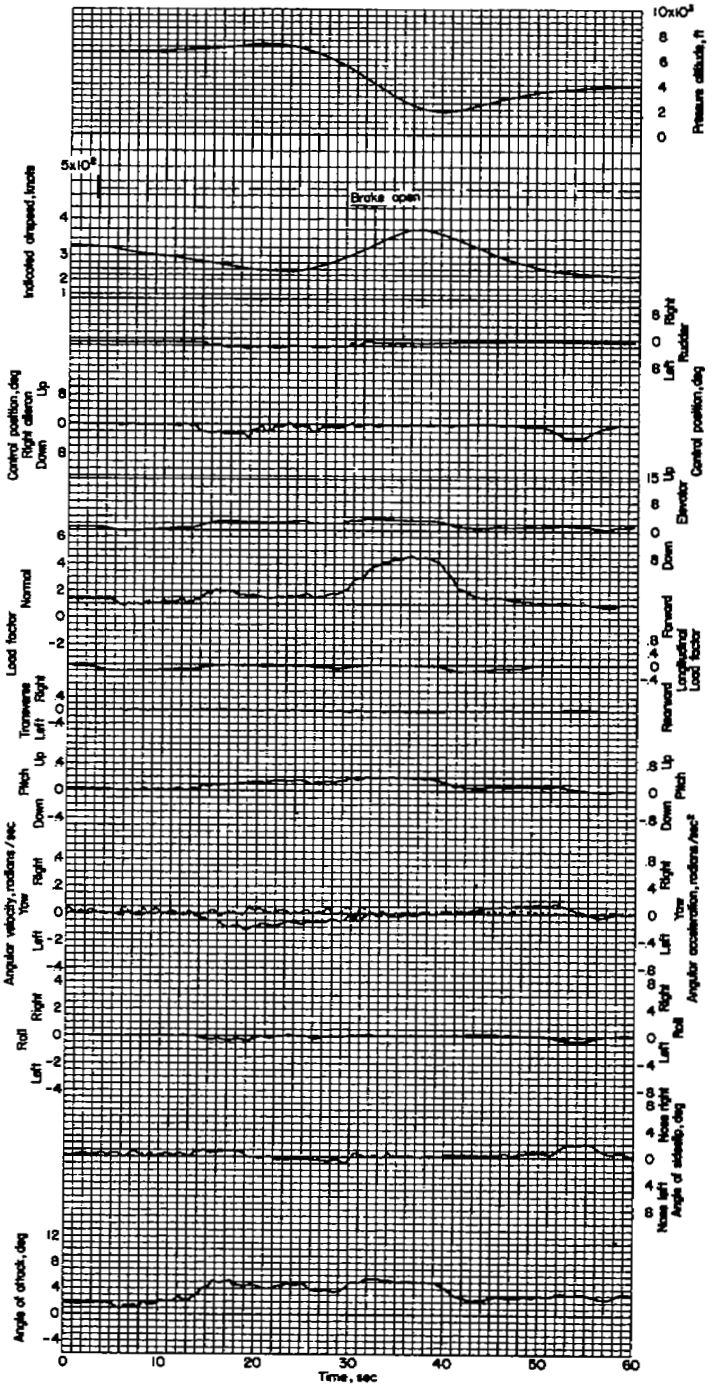
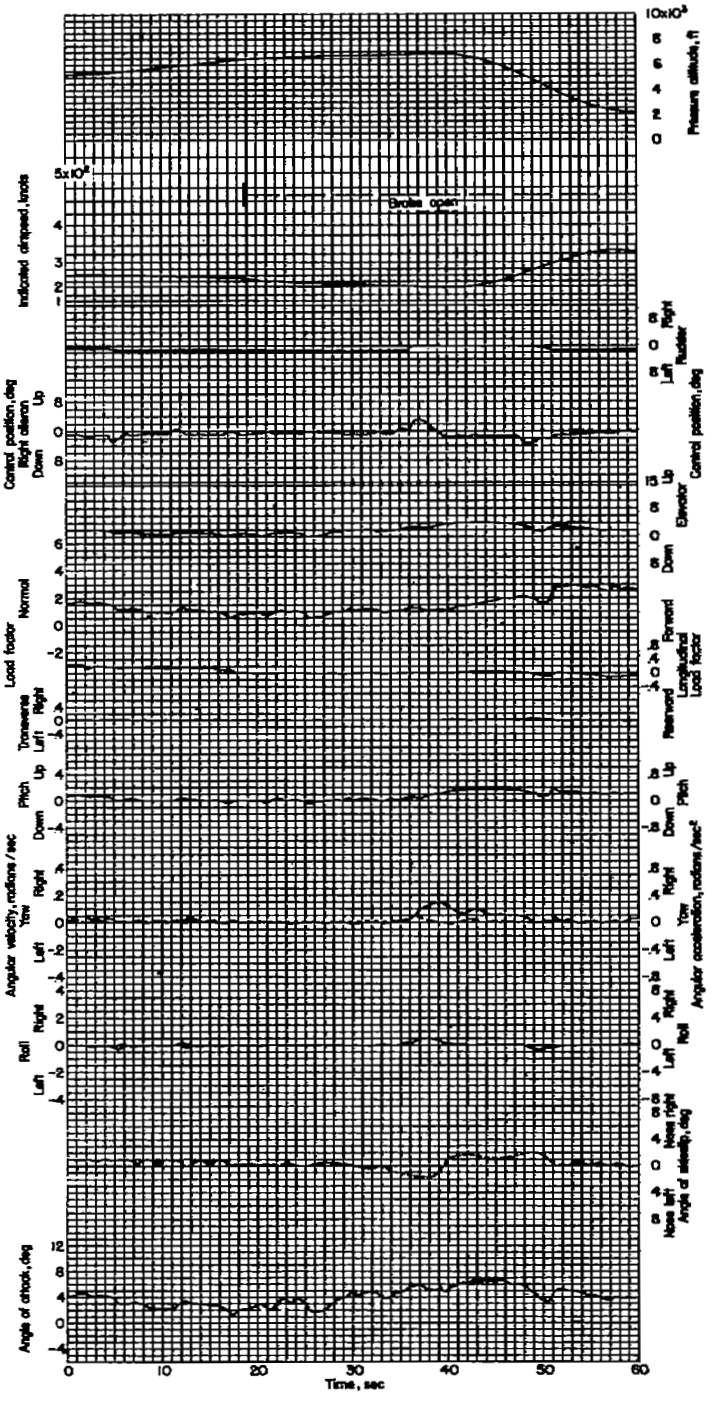


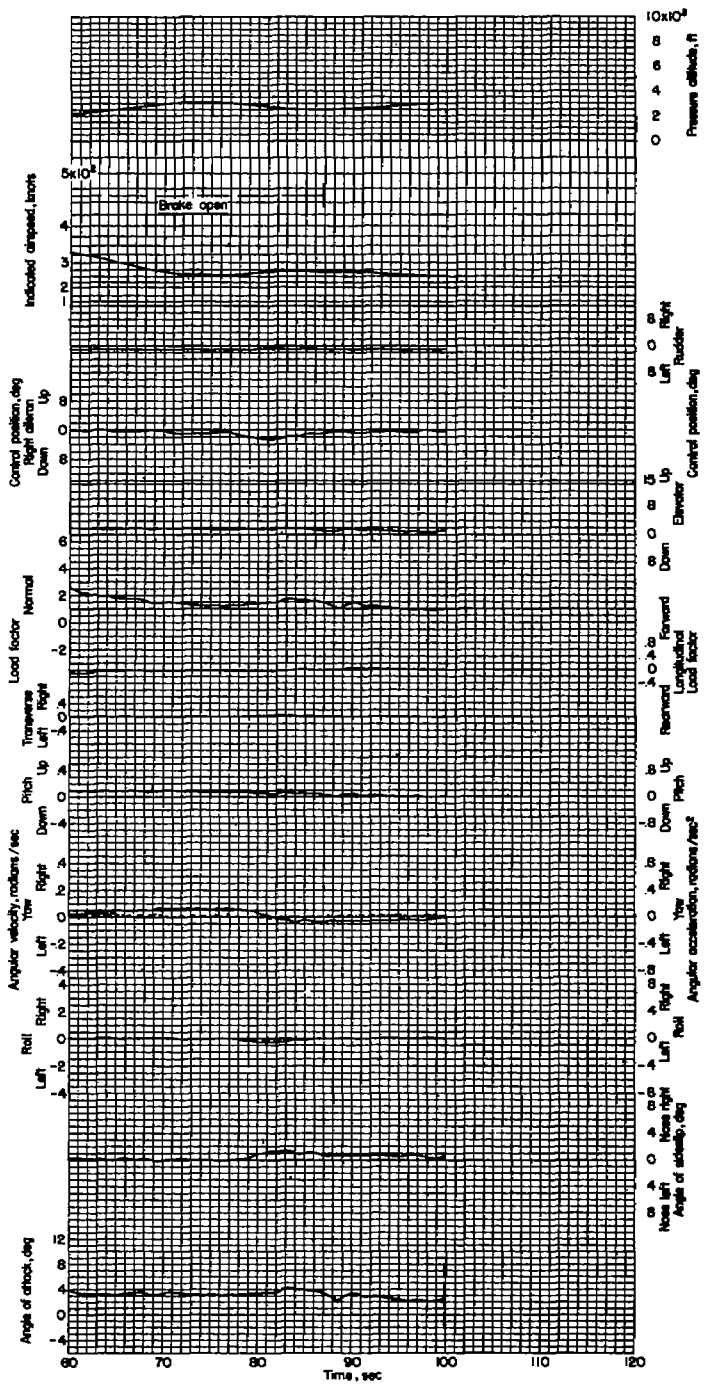
Figure 273.- Peel-off into dive-bombing run. Airplane weight, 16,450 pounds; center of gravity at 24.4 percent M.A.C.; flight 2.



(a)

Figure 274.- Dive-bombing run. Airplane weight, 16,370 pounds; center gravity at 24.3 percent M.A.C.; flight 2.

[redacted]



(b)

Figure 274.- Concluded.

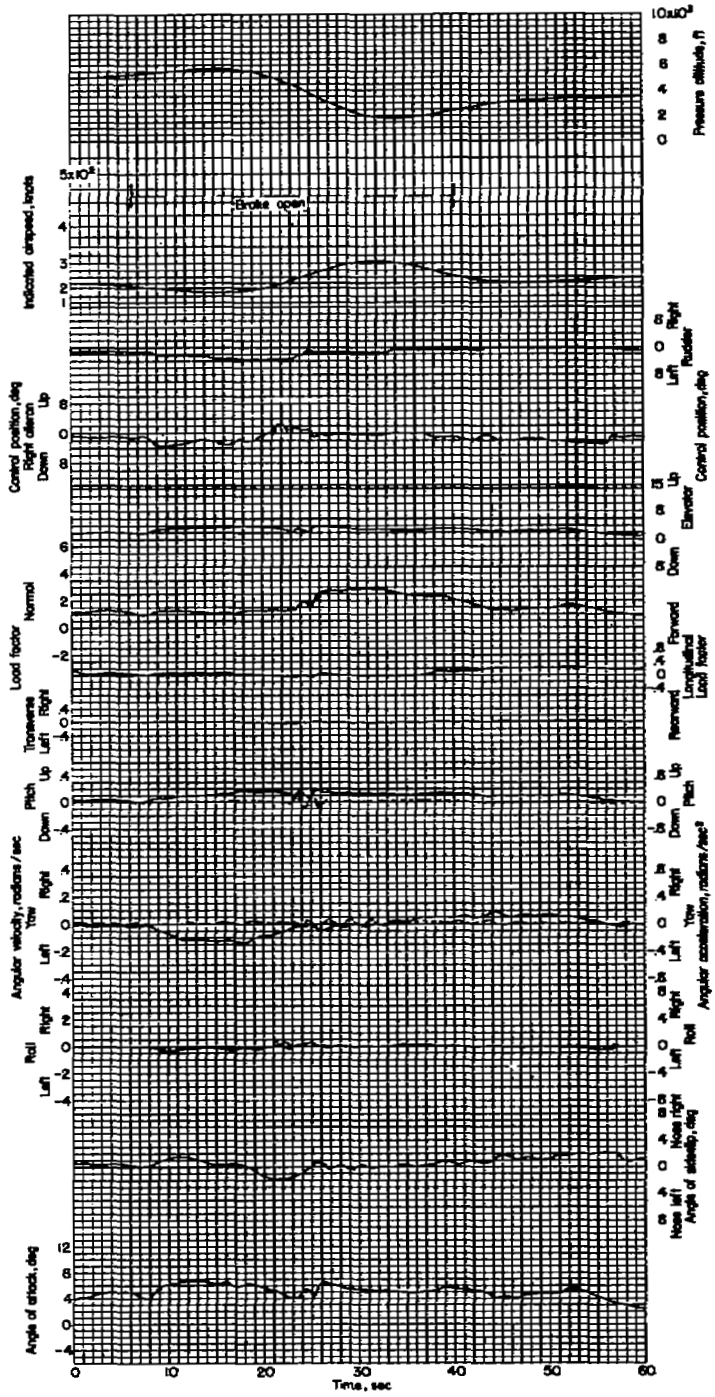


Figure 275.- Peel-off into dive-bombing run. Airplane weight, 16,270 pounds; center of gravity at 24.3 percent M.A.C.; flight 2.

[redacted]

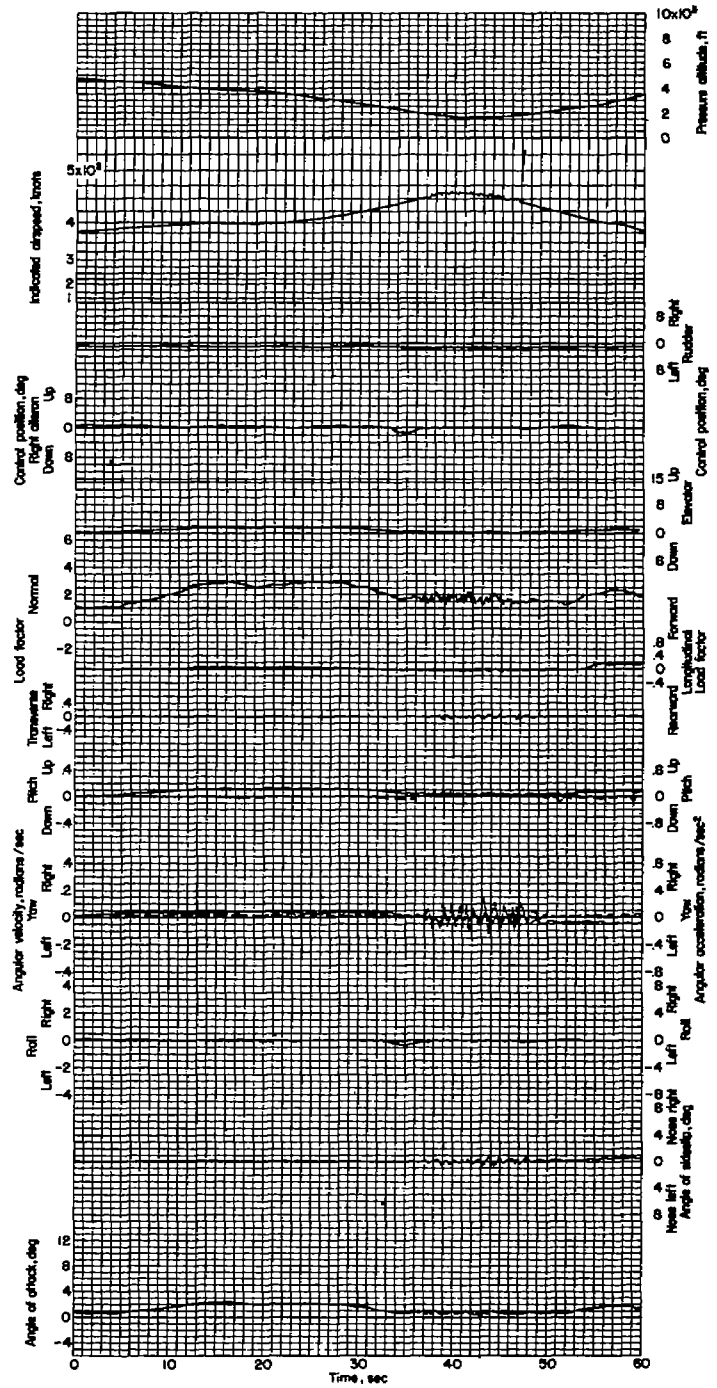
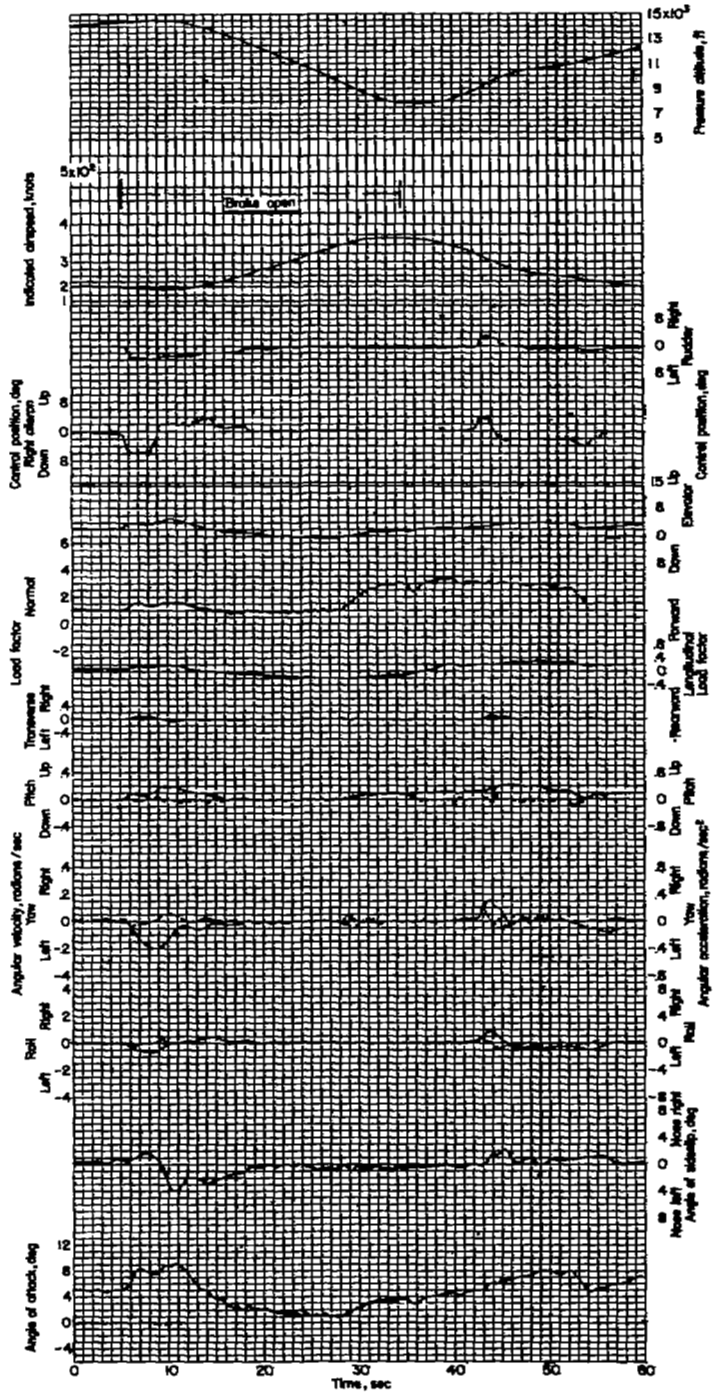


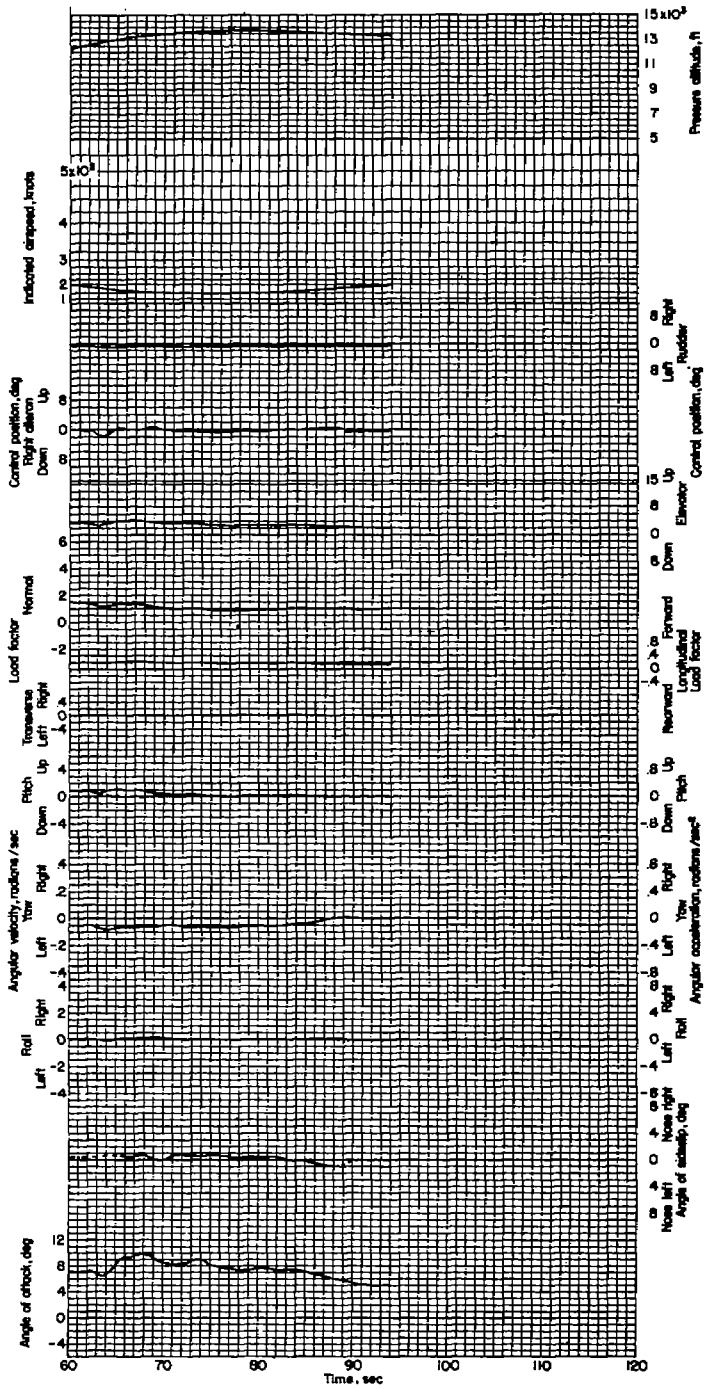
Figure 276.- Dive-bombing run. Airplane weight, 16,170 pounds; center of gravity at 24.2 percent M.A.C.; flight 2.

[redacted]



(a)

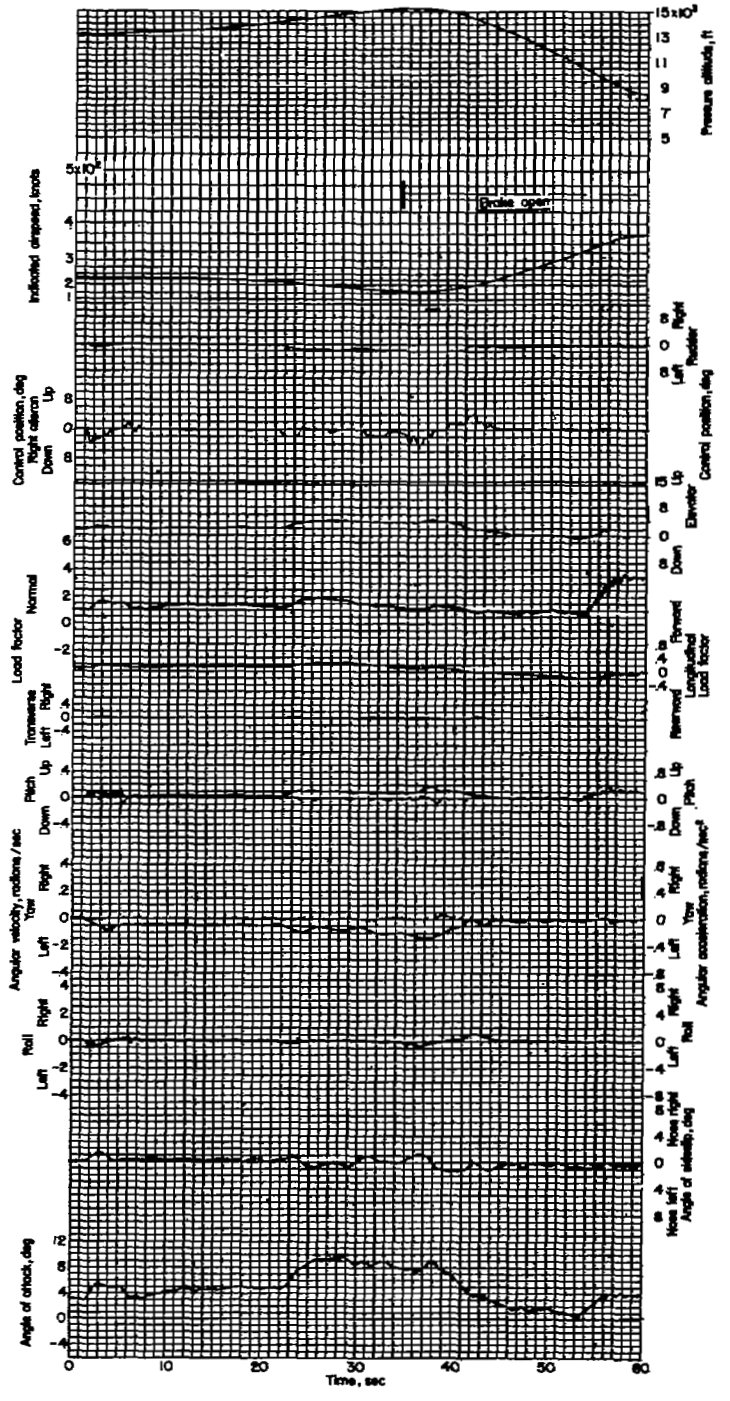
Figure 277.- Peel-off into dive-bombing run. Airplane weight, 16,450 pounds; center of gravity at 24.4 percent M.A.C.; flight 6.



(b)

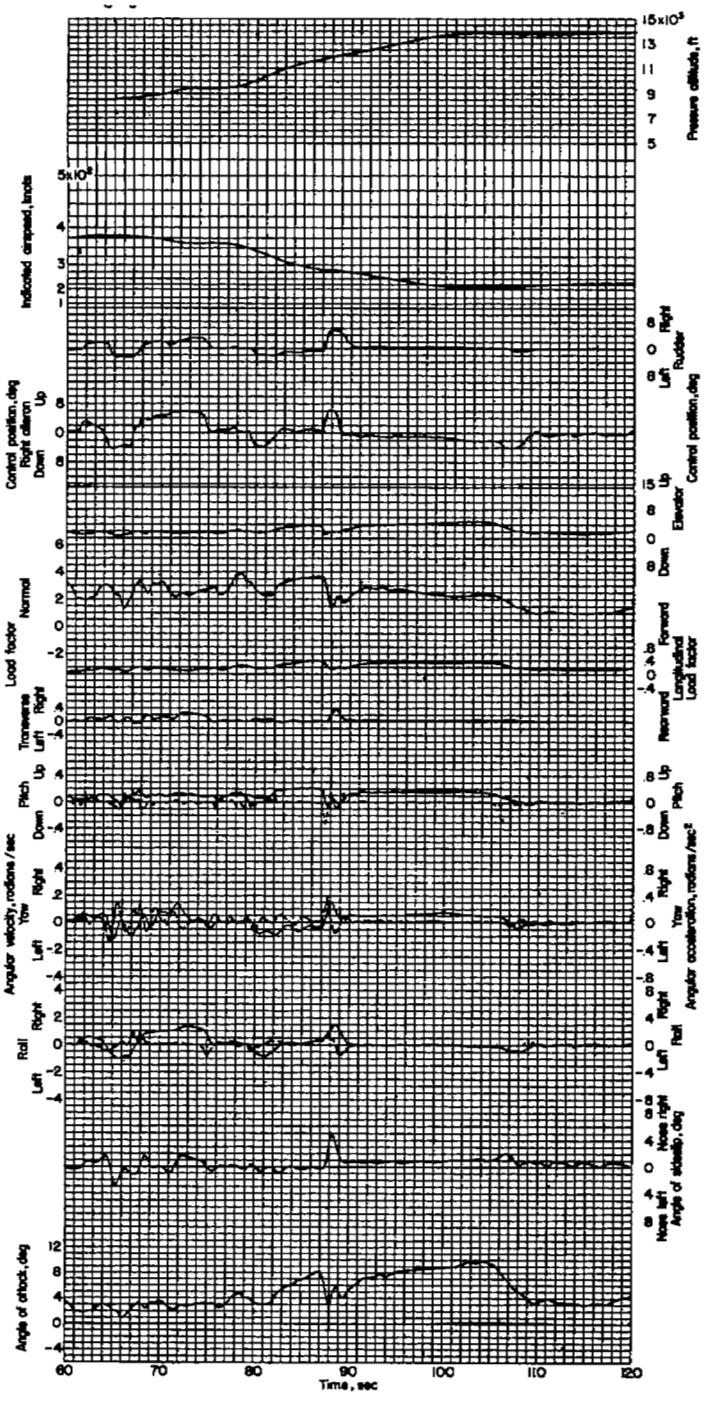
Figure 277.- Concluded.

[redacted]



(a)

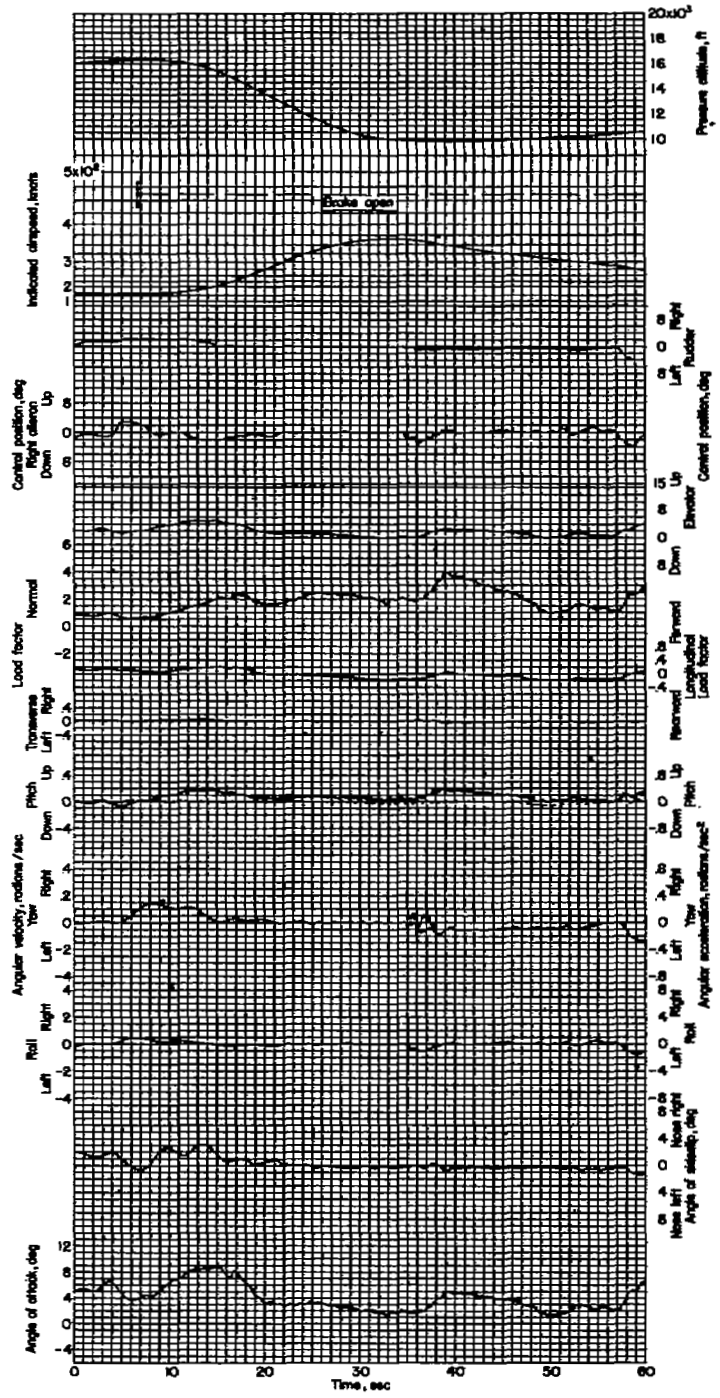
Figure 278.- Dive-bombing run followed by right and left bank into right barrel roll followed by chandelle. Airplane weight, 16,360 pounds; center of gravity at 24.3 percent M.A.C.; flight 6.



(b)

Figure 278.- Concluded.

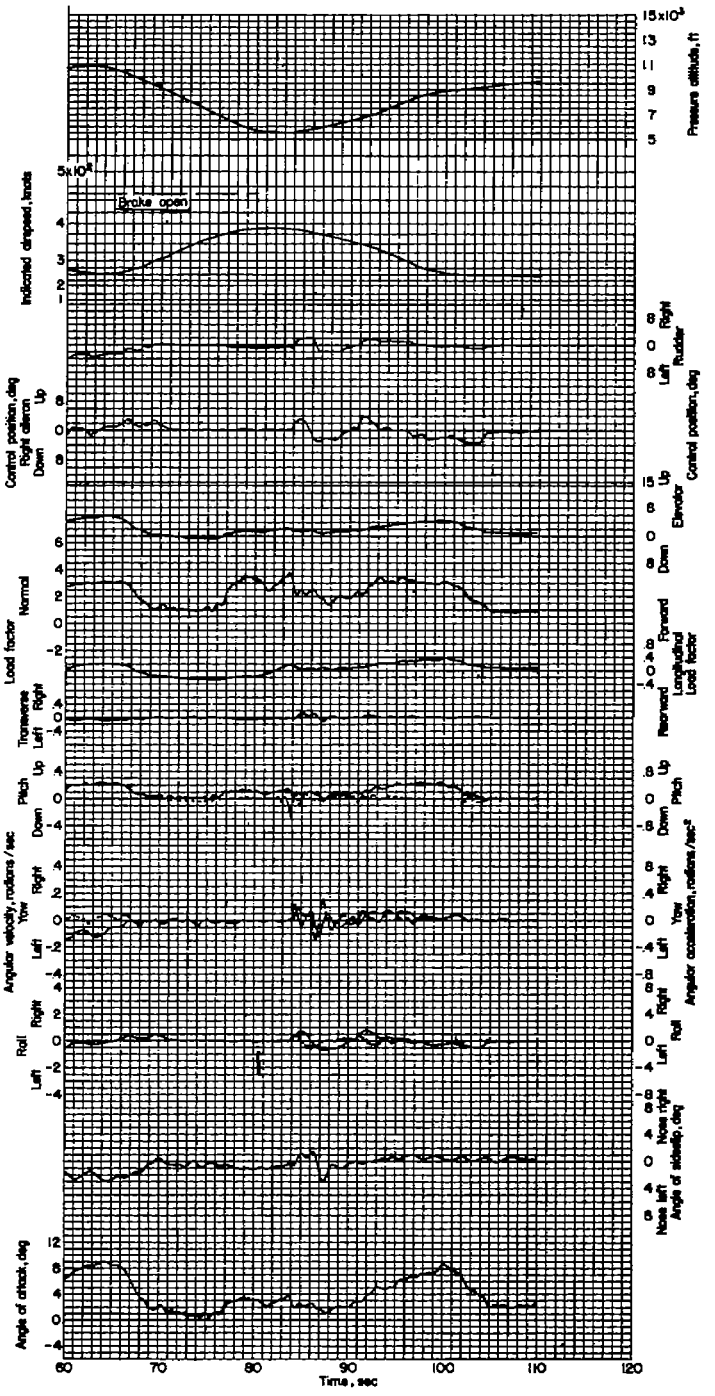
[redacted]



(a)

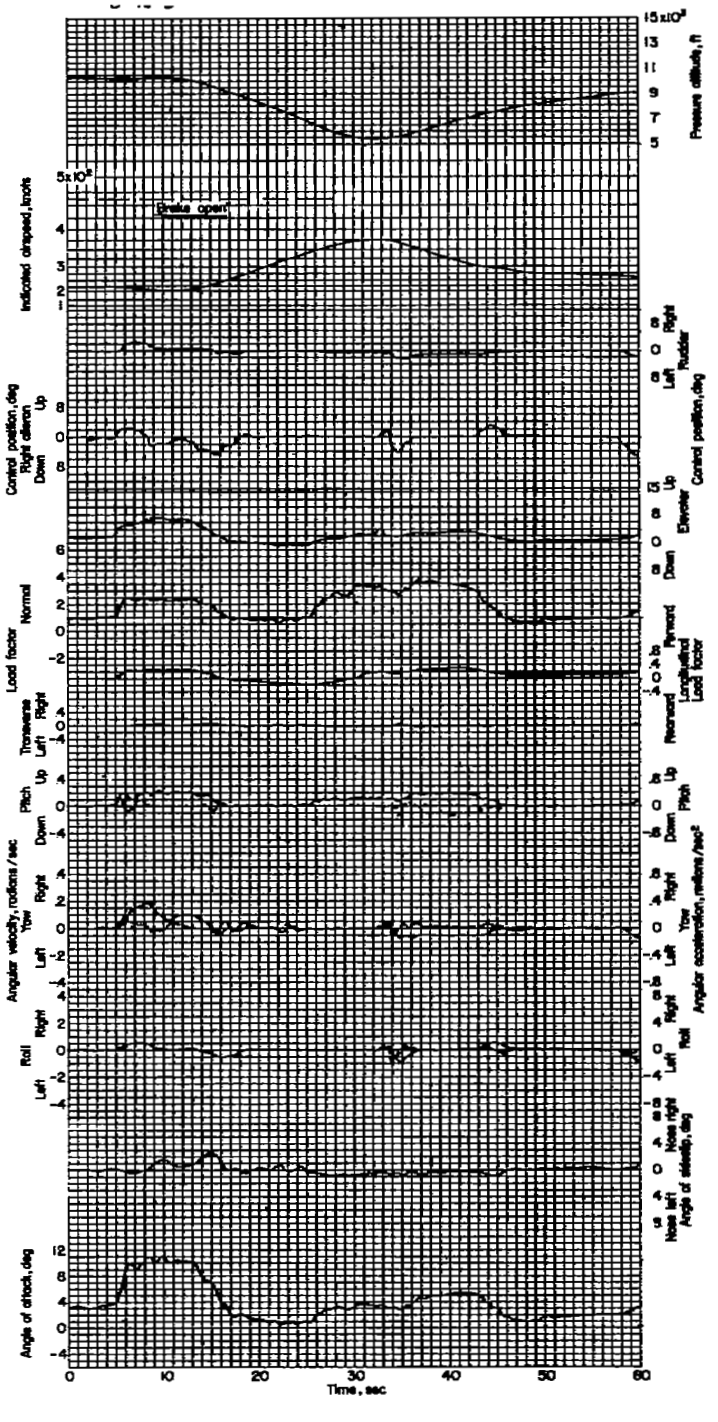
Figure 279.- Two dive-bombing runs. Airplane weight, 16,260 pounds; center of gravity at 24.3 percent M.A.C.; flight 6.

[redacted]



(b)

Figure 279.- Concluded.



(a)

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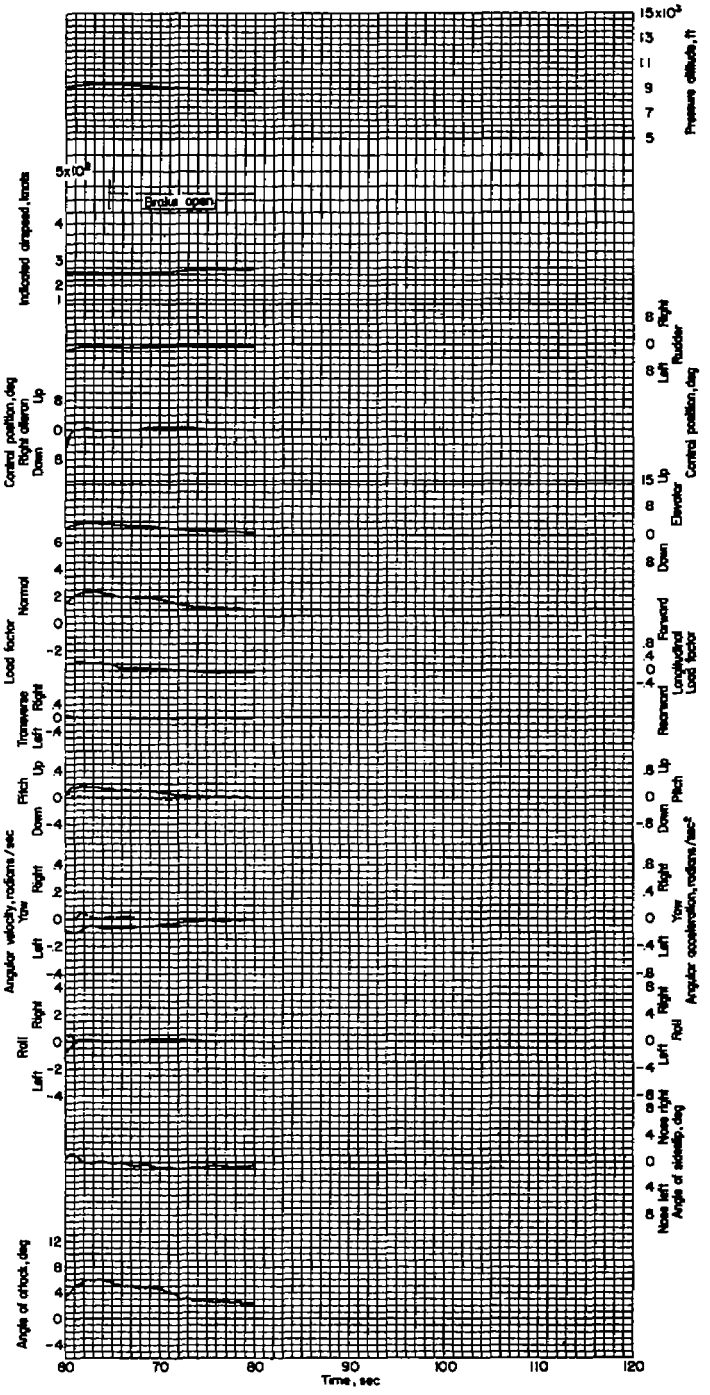
Figure 280.- Turn entry into dive-bombing run. Airplane weight, 16,150 pounds; center of gravity at 24.2 percent M.A.C.; flight 6.

[redacted]



(b)

Figure 280.- Concluded.

[redacted]

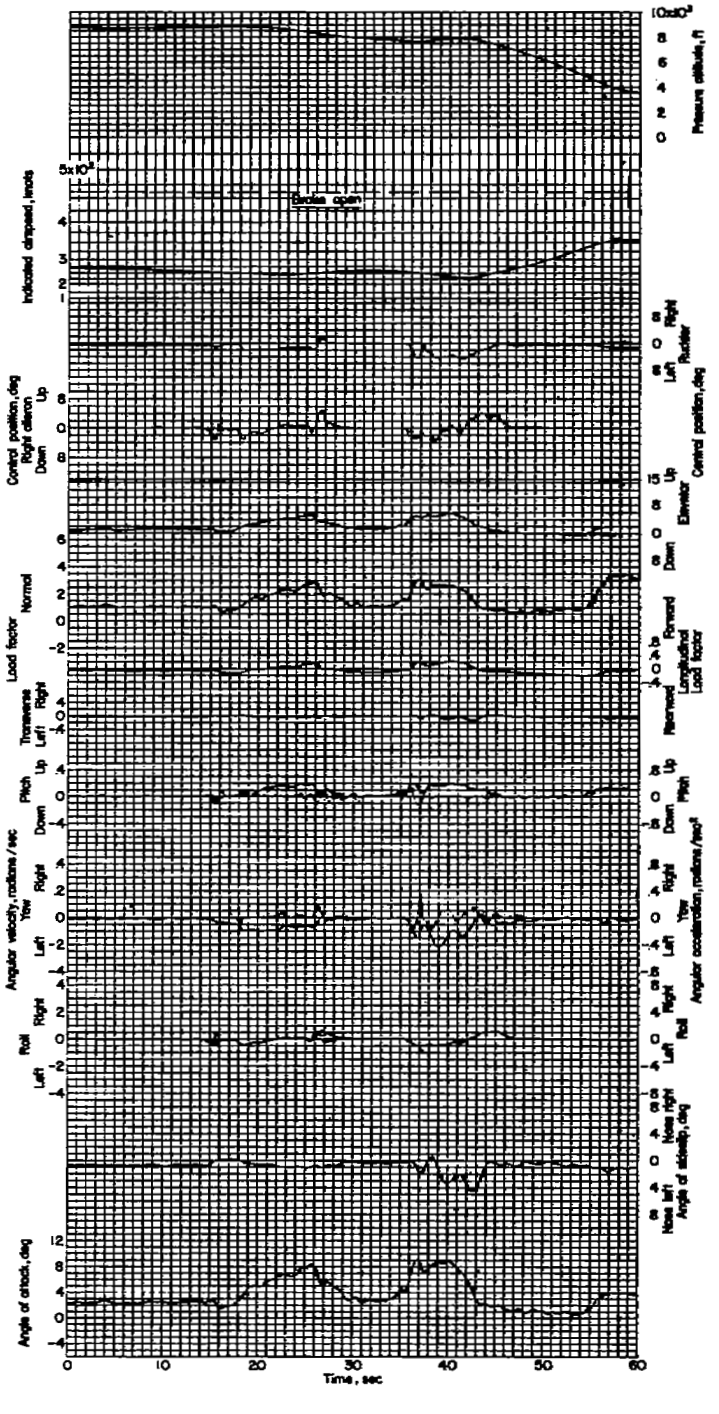
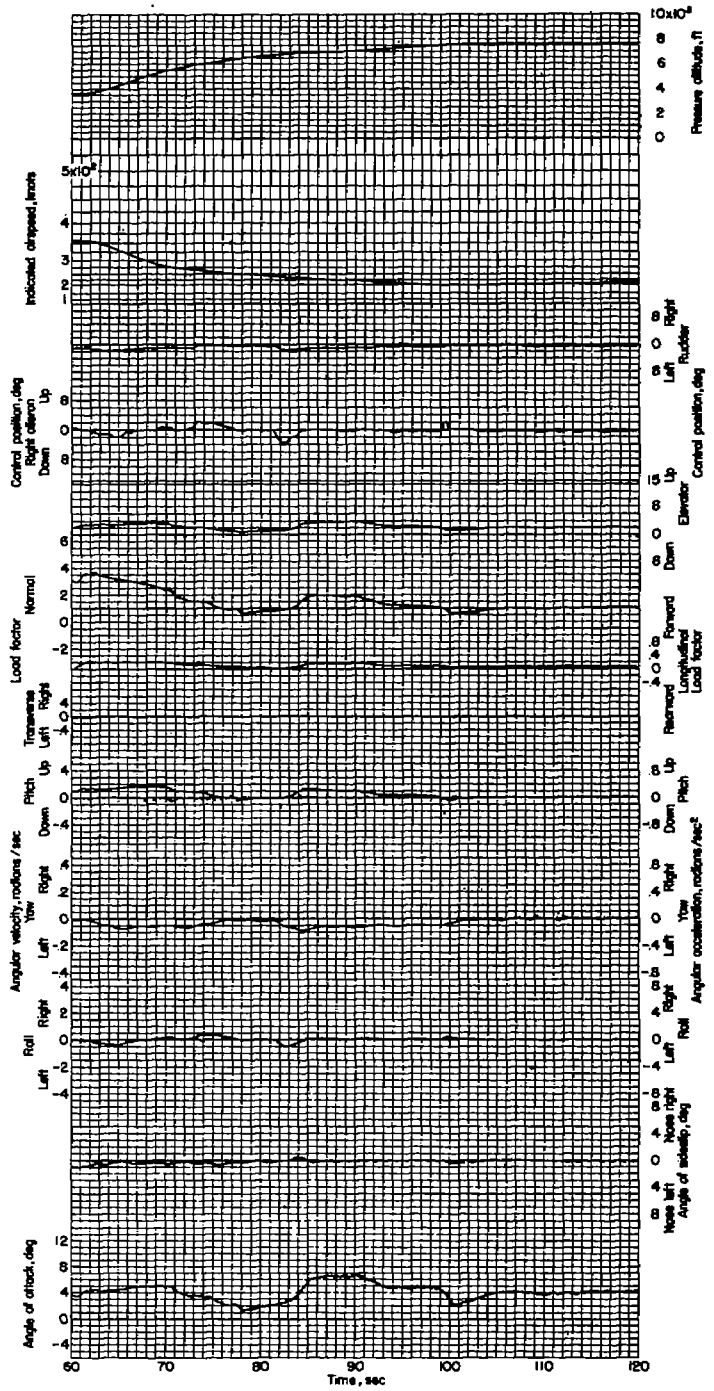


Figure 281.- Turn entry into dive-bombing run. Airplane weight, 16,080 pounds; center of gravity at 24.2 percent M.A.C.; flight 6.

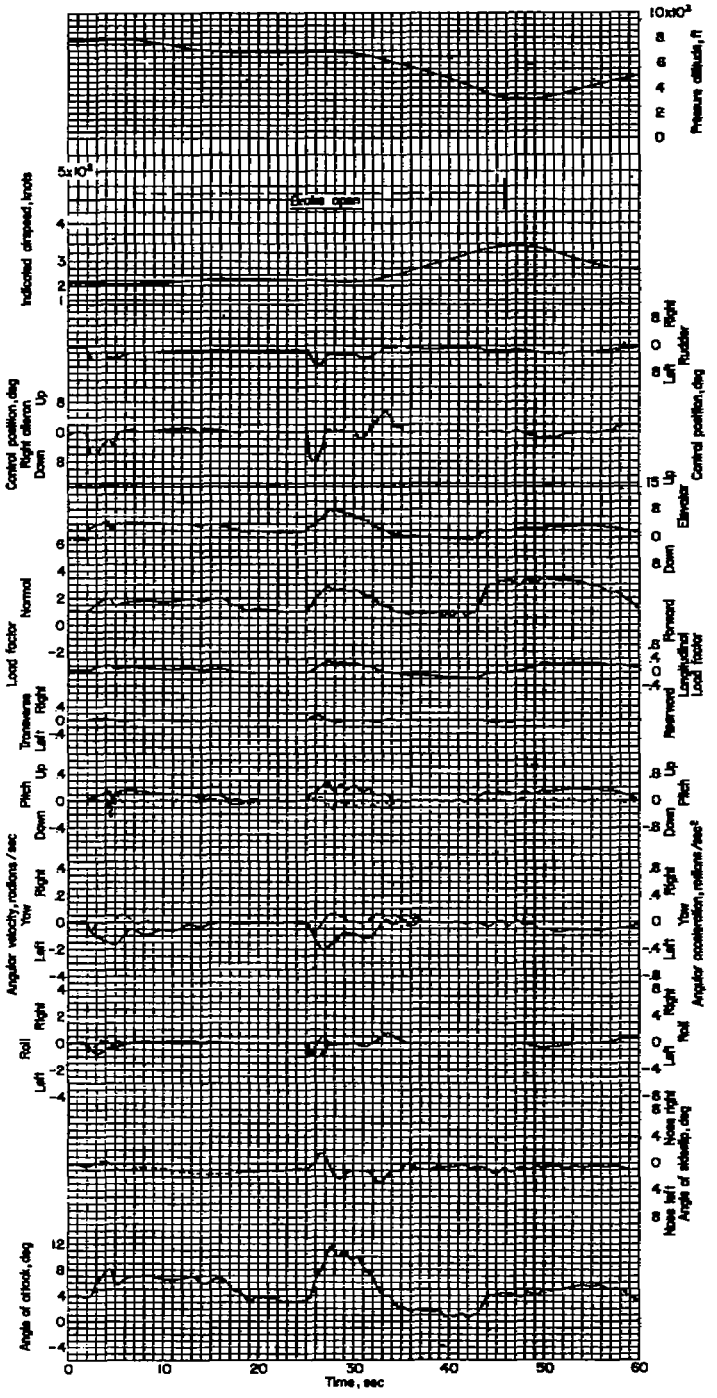
[redacted]



(b)

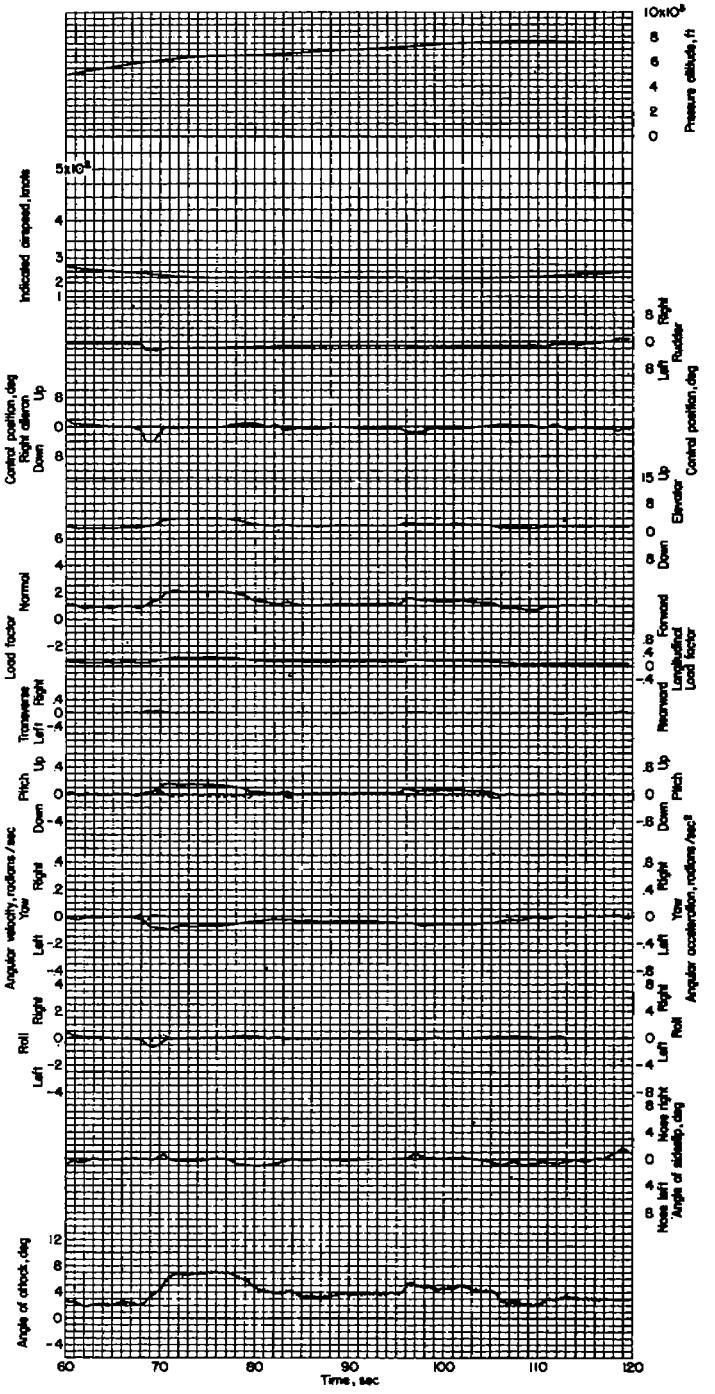
Figure 281.- Concluded.

[redacted]



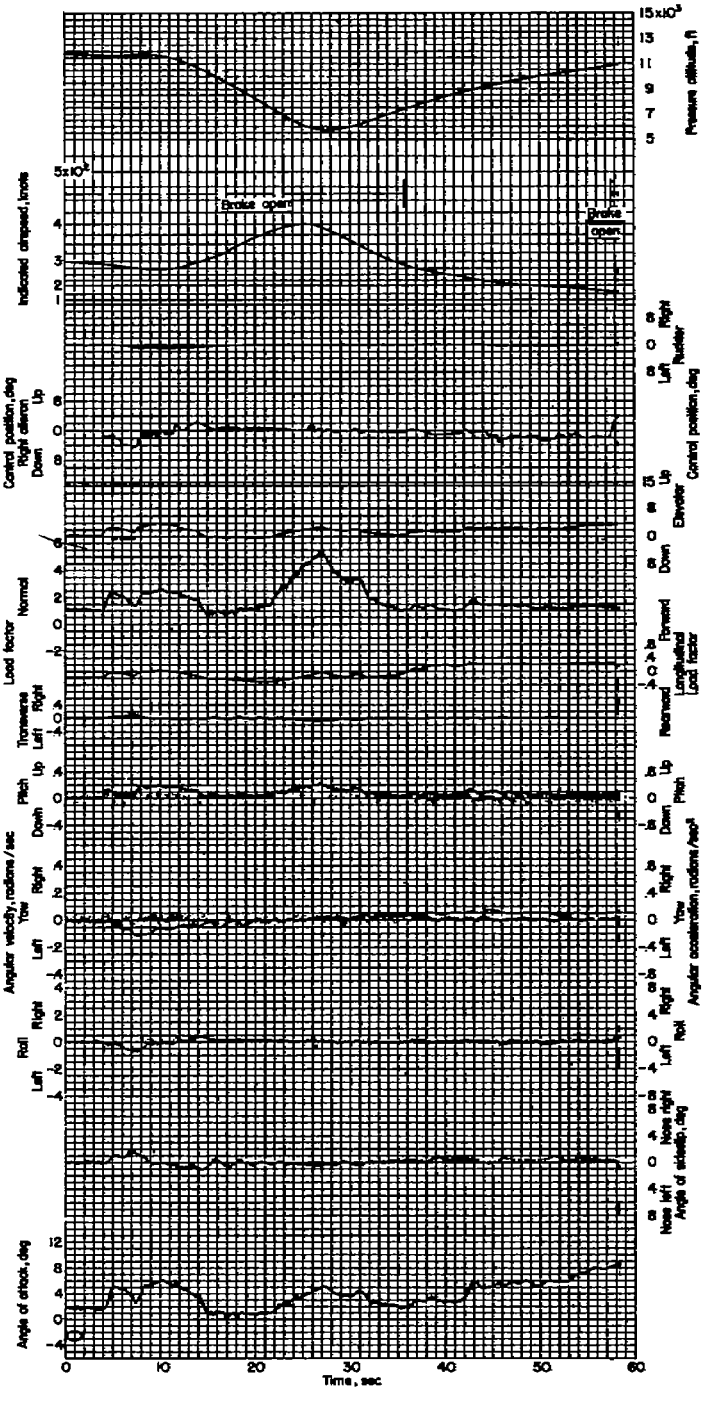
(a)

Figure 282.- Turn entry into dive-bombing run followed by climbing left turn. Airplane weight, 15,980 pounds; center of gravity at 24.1 percent M.A.C.; flight 6.



(b)

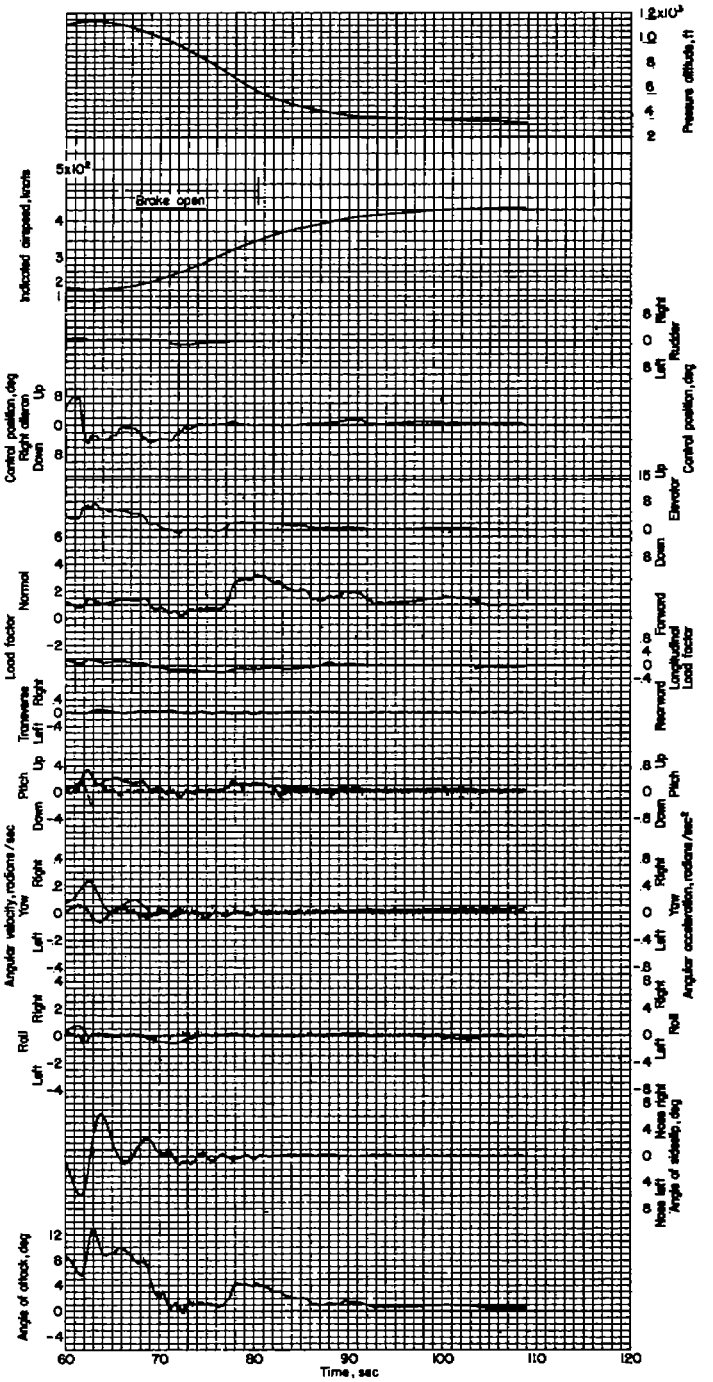
Figure 282.- Concluded.



(a)

NACA

Figure 283.- Turn entry into dive-bombing run and pull-up followed by turn entry into dive. Airplane weight, 16,040 pounds; center of gravity at 24.2 percent M.A.C.; flight 7.



(b)

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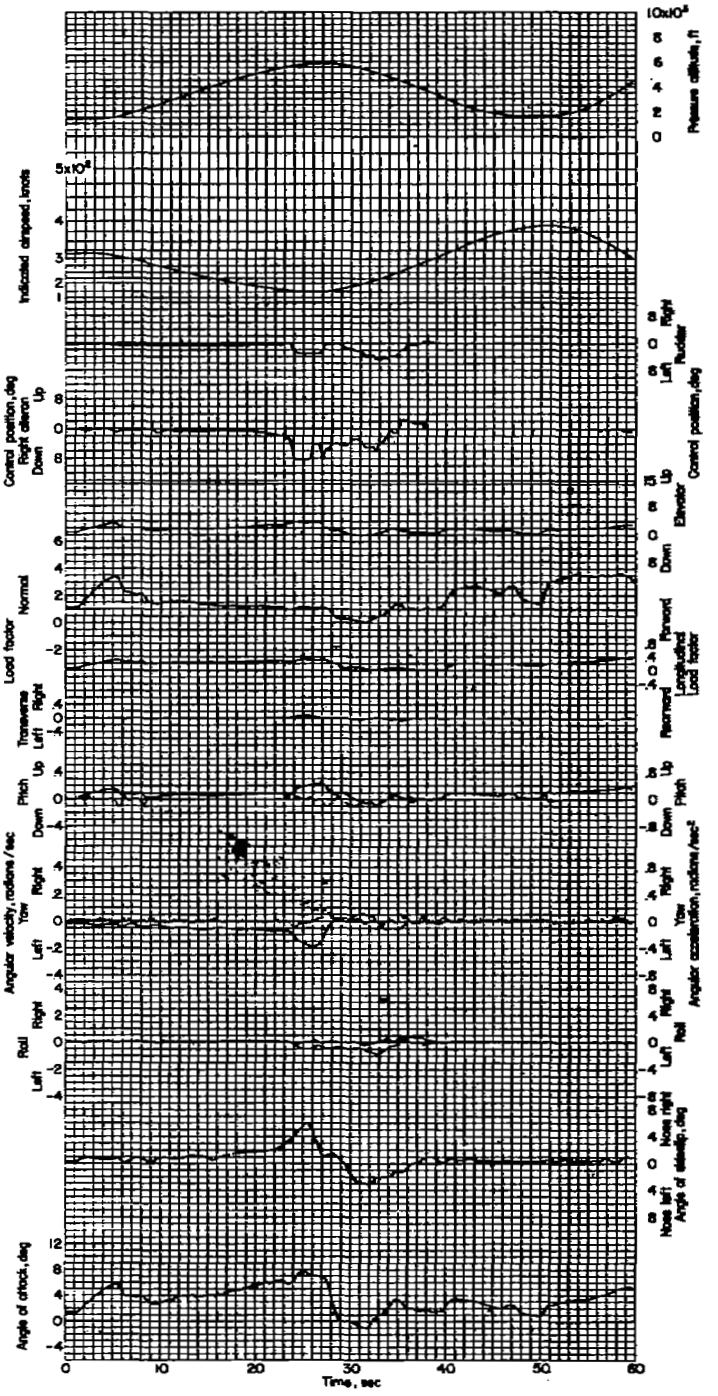
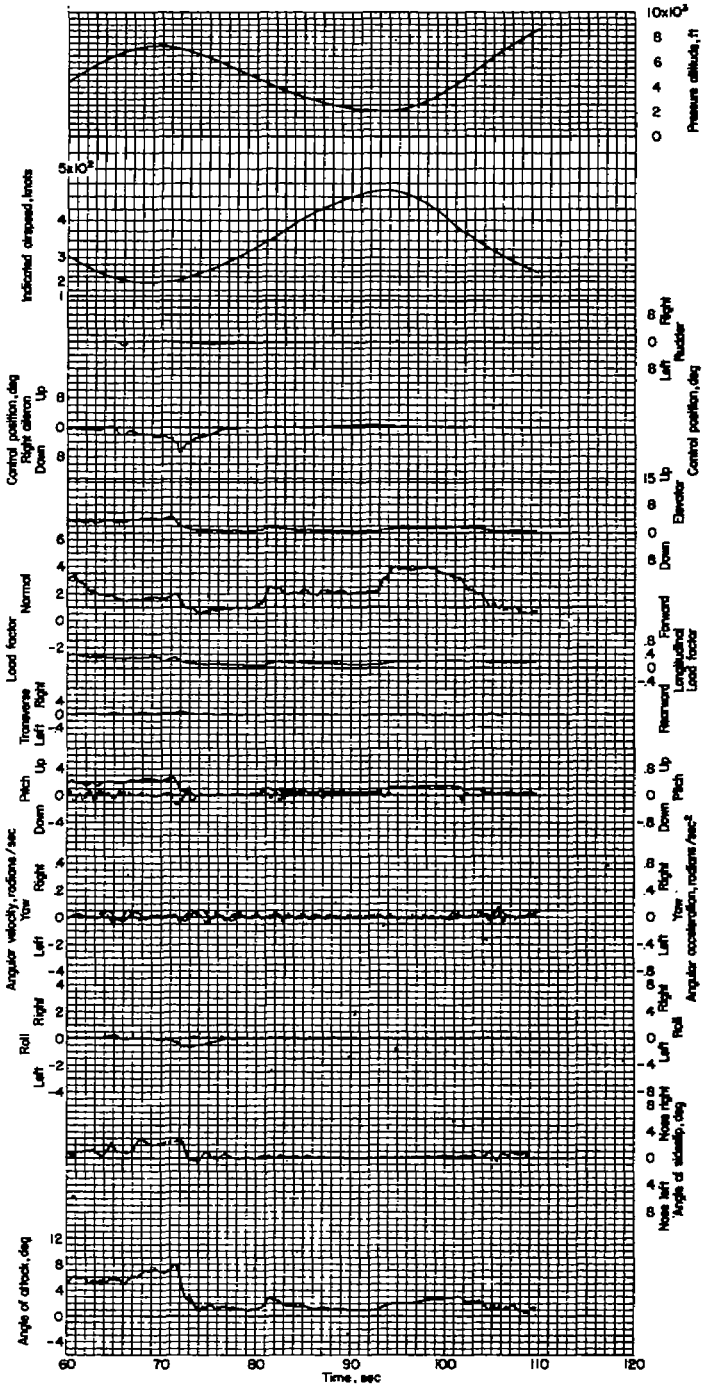


(a)

Figure 284.- Chandelle and left roll entry into dive-bombing run followed by half-loop and left half-roll entry into dive-bombing run. Airplane weight, 15,730 pounds; center of gravity at 24.0 percent M.A.C.; flight 8.

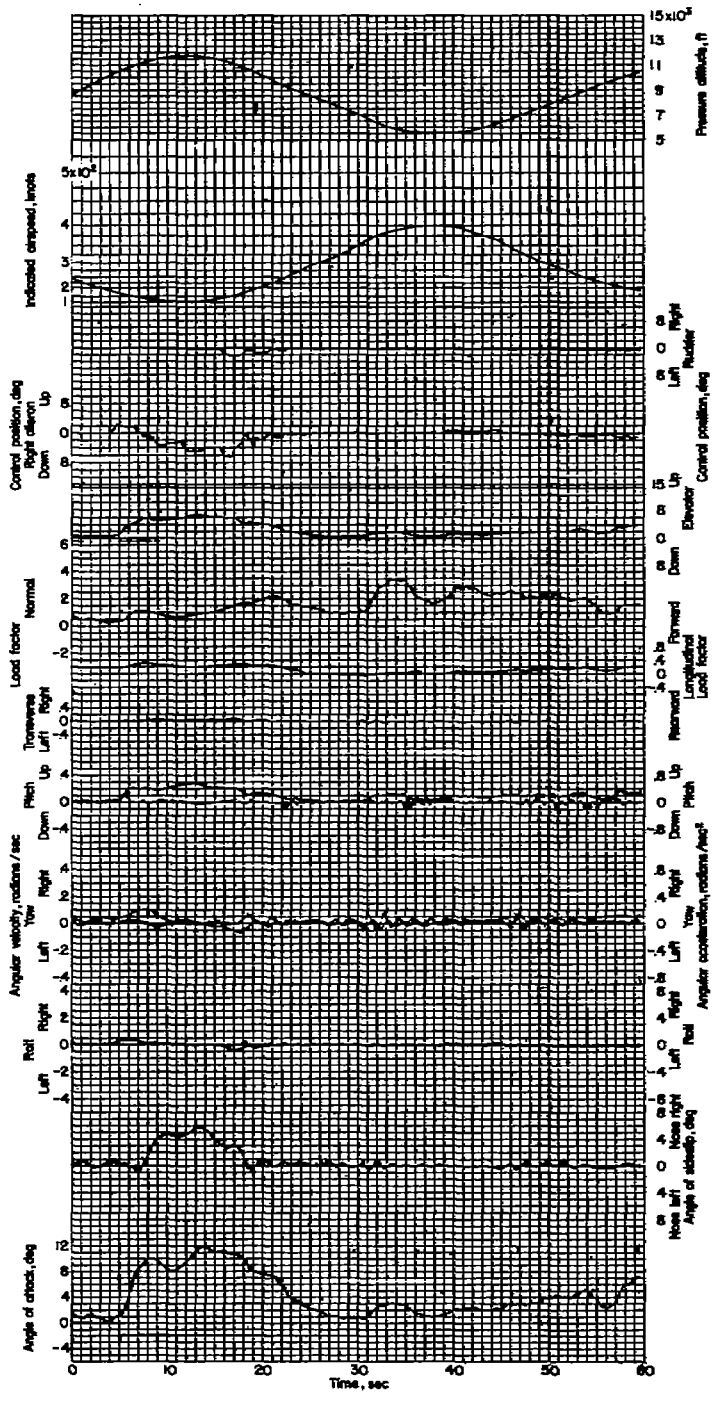
[redacted]



(b)

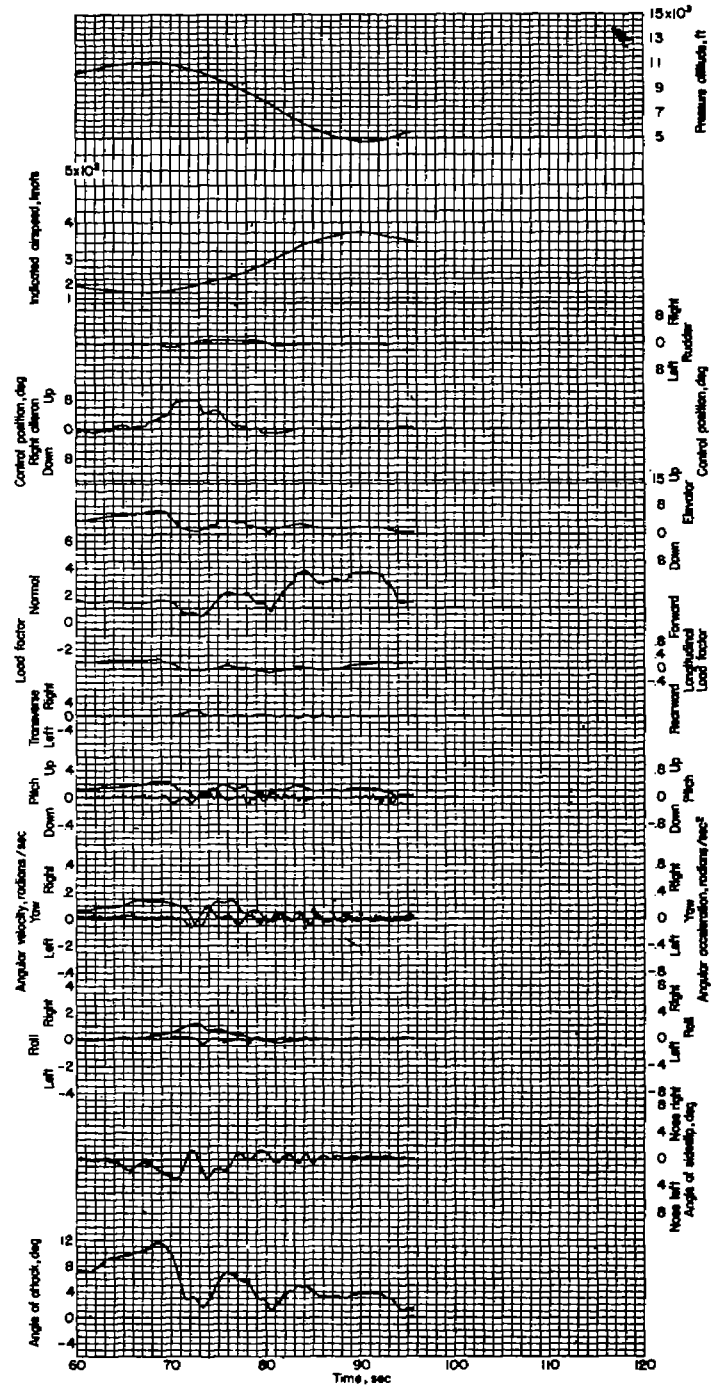
Figure 284.- Concluded.

[redacted]



(a)

Figure 285.- Wing-over into dive-bombing run followed by half-loop and right roll entry into dive-bombing run. Airplane weight, 15,650 pounds; center of gravity at 23.9 percent M.A.C.; flight 8.



(b)

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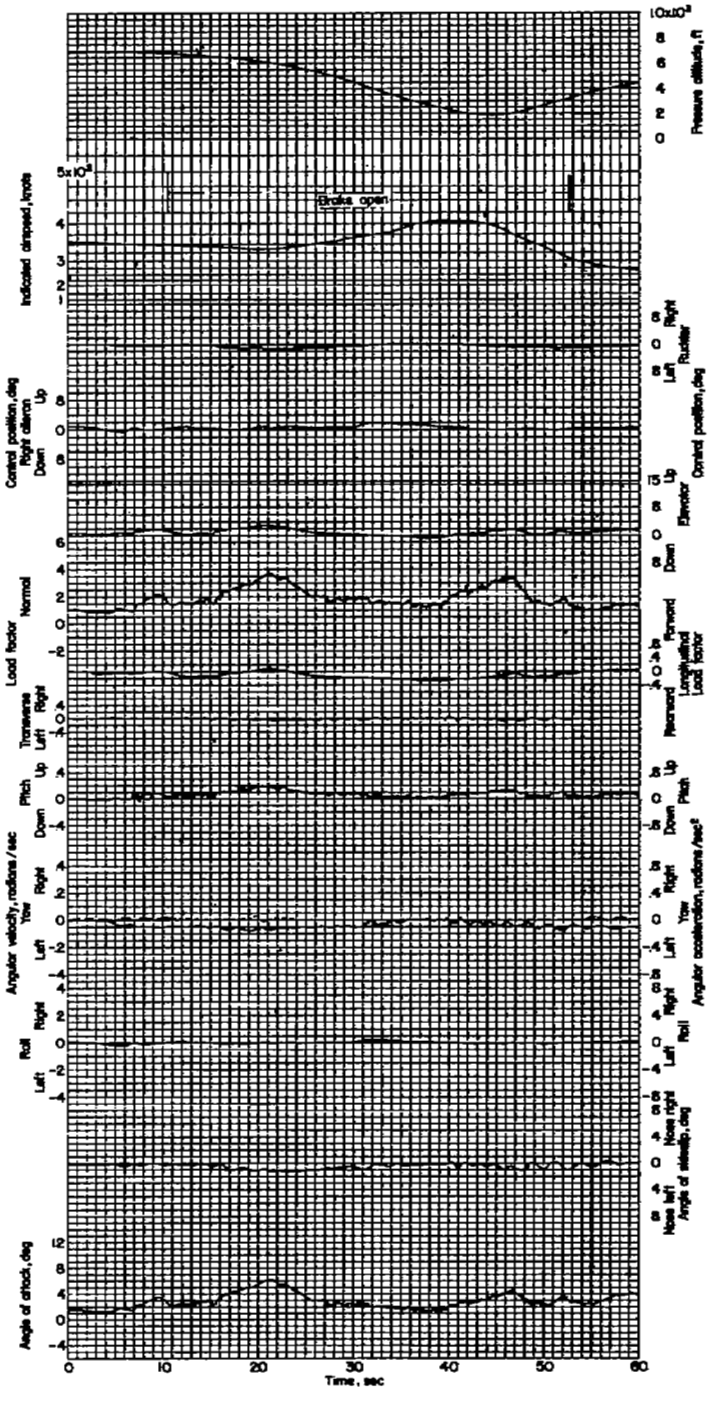
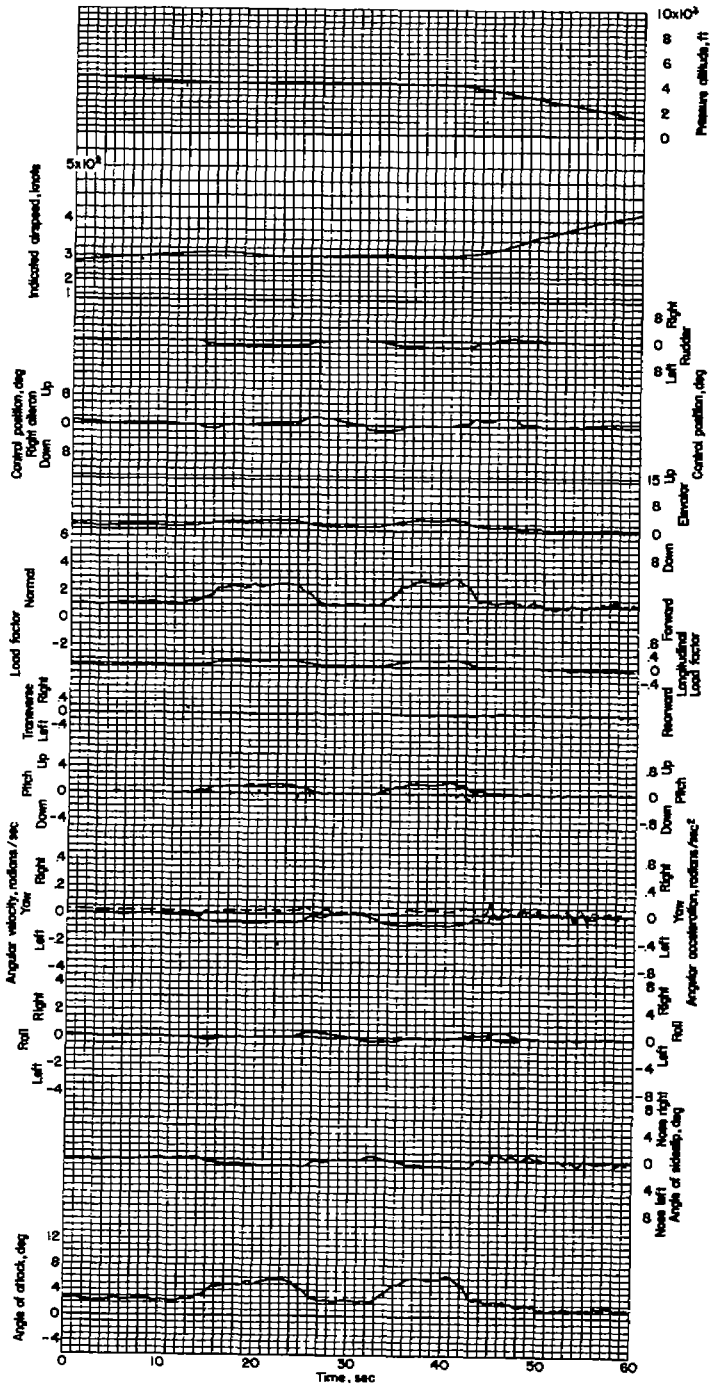


Figure 286.- Dive-bombing run. Airplane weight, 16,590 pounds; center of gravity at 24.5 percent M.A.C.; flight 10.

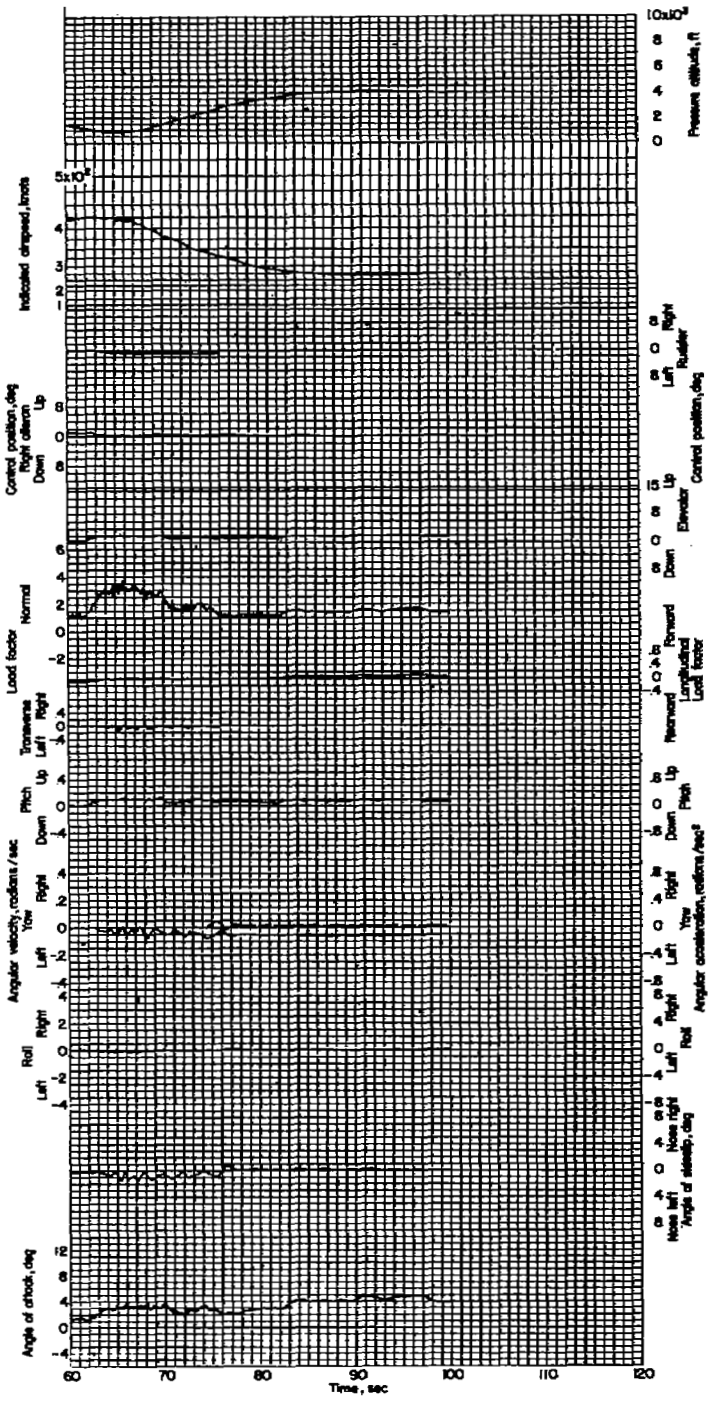


(a)

NACA

Figure 287.- Left turns and dive-bombing run. Airplane weight, 16,510 pounds; center of gravity at 24.4 percent M.A.C.; flight 10.

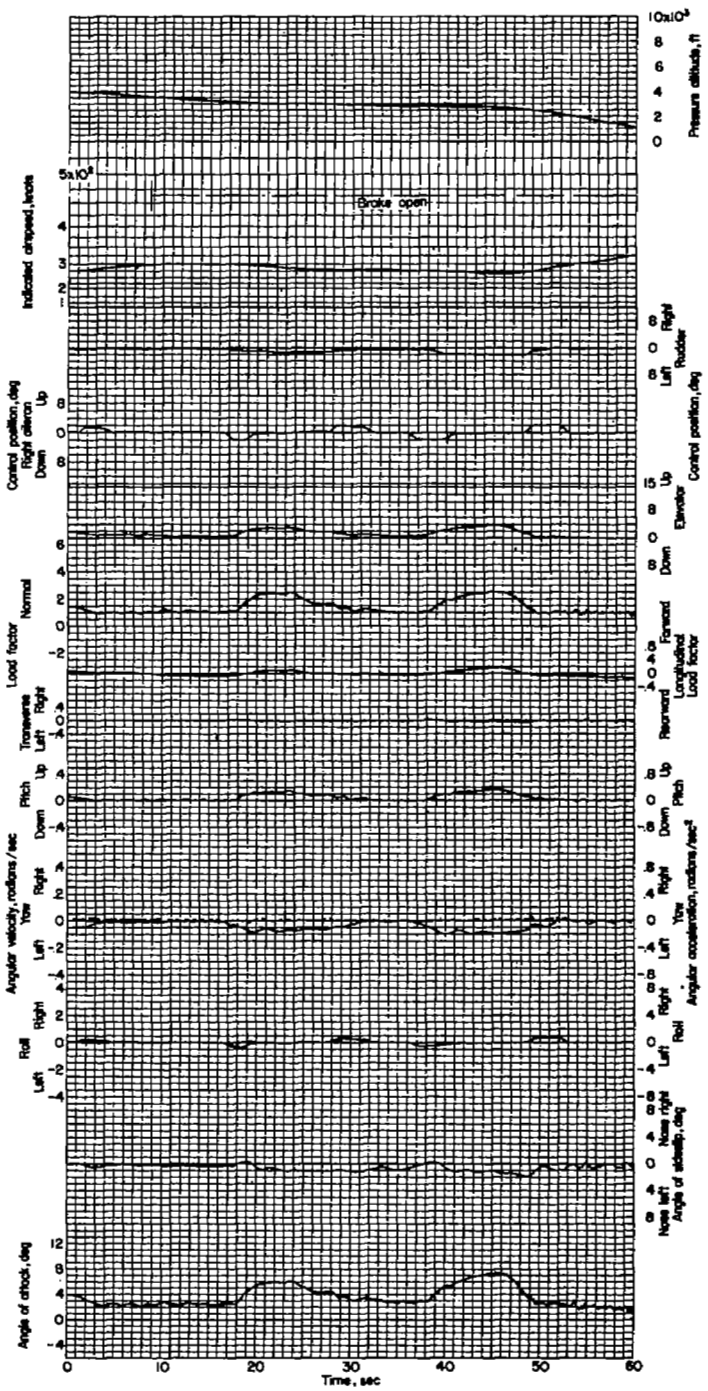
[redacted]



(b)

Figure 287.- Concluded.

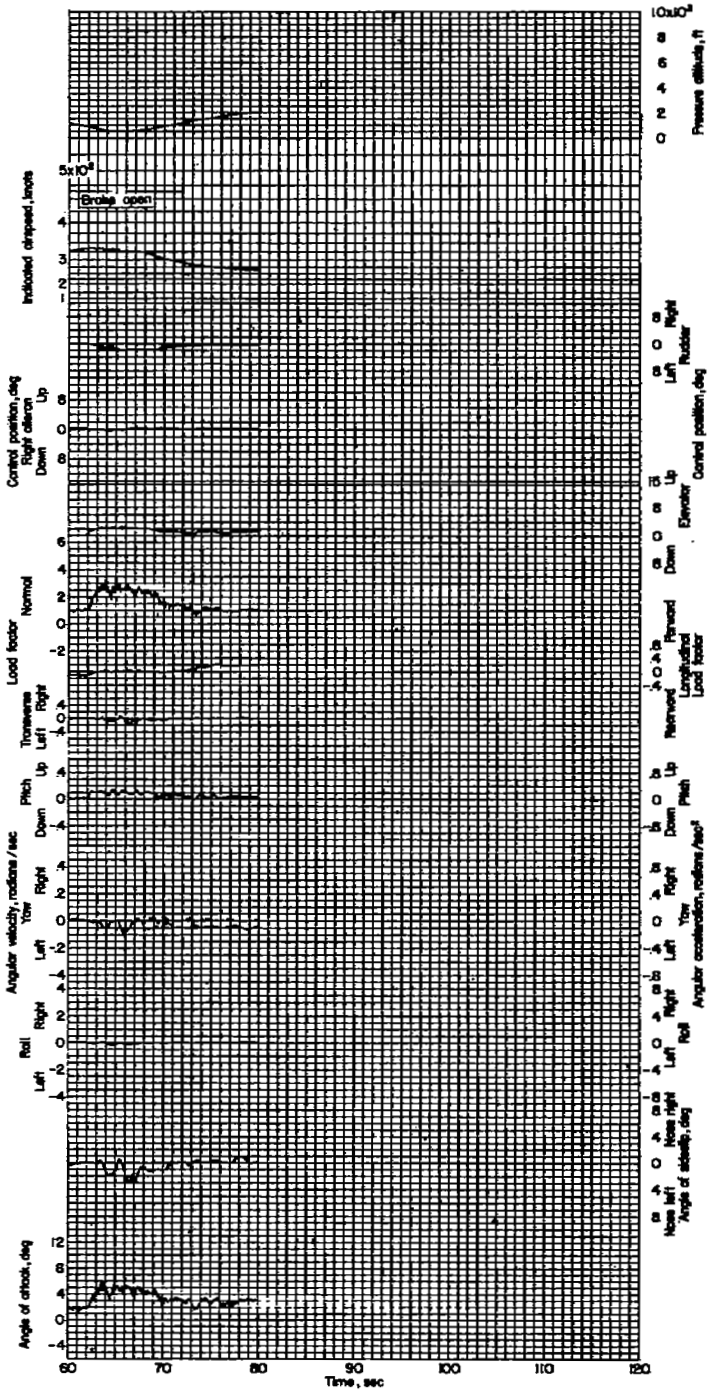
[redacted]



(a)

Figure 288.- Left turns and dive-bombing run. Airplane weight, 16,450 pounds; center of gravity at 24.4 percent M.A.C.; flight 10.

[redacted]



(b)

Figure 288.- Concluded.

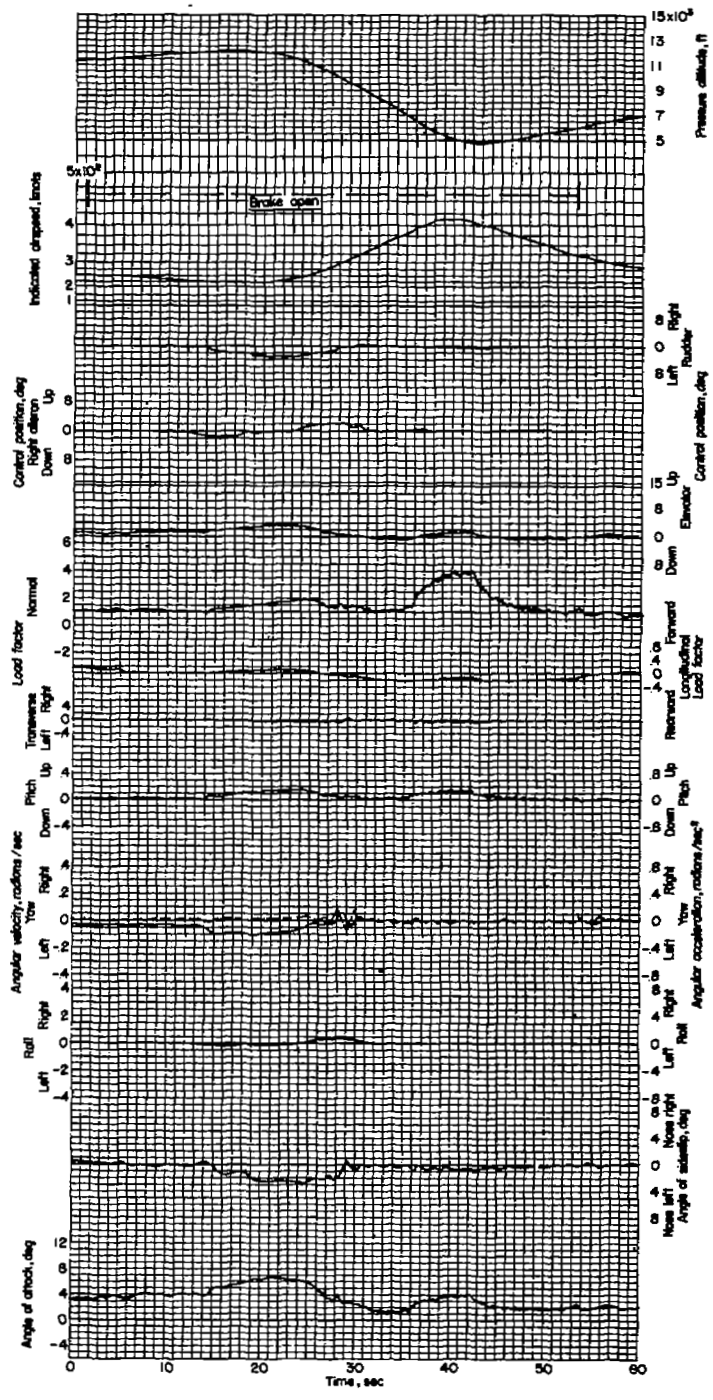


Figure 289.- Peel-off into dive-bombing run. Airplane weight, 16,300 pounds; center of gravity at 24.3 percent M.A.C.; flight 10.

[redacted]

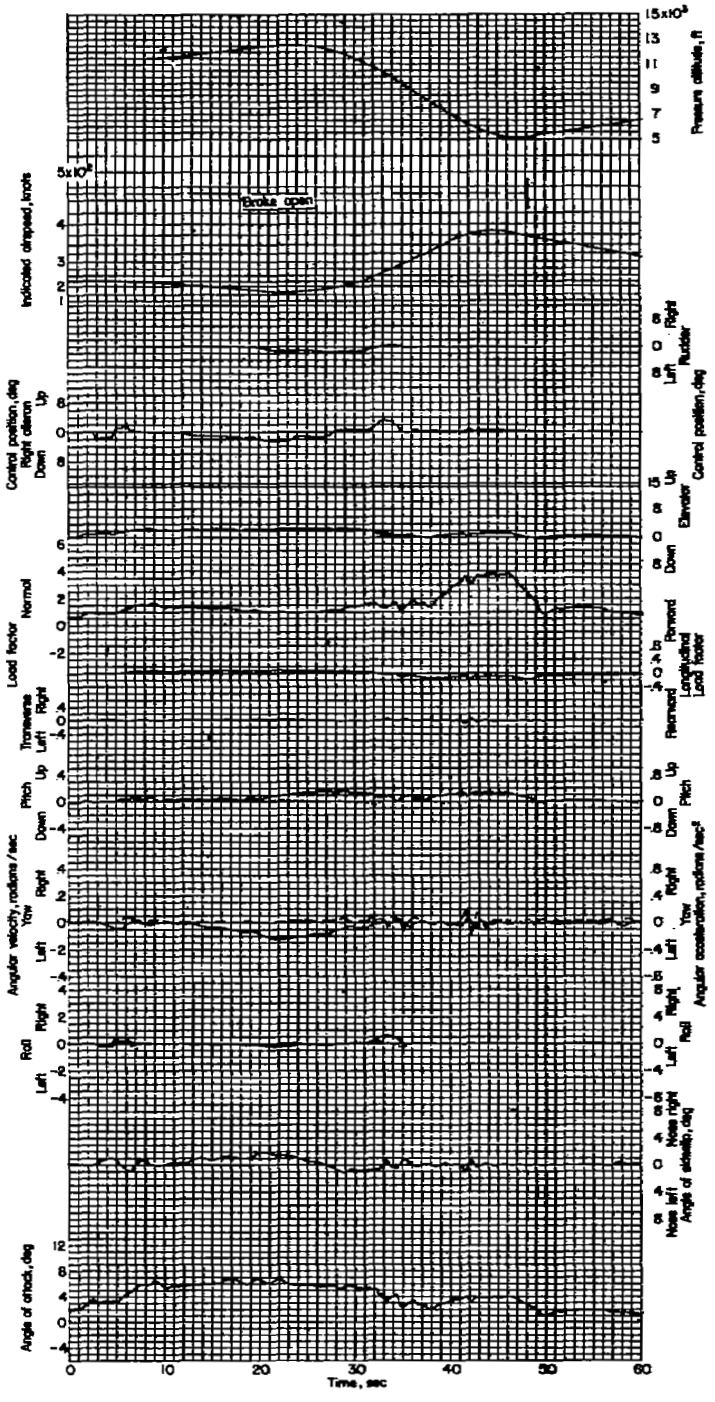
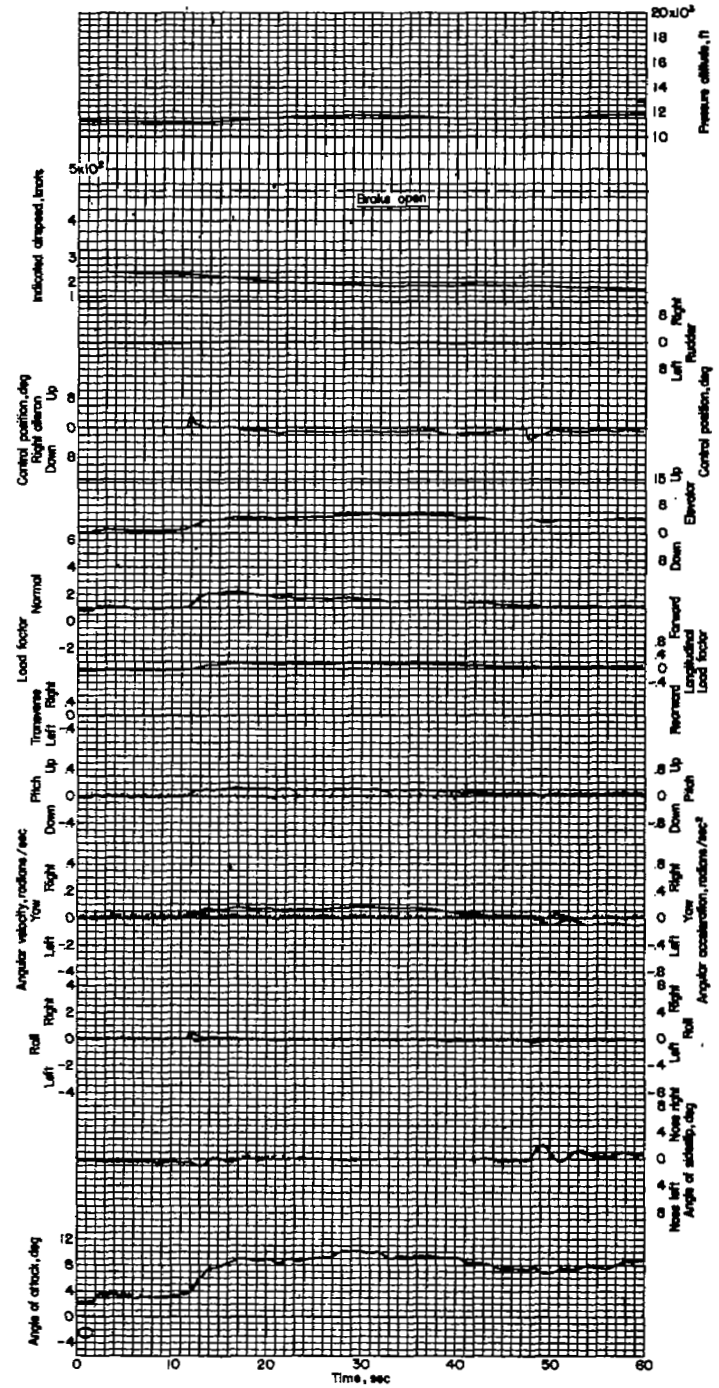


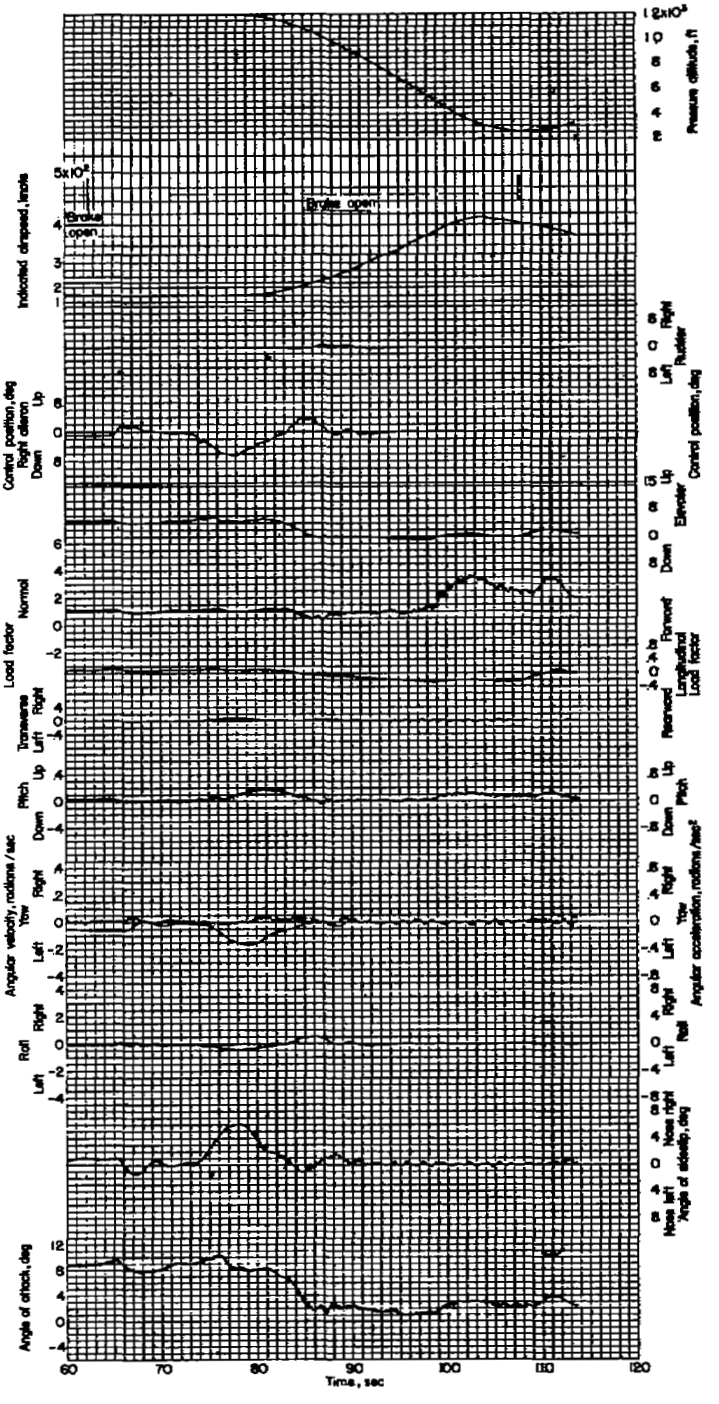
Figure 290.- Peel-off into dive-bombing run. Airplane weight, 15,300 pounds; center of gravity at 23.9 percent M.A.C.; flight 10.



(a)

Figure 291.- Right and left turn followed by peel-off into dive-bombing run. Airplane weight, 15,860 pounds; center of gravity at 24.0 percent M.A.C.; flight 11.

[redacted]

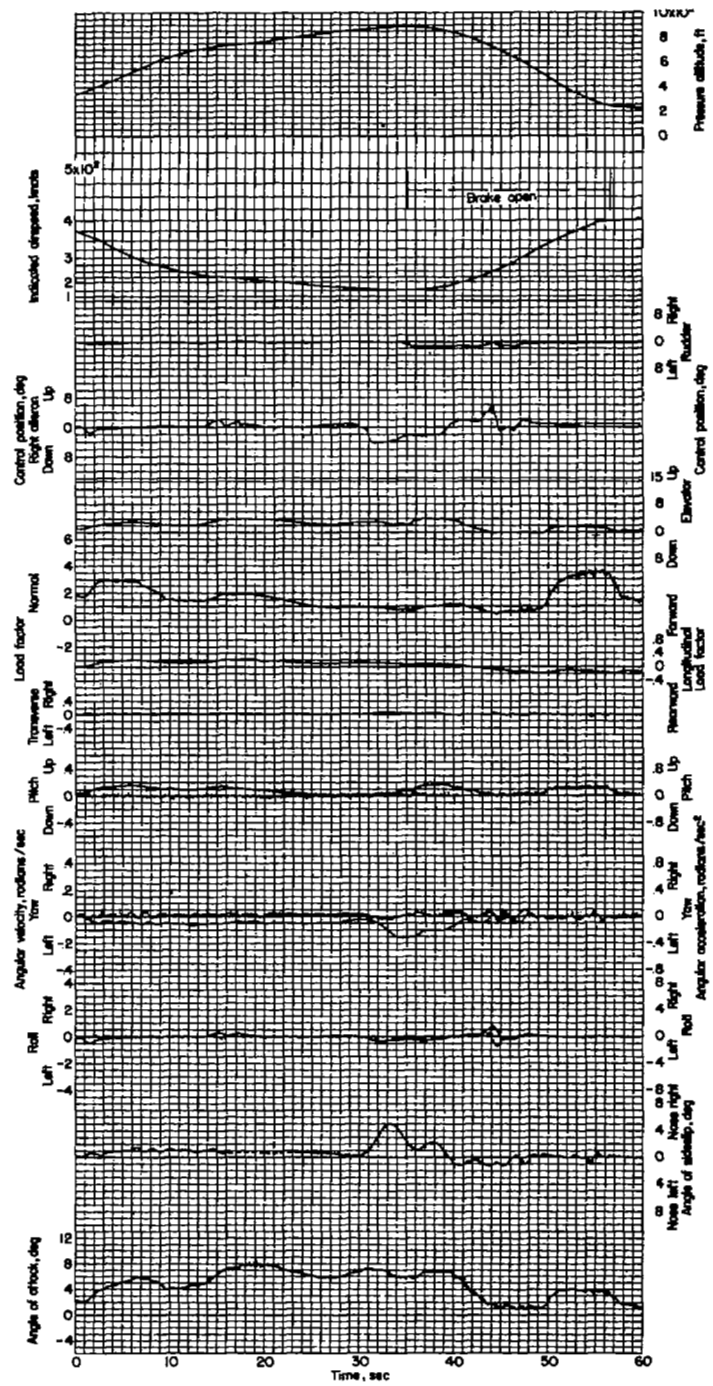


(b)

NACA

Figure 291.- Concluded.

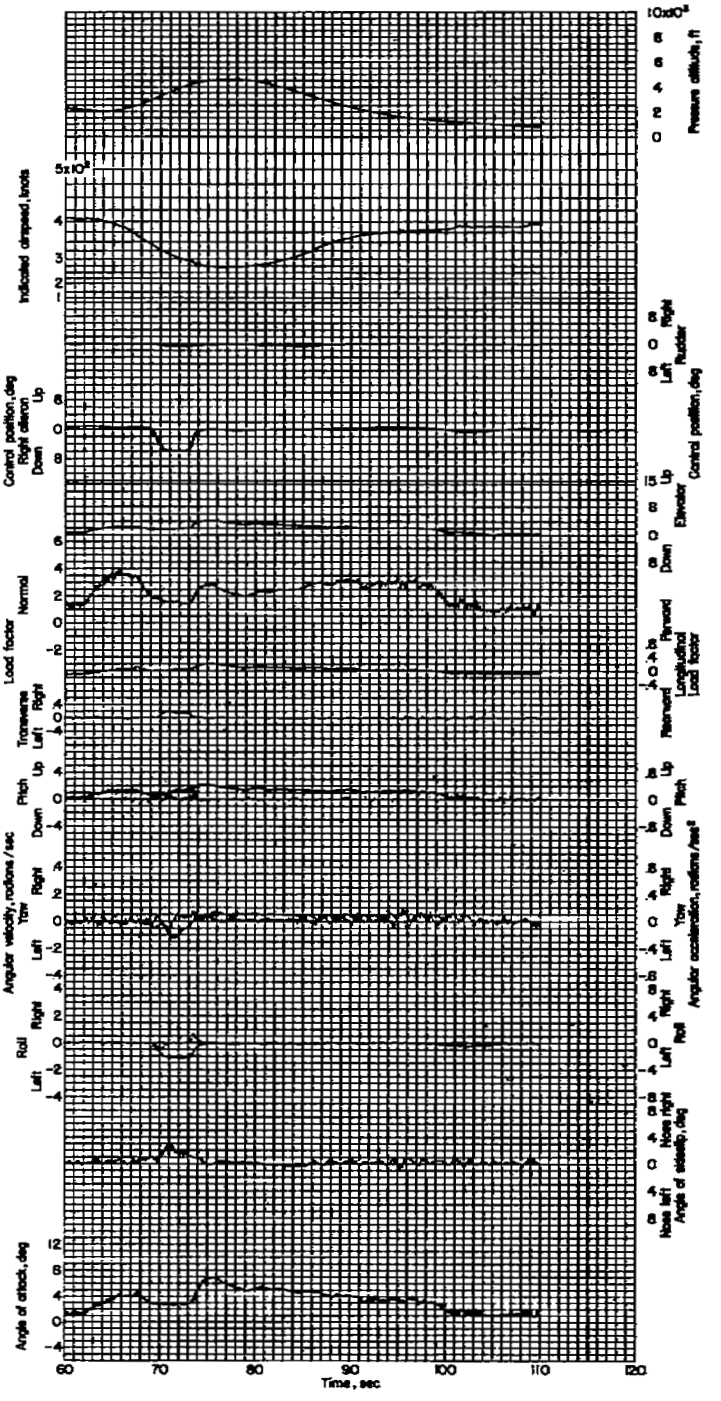
[redacted]



(a)

Figure 292.- Climbing left turn and peel-off into dive-bombing run followed by strafing run. Airplane weight, 15,770 pounds; center of gravity at 24.0 percent M.A.C.; flight 11.

[redacted]



(b)

Figure 292.- Concluded.

[redacted]

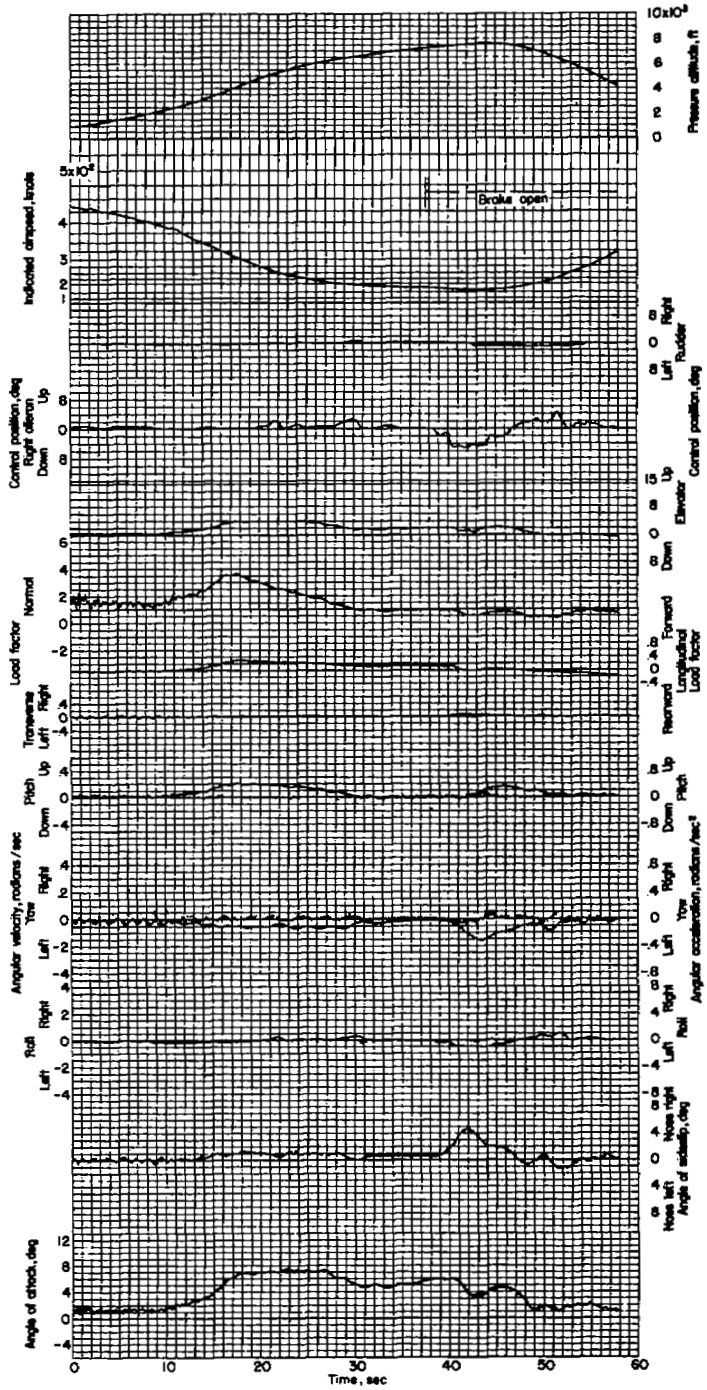
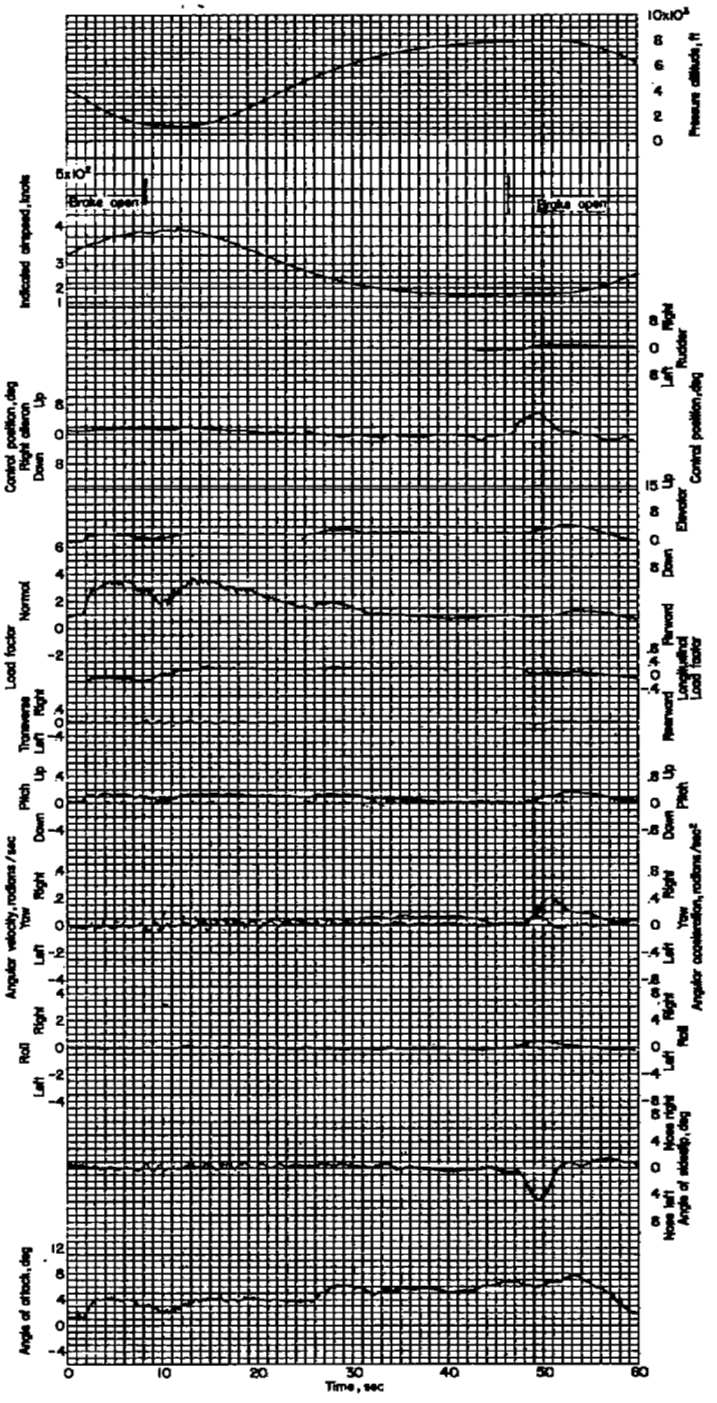


Figure 293.- Climbing left turn followed by peel-off into dive-bombing run. Airplane weight, 15,610 pounds; center of gravity at 23.9 percent M.A.C.; flight 11.

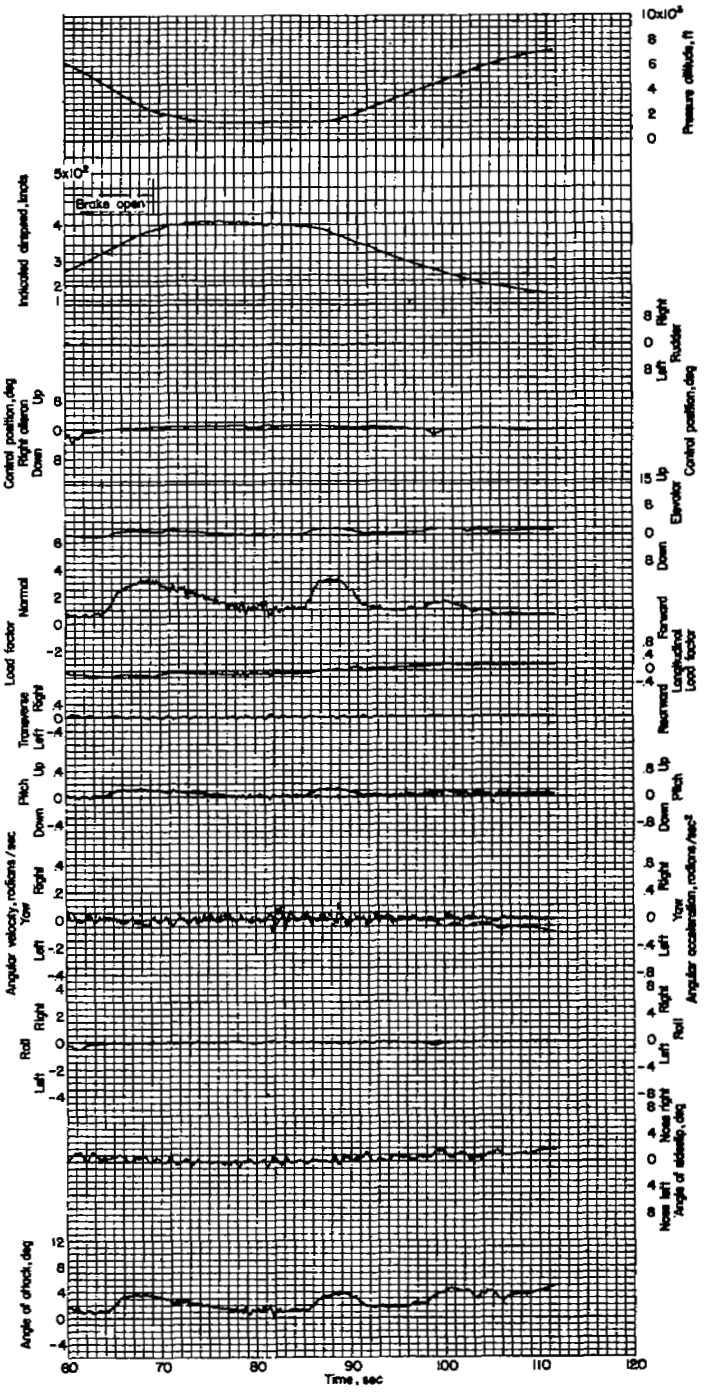


(a)

NACA

Figure 294.- Pull-out from dive-bombing run followed by peel-off into strafing run. Airplane weight, 15,570 pounds; center of gravity at 23.9 percent M.A.C.; flight 11.

[redacted]



(b)

Figure 294.- Concluded.

[redacted]

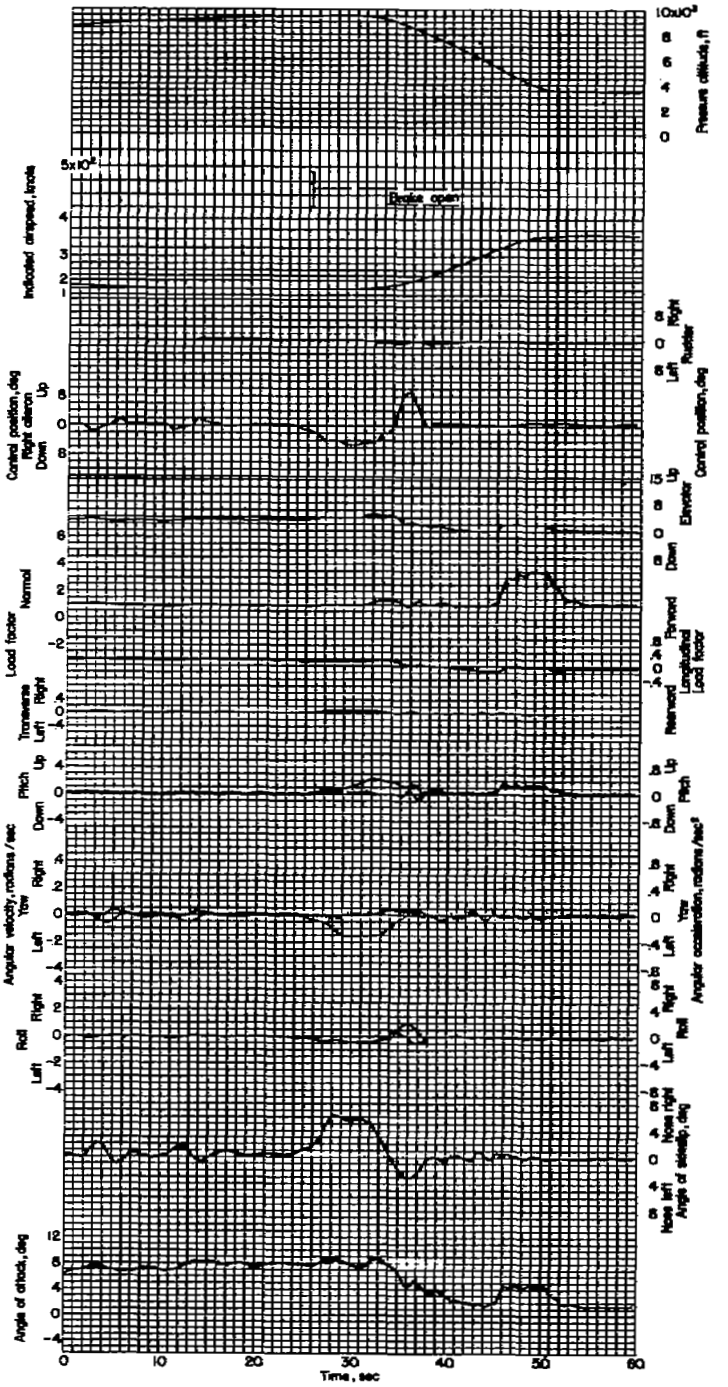
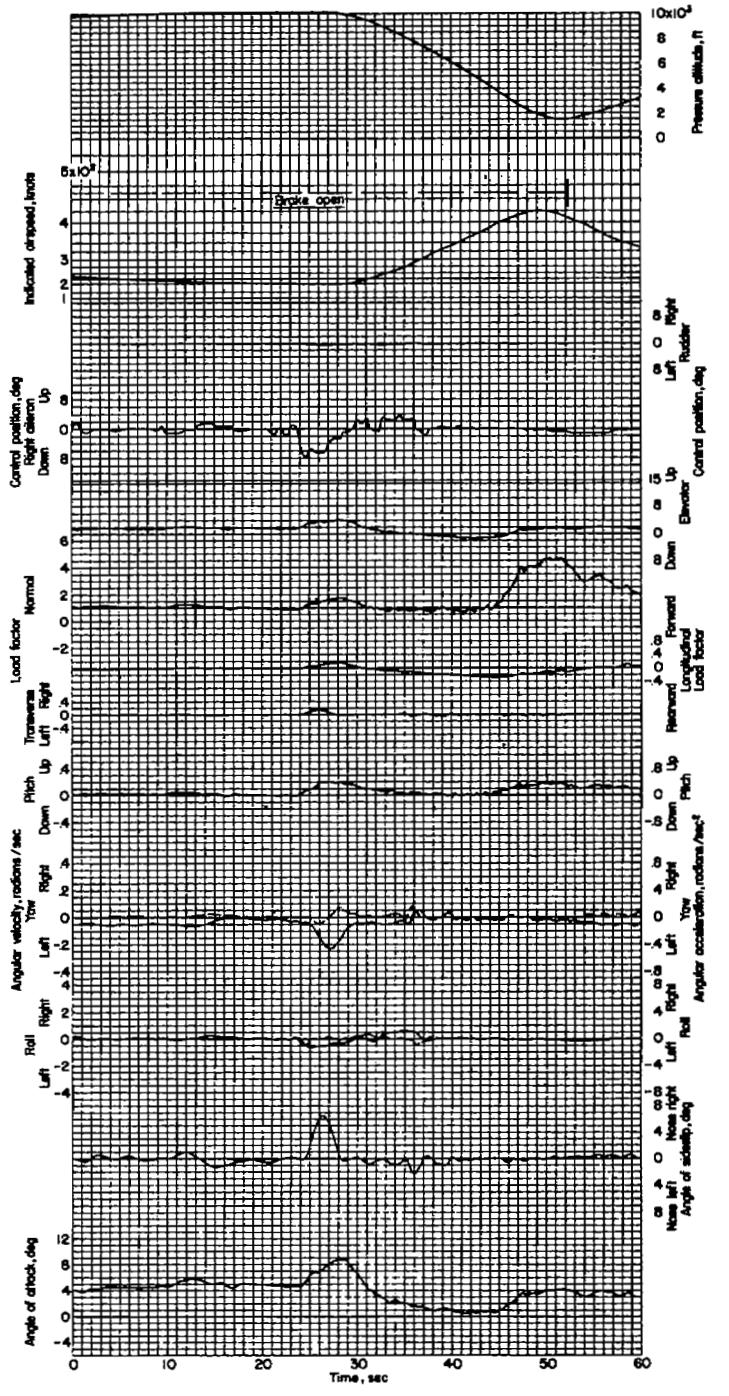


Figure 295.- Peel-off into dive-bombing run. Airplane weight, 15,430 pounds; center of gravity at 23.8 percent M.A.C.; flight 11.

[redacted]

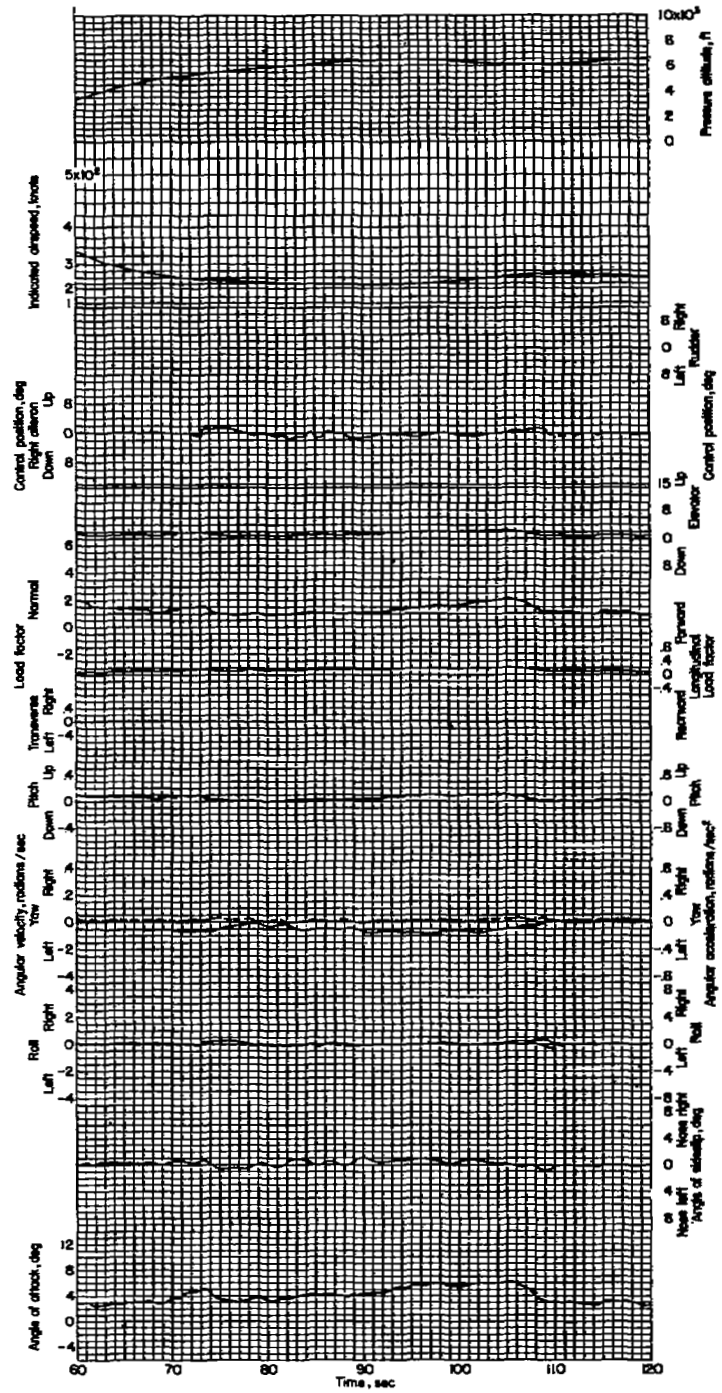


(a)

NACA

Figure 296.- Peel-off into dive-bombing run followed by climbing left turn. Airplane weight, 16,630 pounds; center of gravity at 24.5 percent M.A.C.; flight 13.

[redacted]



(b)

Figure 296.- Concluded.

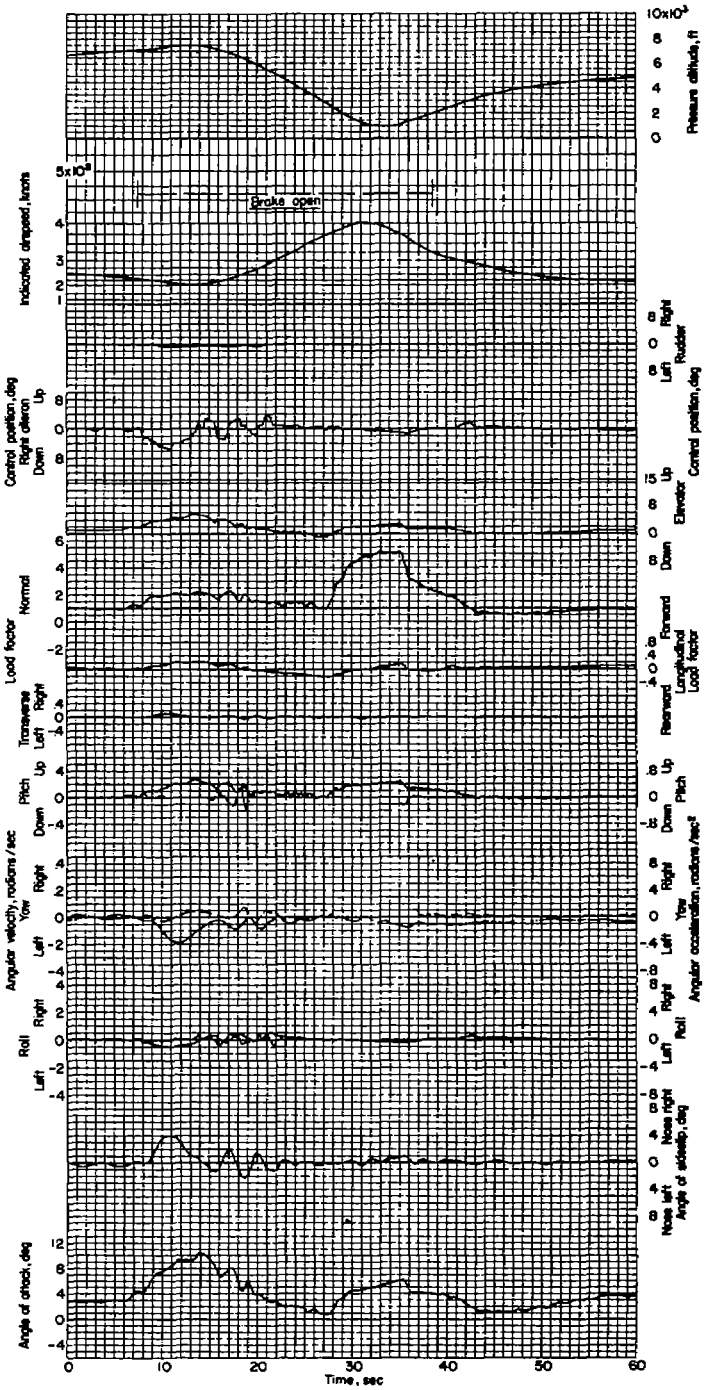
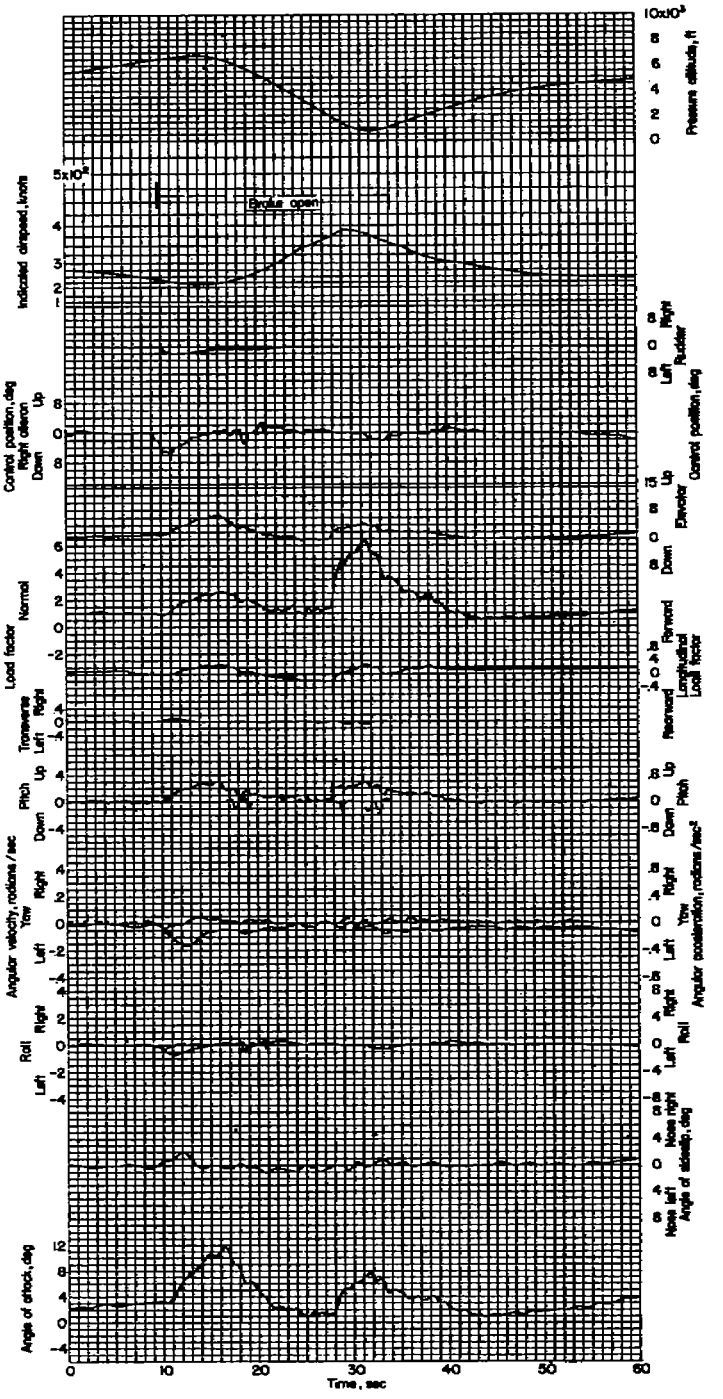


Figure 297.- Peel-off into dive-bombing run and pull-out into climbing left turn. Airplane weight, 16,570 pounds; center of gravity at 24.4 percent M.A.C.; flight 13.

[redacted]

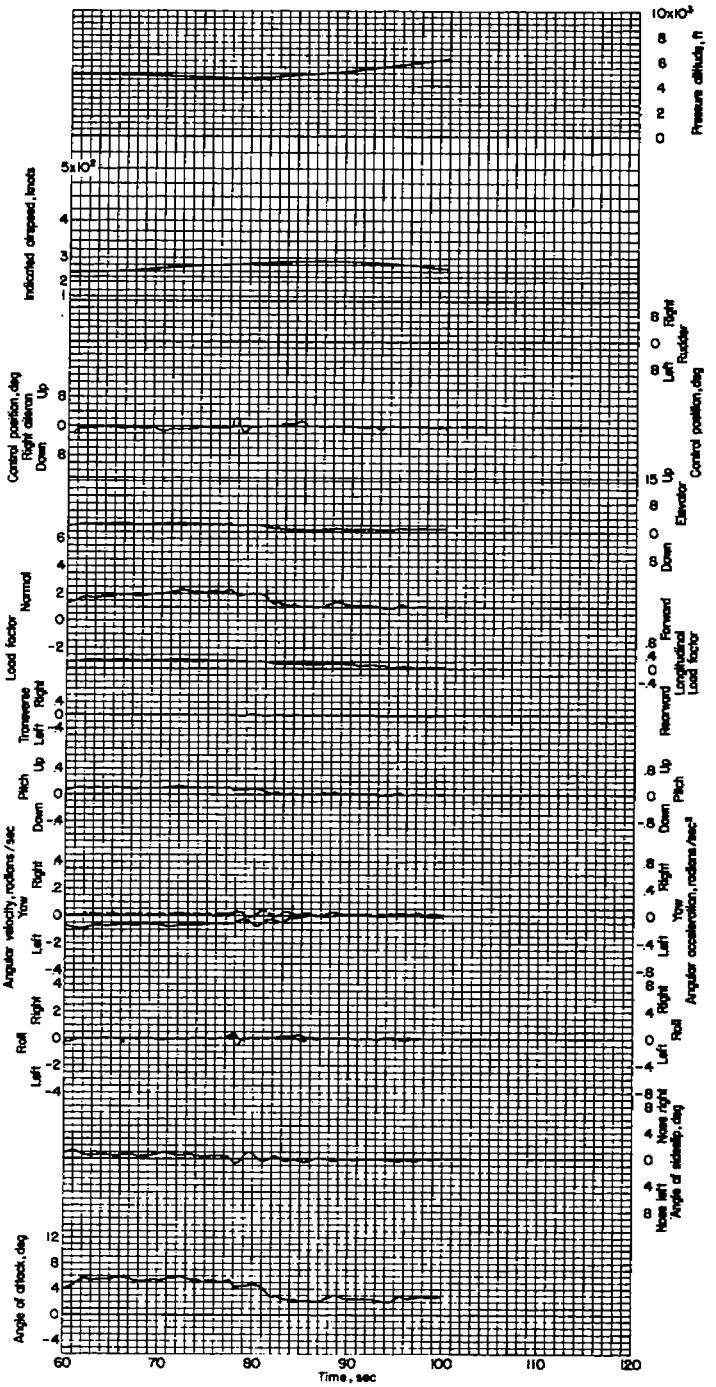


(a)

NACA

Figure 298.- Peel-off into dive-bombing run and pull-out into climbing left turn. Airplane weight, 16,480 pounds; center of gravity at 24.4 percent M.A.C.; flight 13.

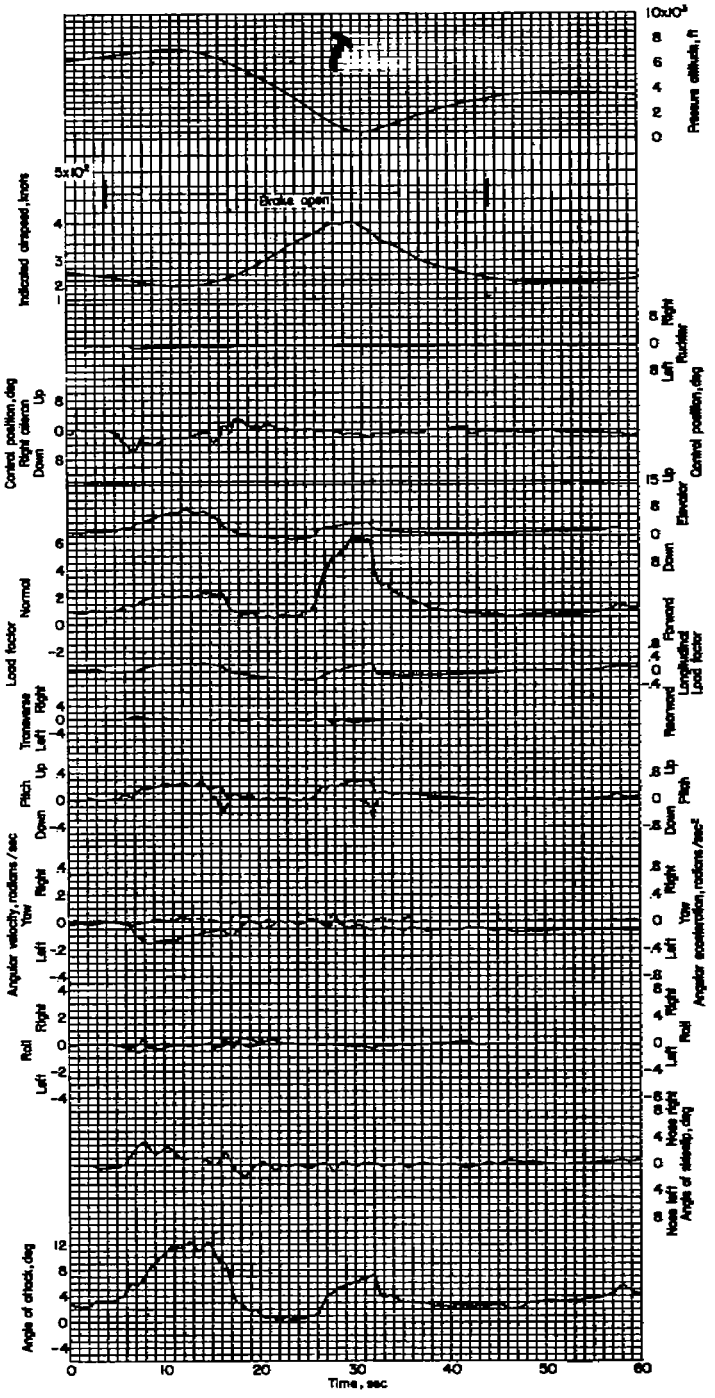
[redacted]



(b)

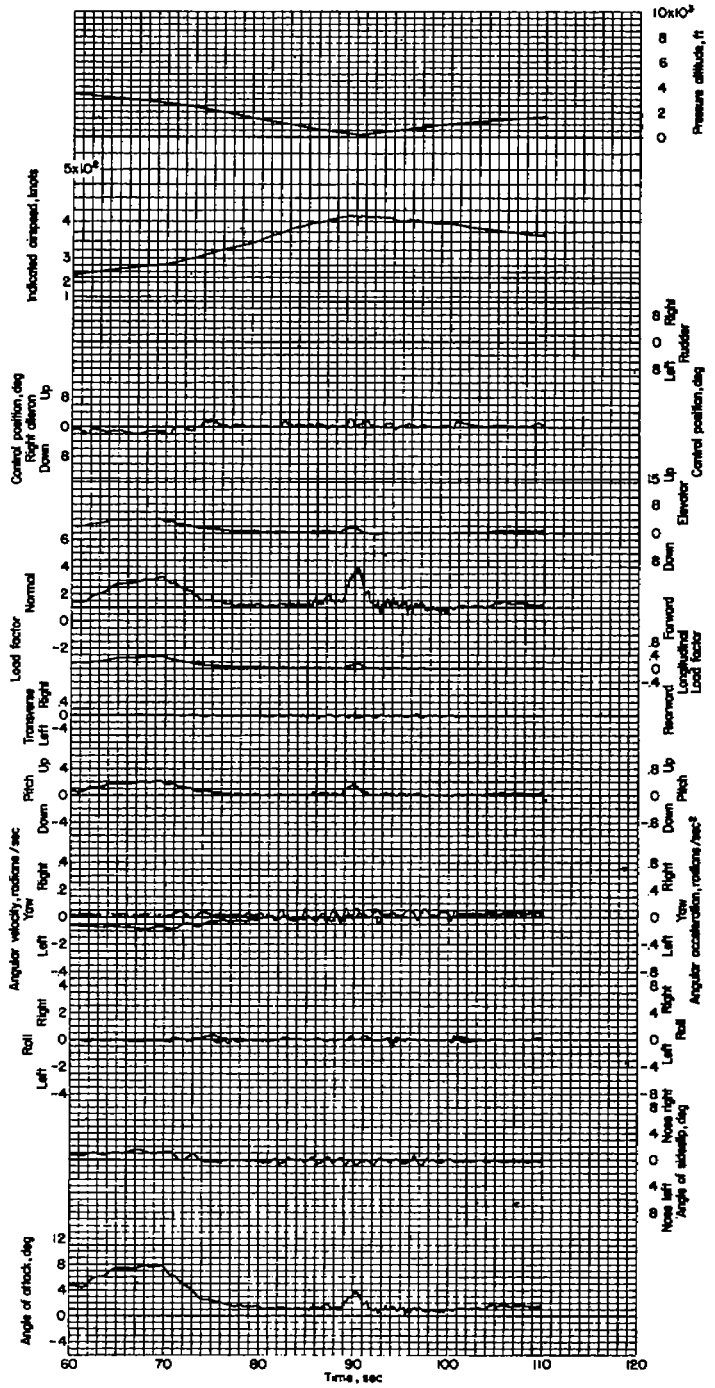
Figure 298.- Concluded.

[redacted]



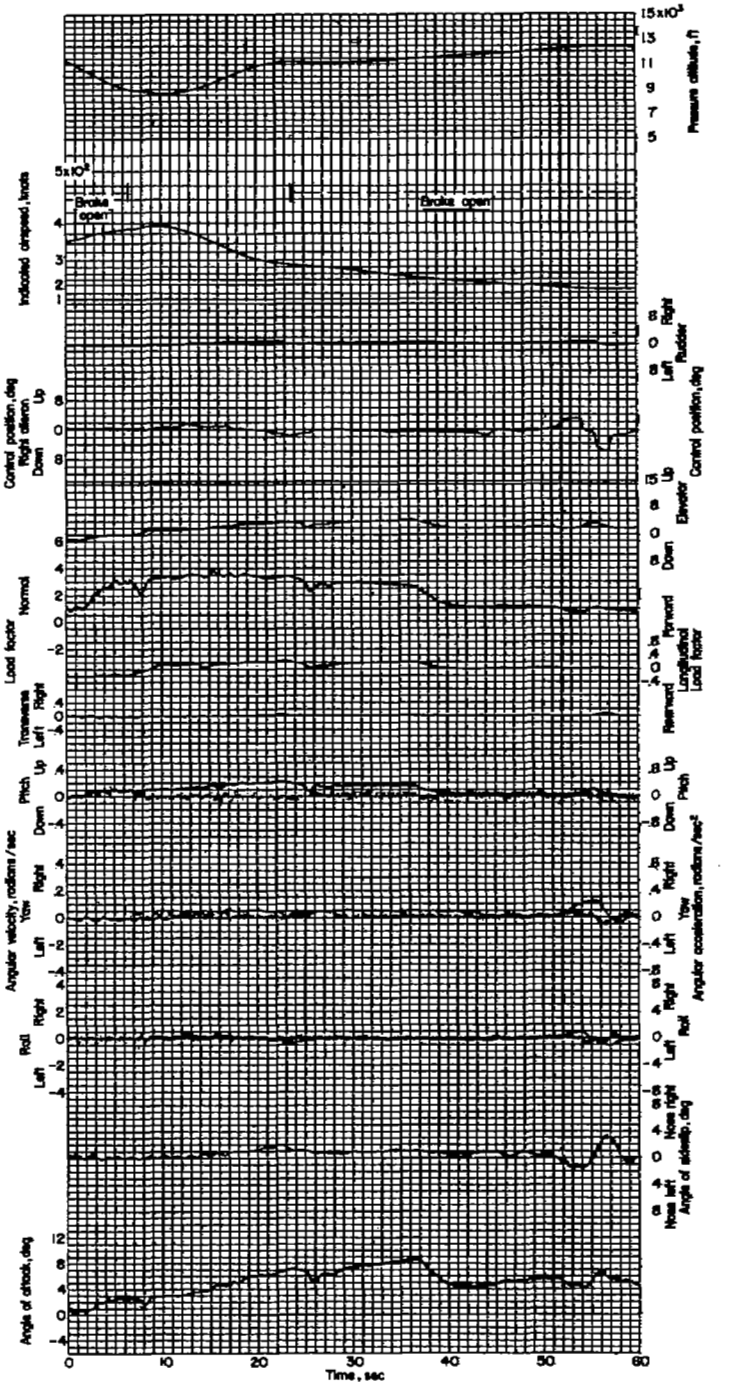
(a)

Figure 299.- Peel-off into dive-bombing run followed by wing-over into ground-gunnery run. Airplane weight, 16,400 pounds; center of gravity at 24.4 percent M.A.C.; flight 13.



(b)

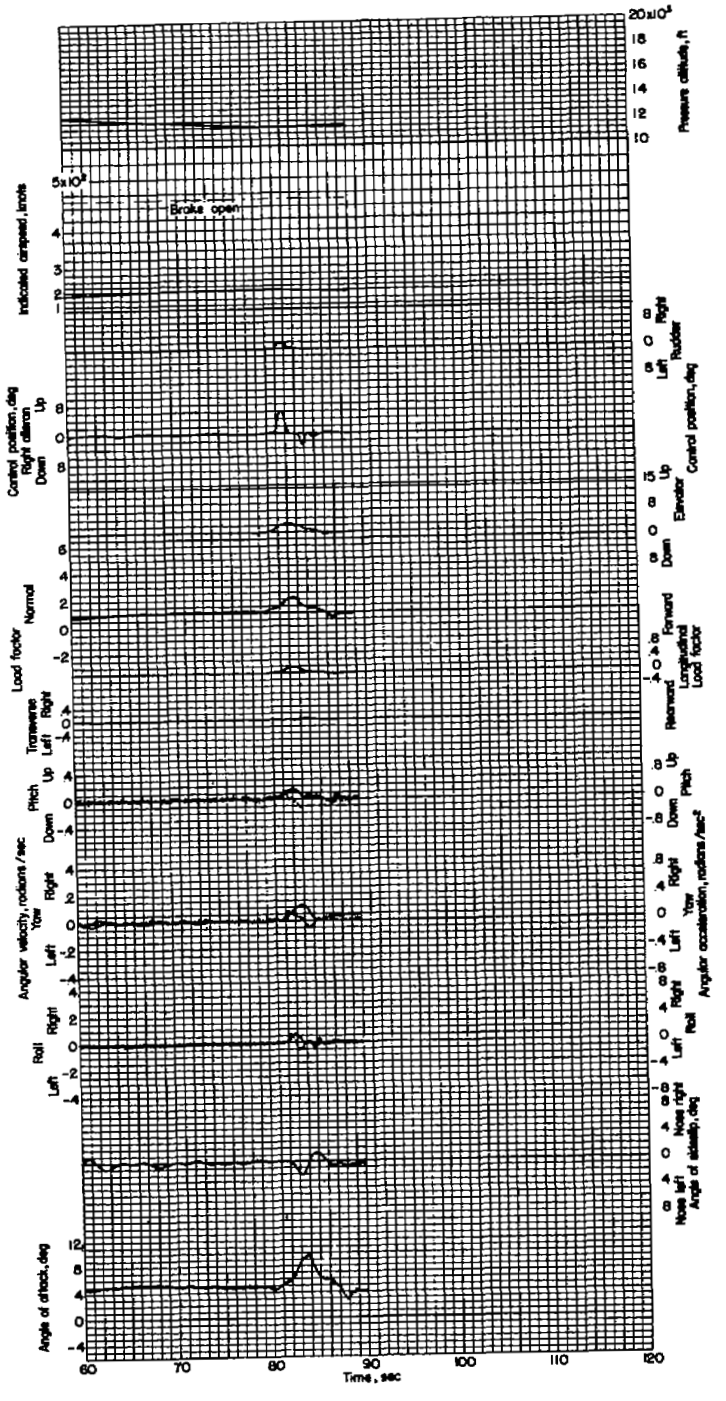
Figure 299.- Concluded.



(a)

Figure 300.- Dive-bombing run followed by climbing right turn. Airplane weight, 15,090 pounds; center of gravity at 24.2 percent M.A.C.; flight 15.

[redacted]



(b)

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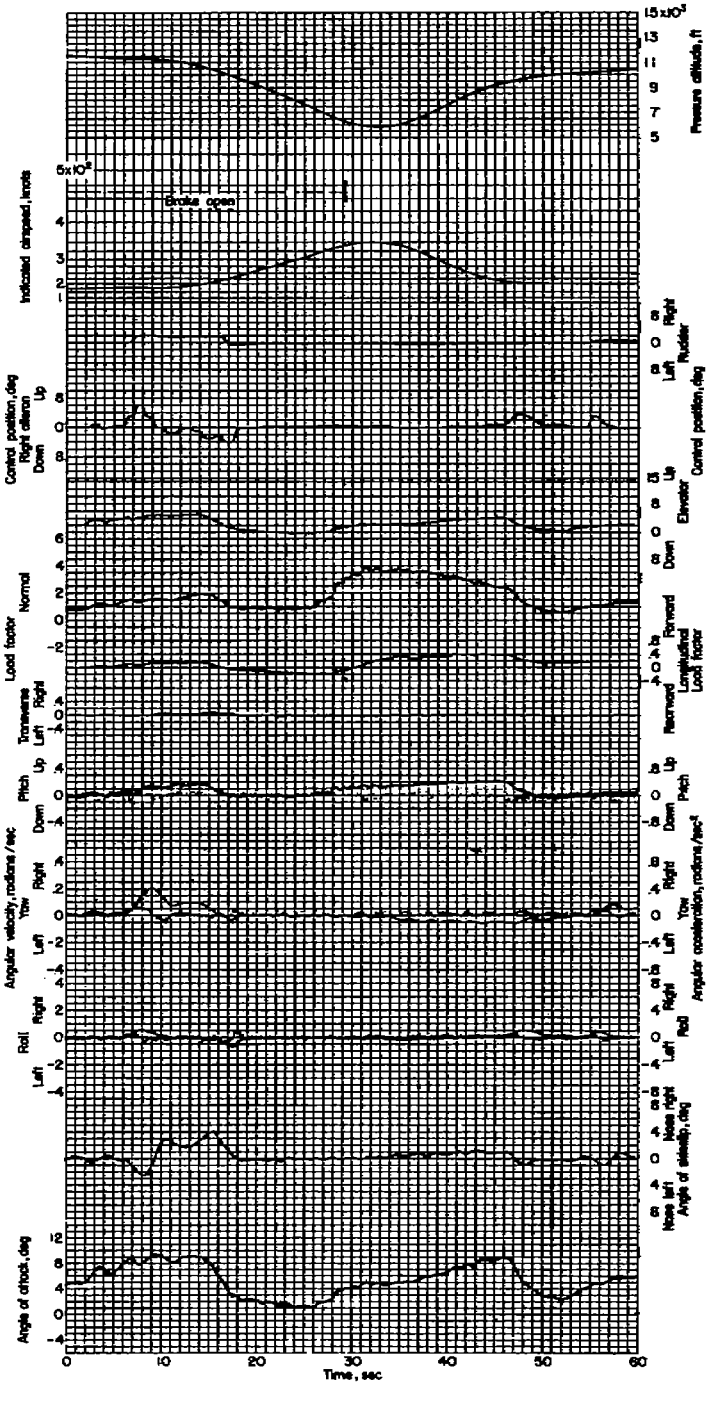
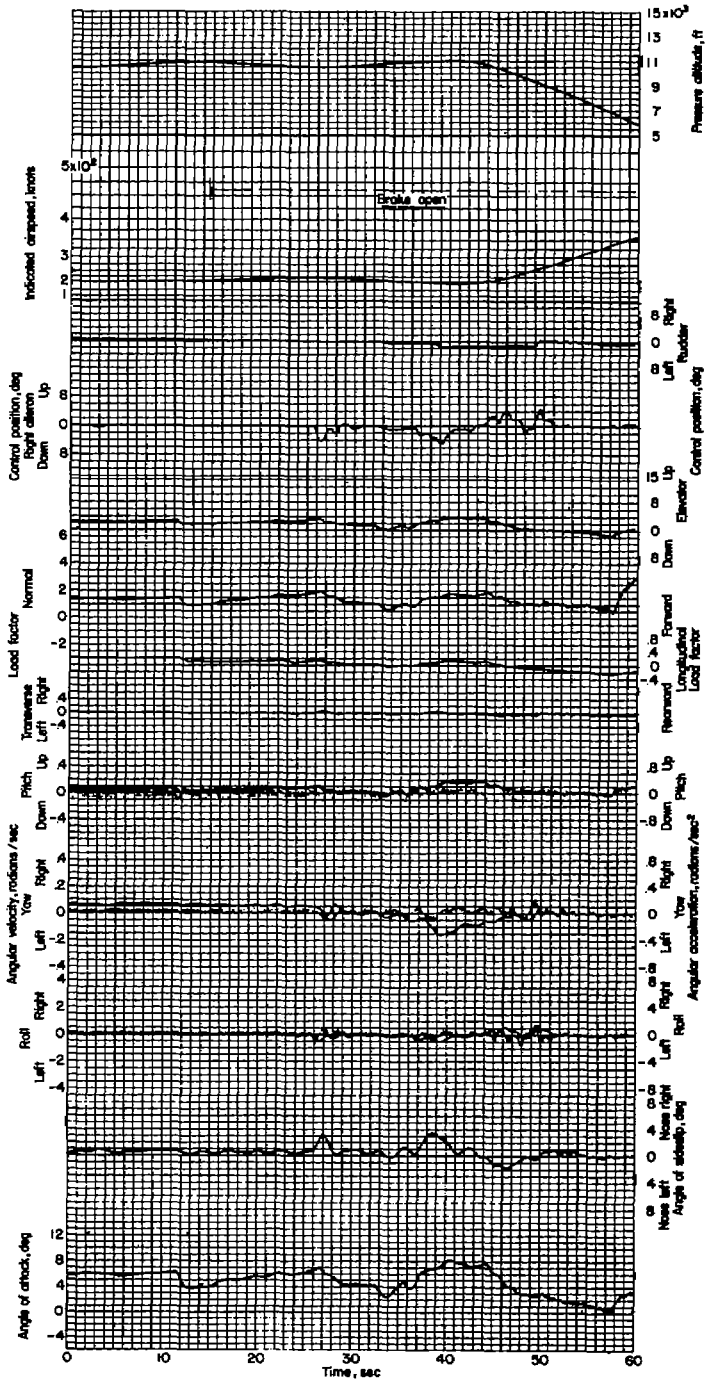


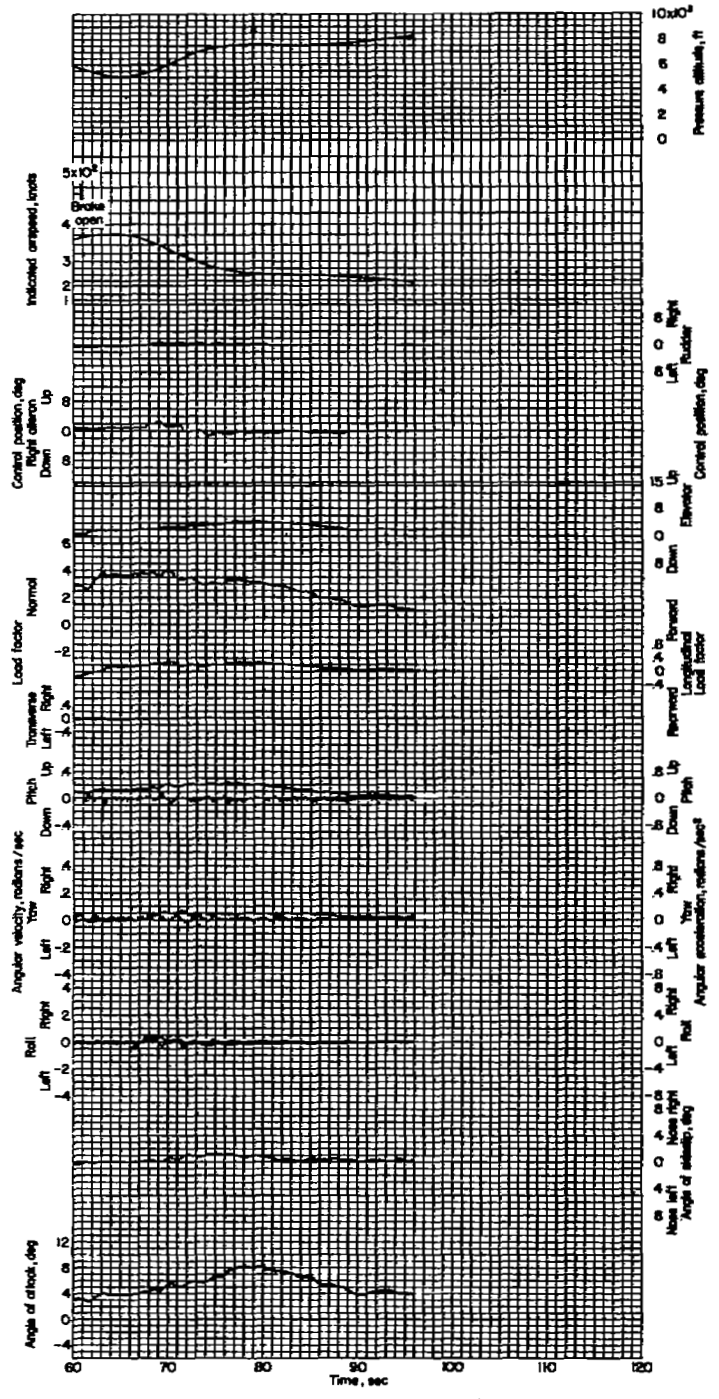
Figure 301.- Peel-off into dive-bombing run. Airplane weight, 14,980 pounds; center of gravity at 24.4 percent M.A.C.; flight 15.



(a)

Figure 302.- Right turn followed by peel-off into dive-bombing run. Airplane weight, 14,920 pounds; center of gravity at 24.5 percent M.A.C.; flight 15.

[redacted]



(b)

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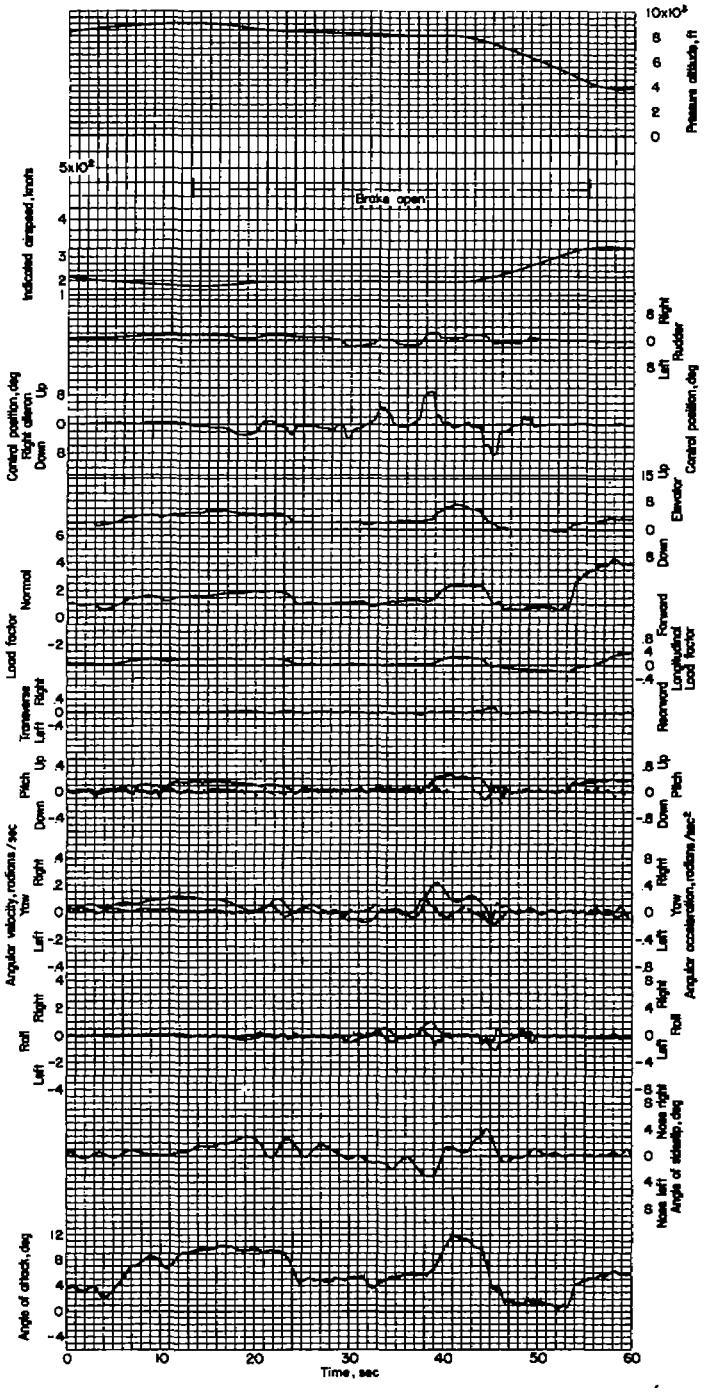
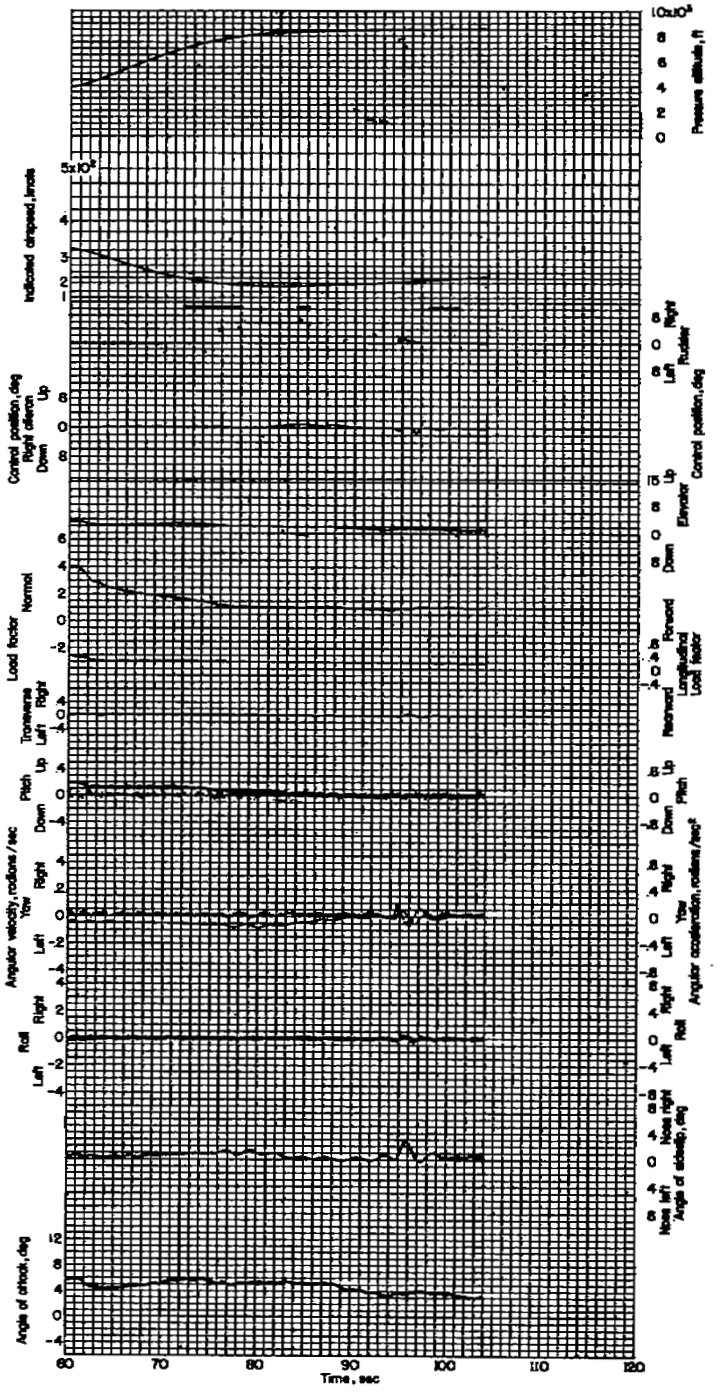


(a)

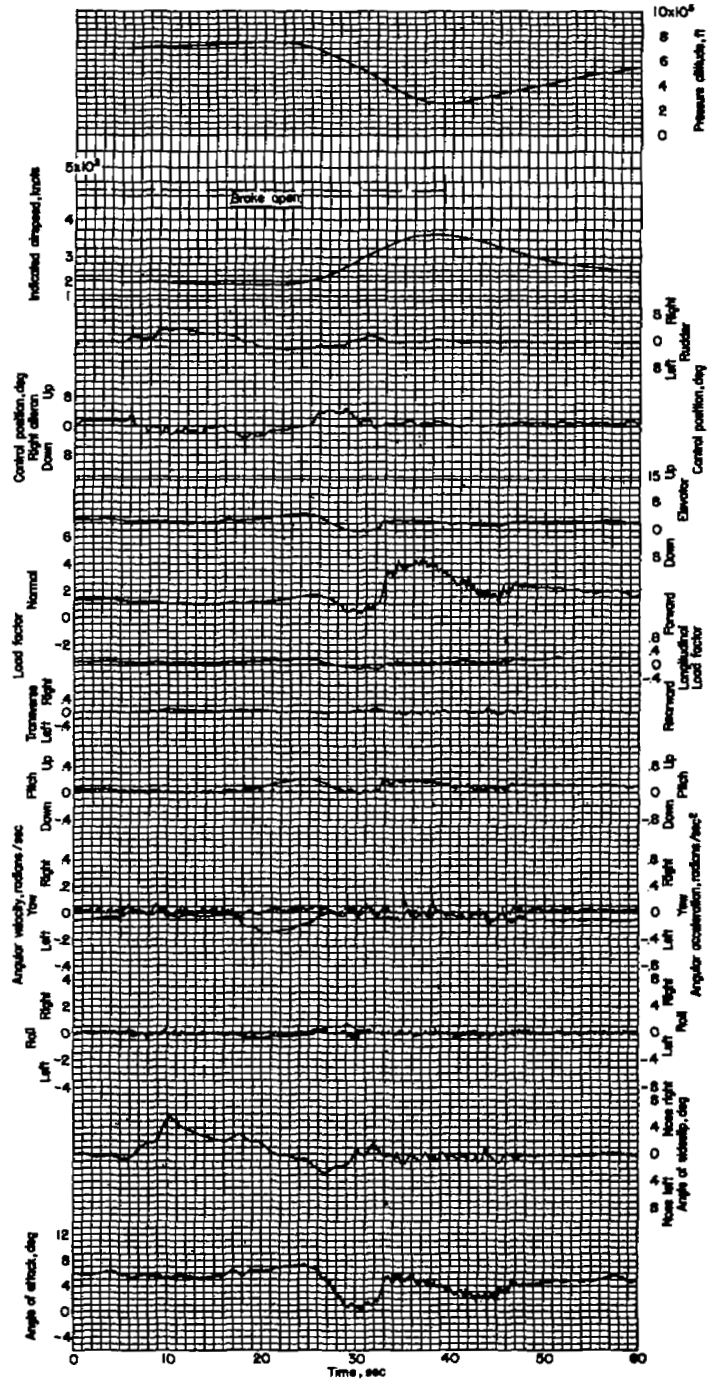
Figure 303.- Right turn and peel-off into dive-bombing run followed by climbing left turn. Airplane weight, 14,840 pounds; center of gravity at 24.6 percent M.A.C.; flight 15.

[redacted]



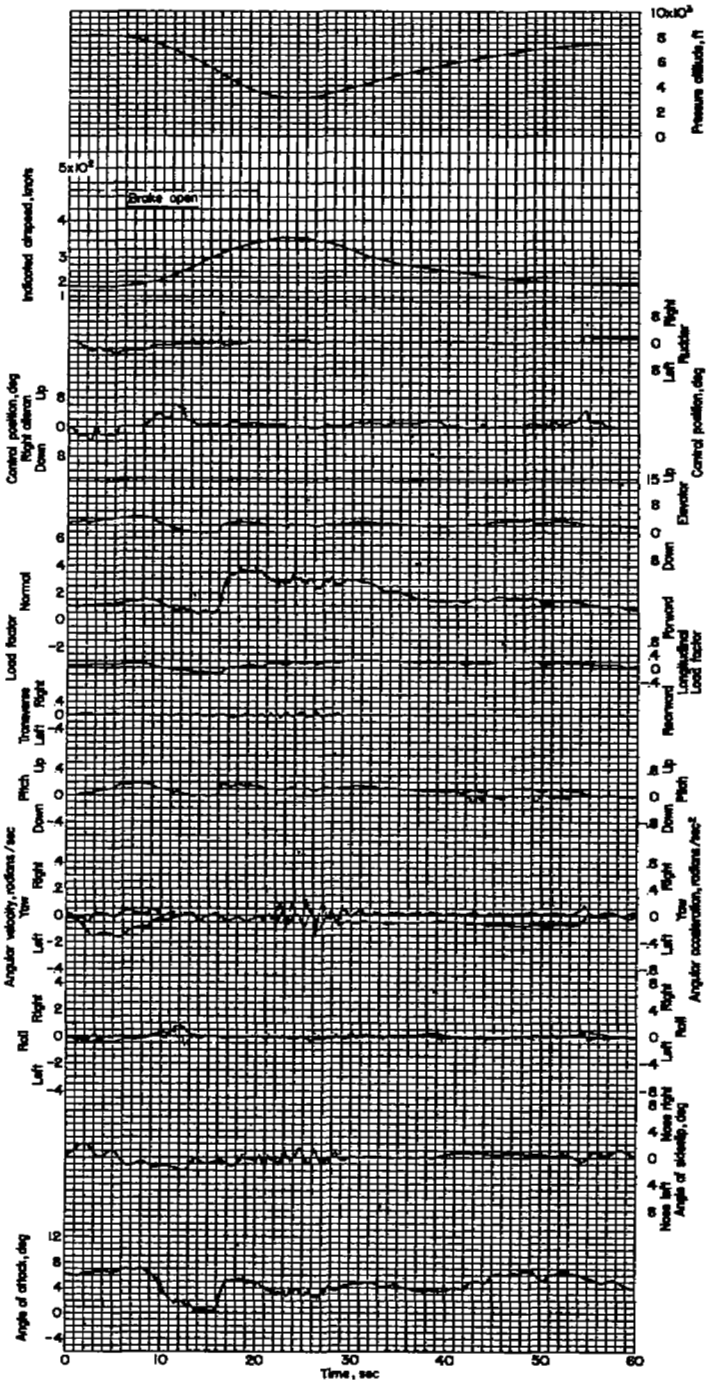
(b)

Figure 303.- Concluded.



NACA

Figure 304.- Peel-off into dive-bombing run followed by pull-up into climbing left turn. Airplane weight, 15,410 pounds; center of gravity at 23.8 percent M.A.C.; flight 17.



NACA

Figure 305.- Peel-off into dive-bombing run followed by pull-up into climbing left turn. Airplane weight, 15,310 pounds; center of gravity at 23.9 percent M.A.C.; flight 17.

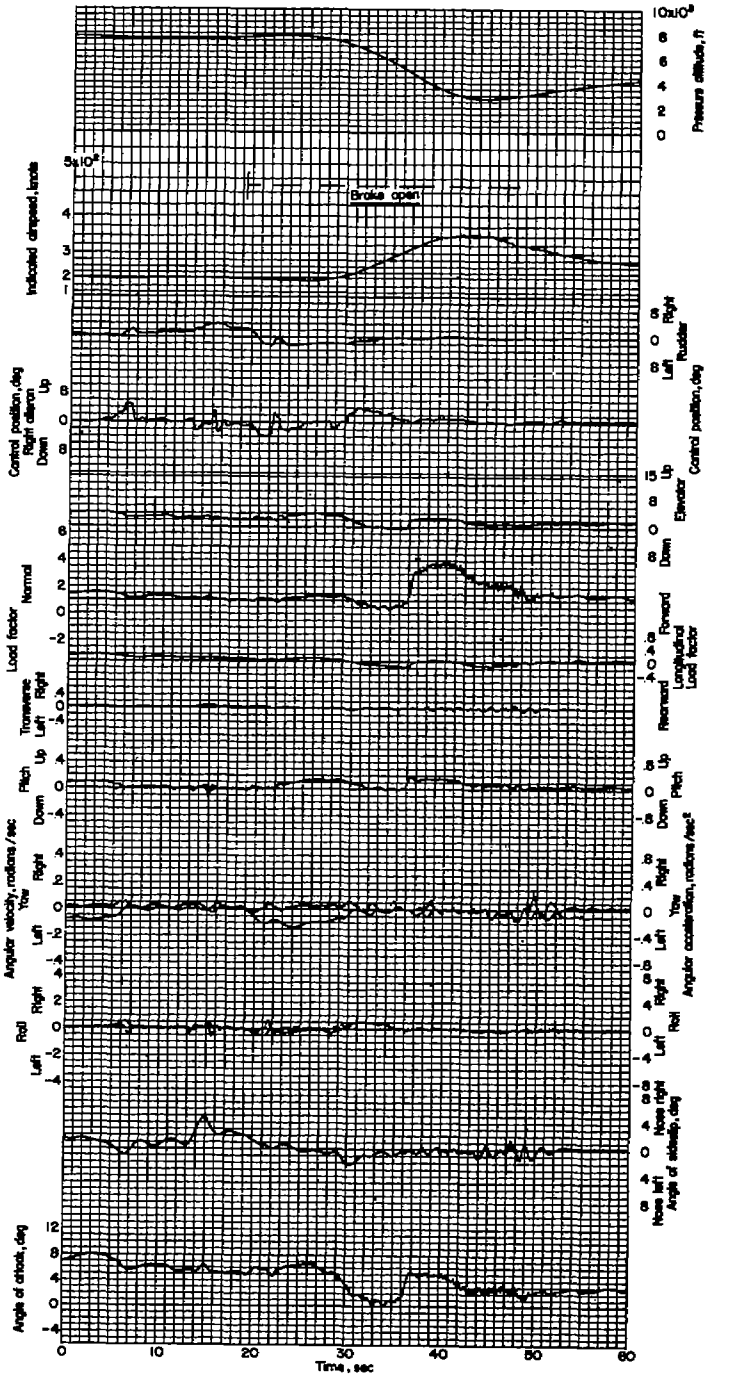


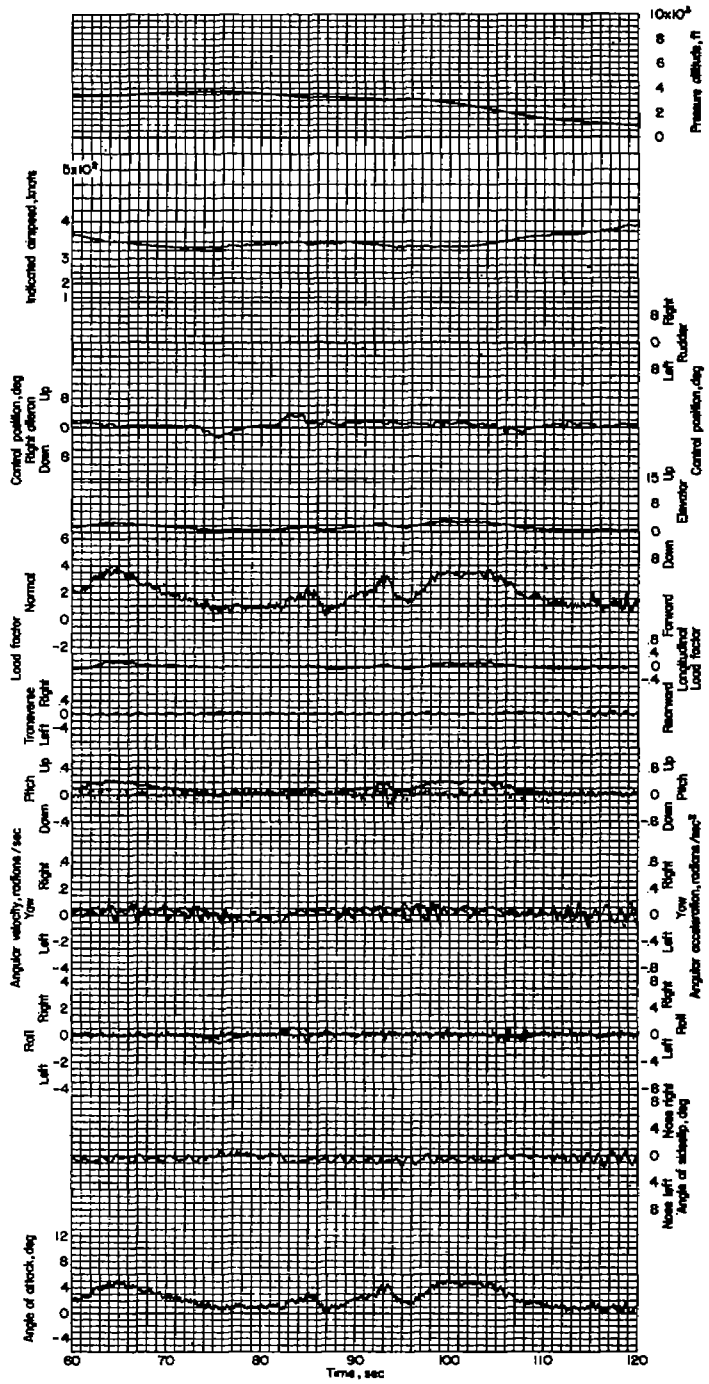
Figure 306.- Peel-off into dive-bombing run followed by pull-up into climbing left turn. Airplane weight, 15,250 pounds; center of gravity at 24.0 percent M.A.C.; flight 17.

NACA

(a)

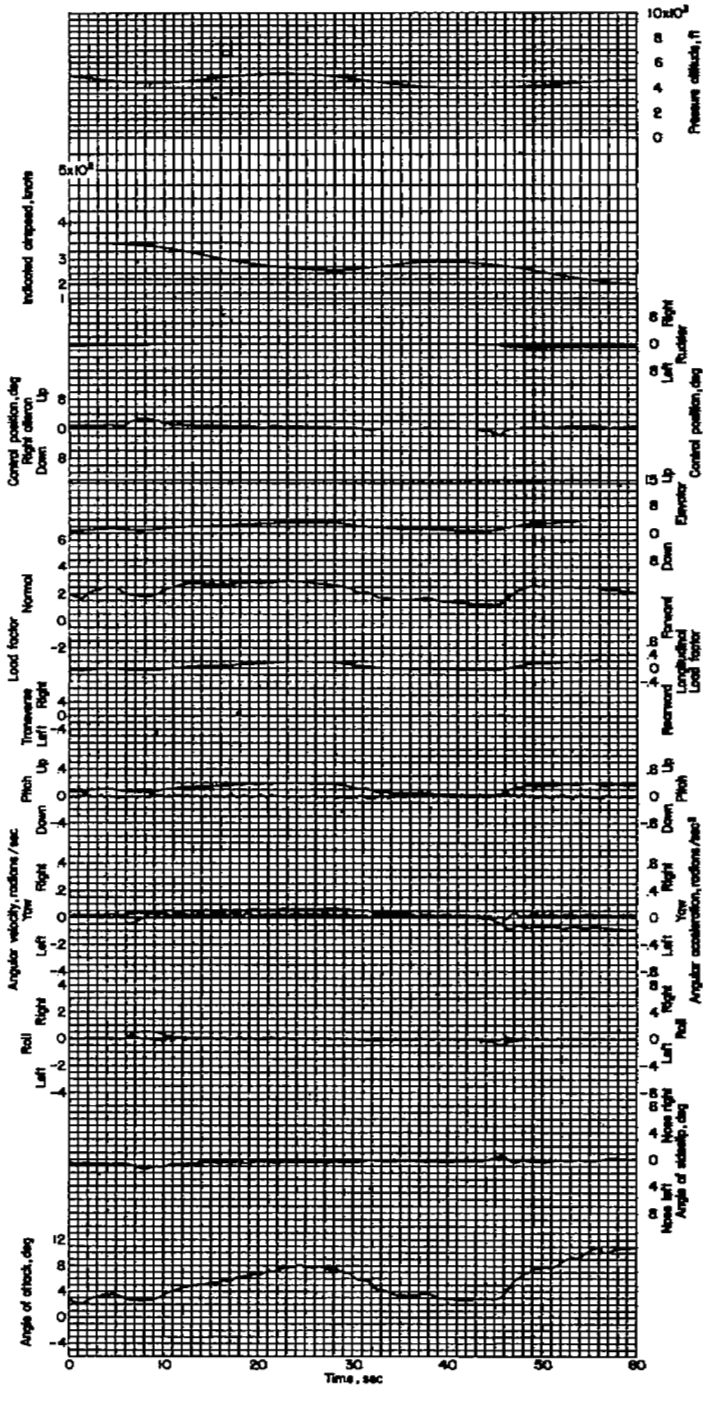
Figure 307.- Peel-off into dive-bombing run followed by strafing run. Airplane weight, 14,850 pounds; center of gravity at 24.5 percent M.A.C.; flight 18.

[redacted]



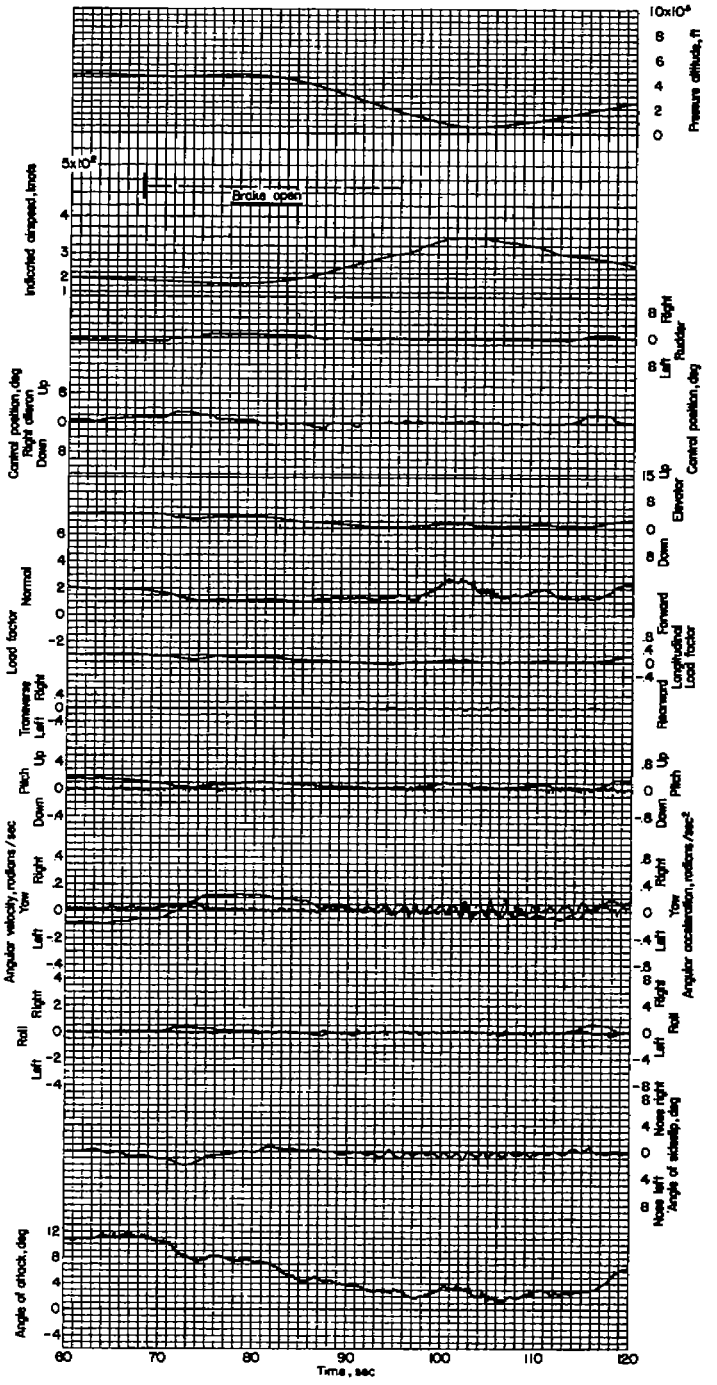
(b)

Figure 307.- Concluded.



(a)

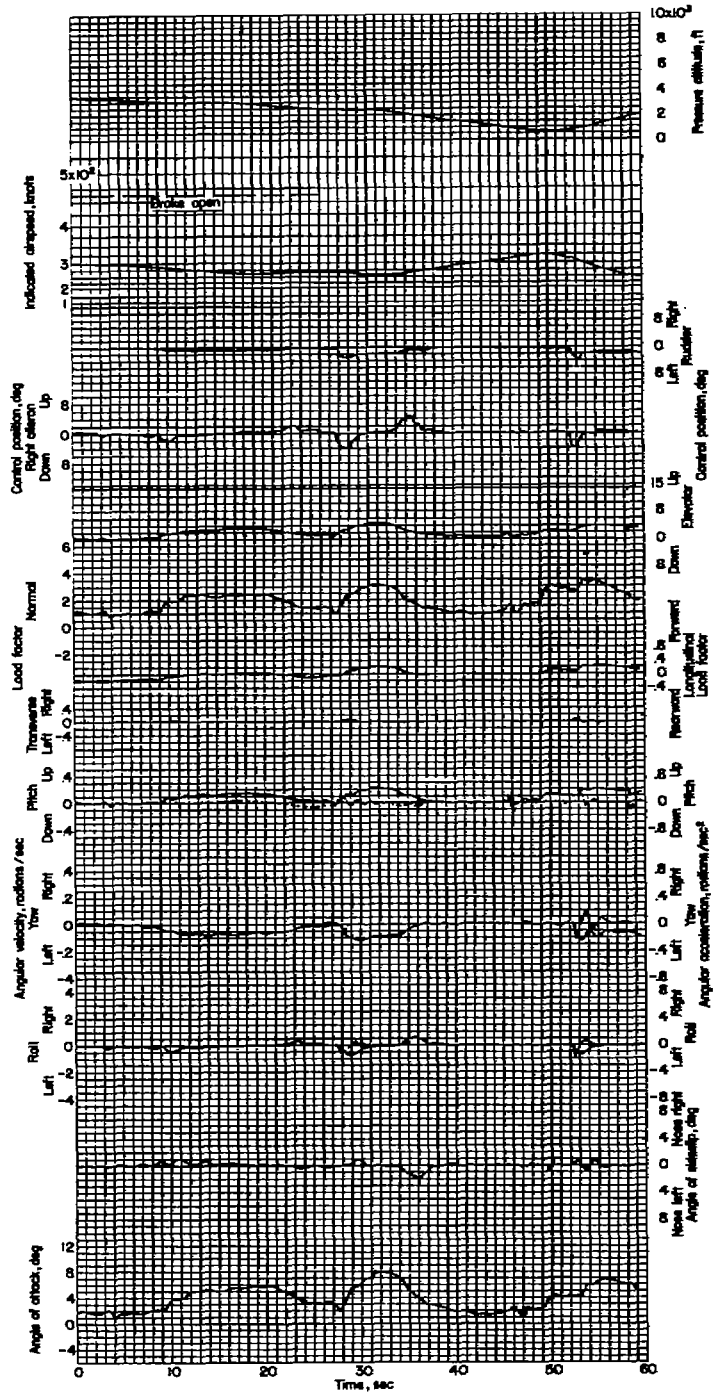
Figure 308.- Series of turns followed by dive-bombing run. Airplane weight, 14,330 pounds; center of gravity at 24.4 percent M.A.C.; flight 19.



(b)

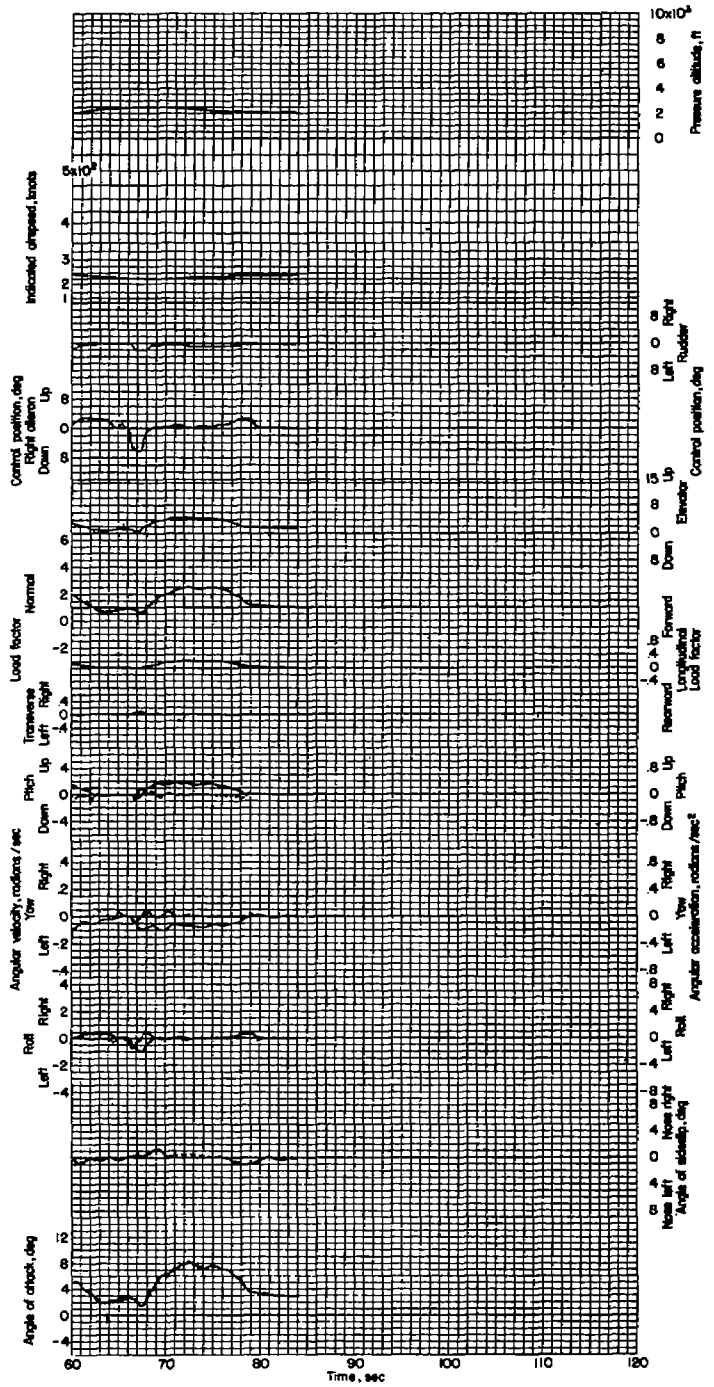
Figure 308.- Concluded.

[redacted]



(a)

Figure 309.- Ground-gunnery run. Airplane weight, 15,210 pounds; center of gravity at 24.0 percent M.A.C.; flight 6.



(b)

Figure 309.- Concluded.

[redacted]

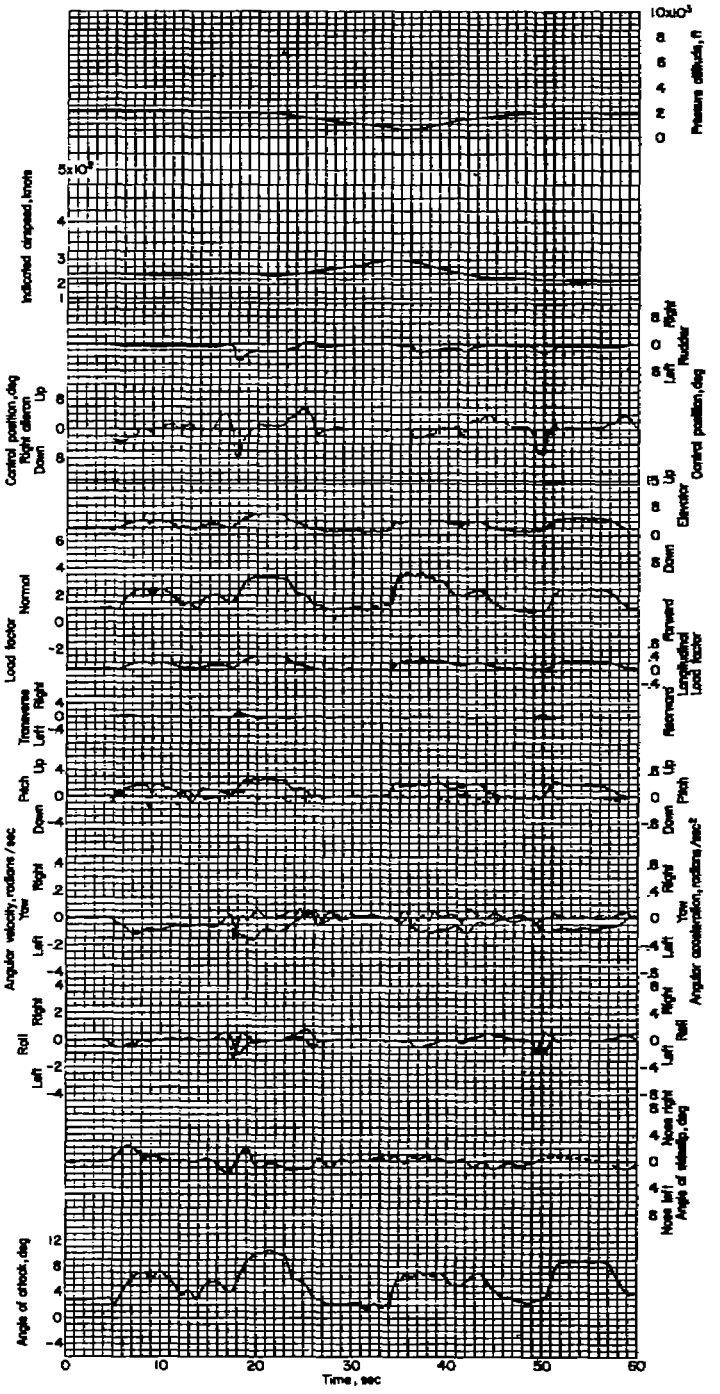


Figure 310.- Ground-gunnery run. Airplane weight, 15,160 pounds; center of gravity at 24.1 percent M.A.C.; flight 6.

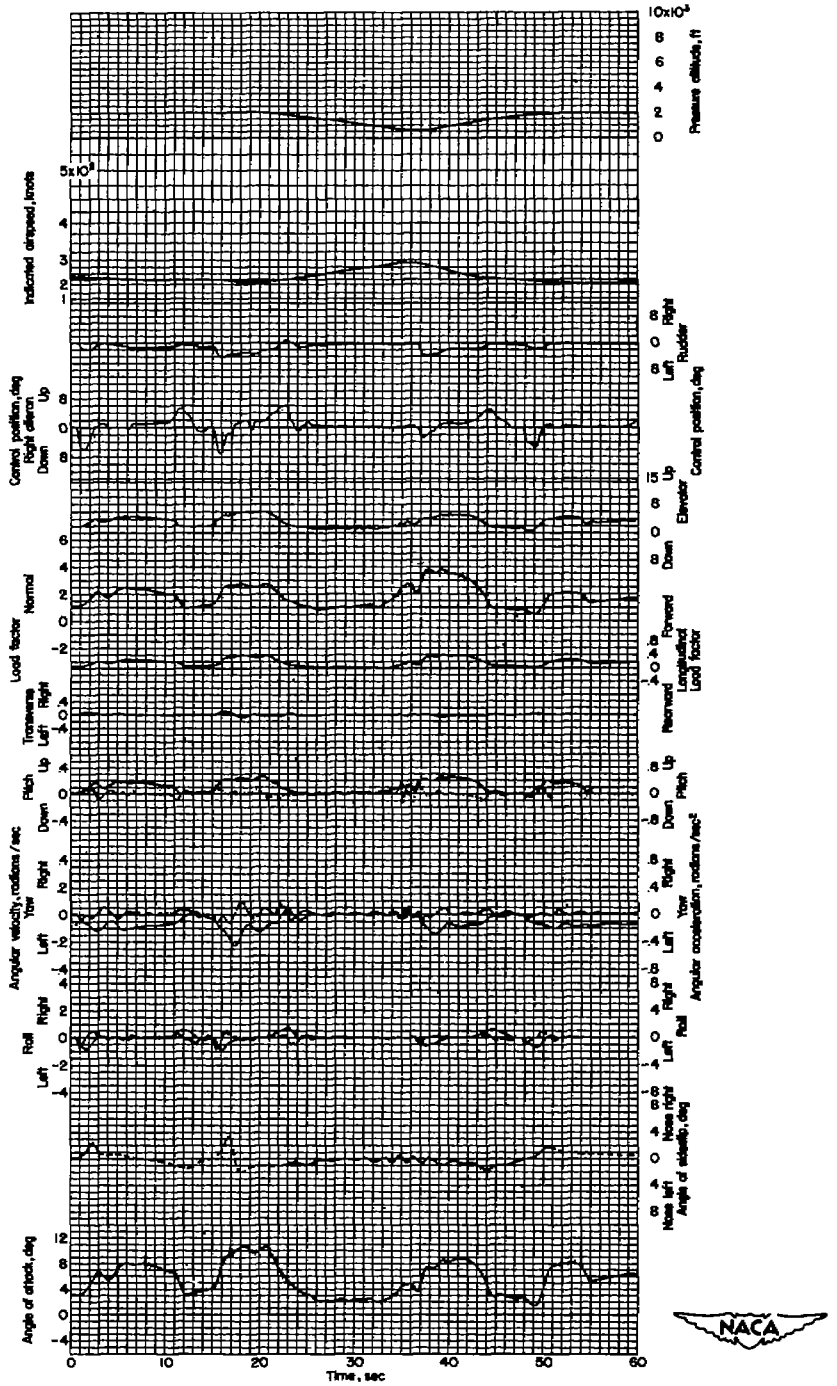
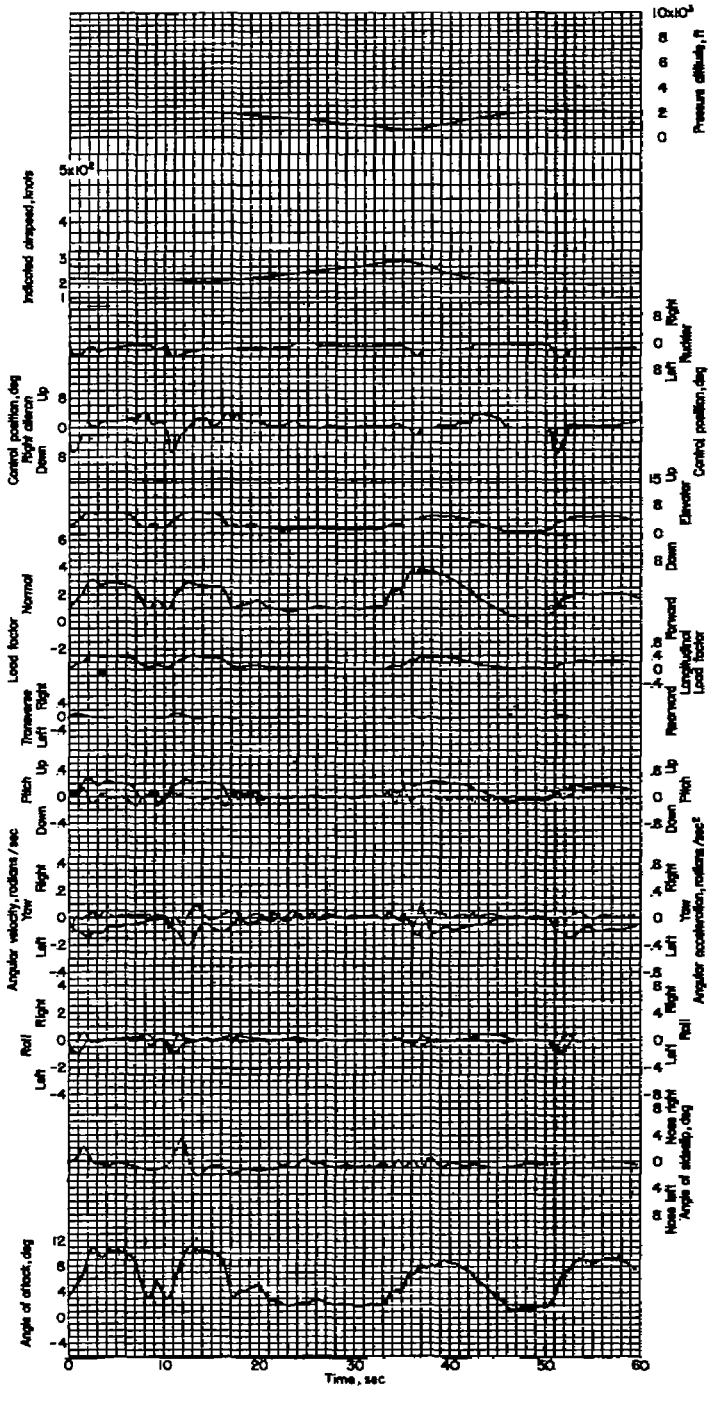


Figure 311.- Ground-gunnery run. Airplane weight, 15,100 pounds; center of gravity at 24.2 percent M.A.C.; flight 6.

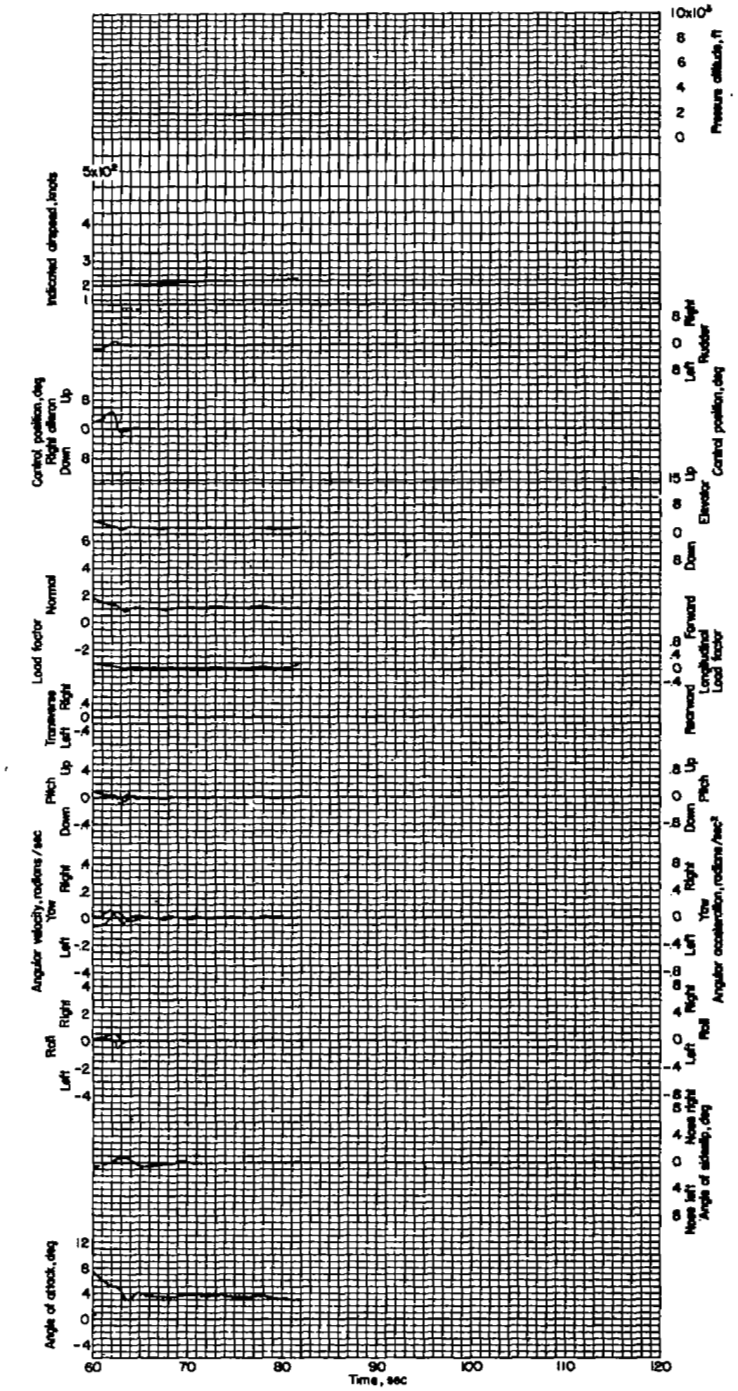
[redacted]



(a)

Figure 312.- Ground-gunnery run. Airplane weight, 15,030 pounds; center of gravity at 24.3 percent M.A.C.; flight 6.

[redacted]



(b)

Figure 312.- Concluded.

[redacted]

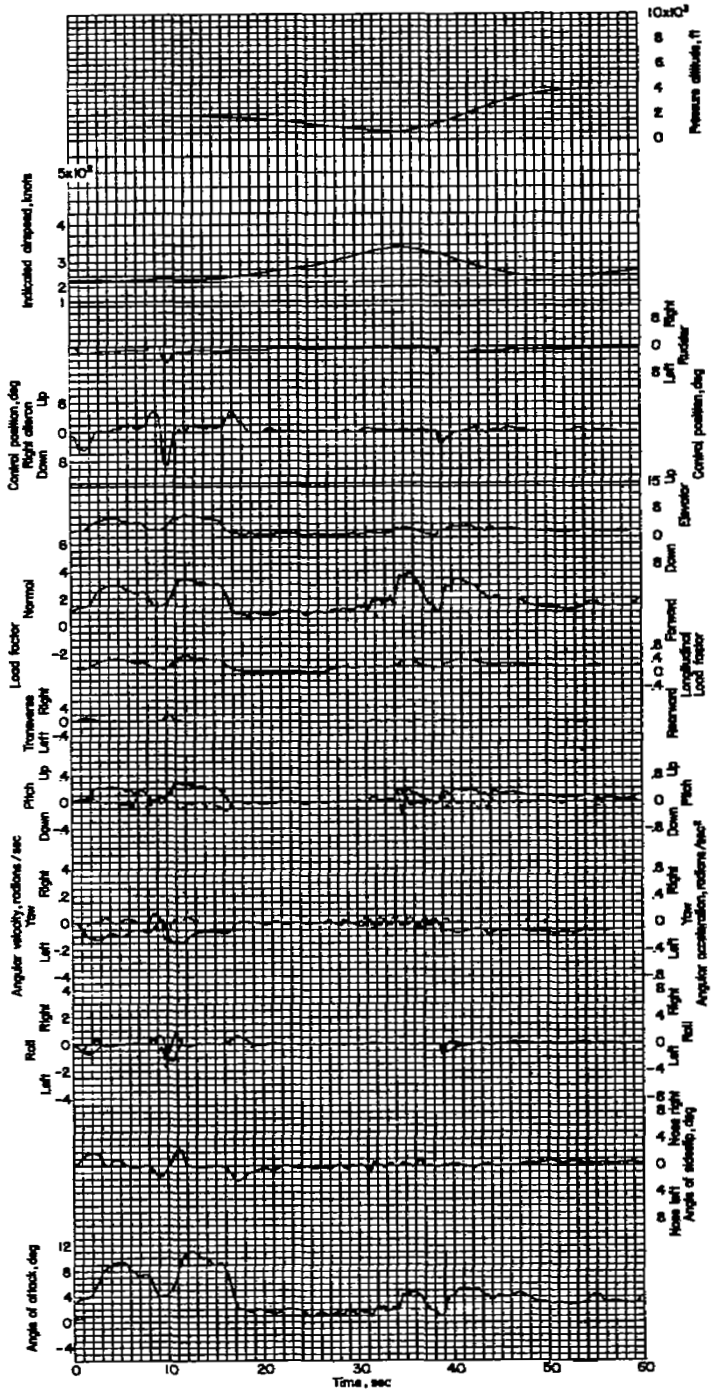
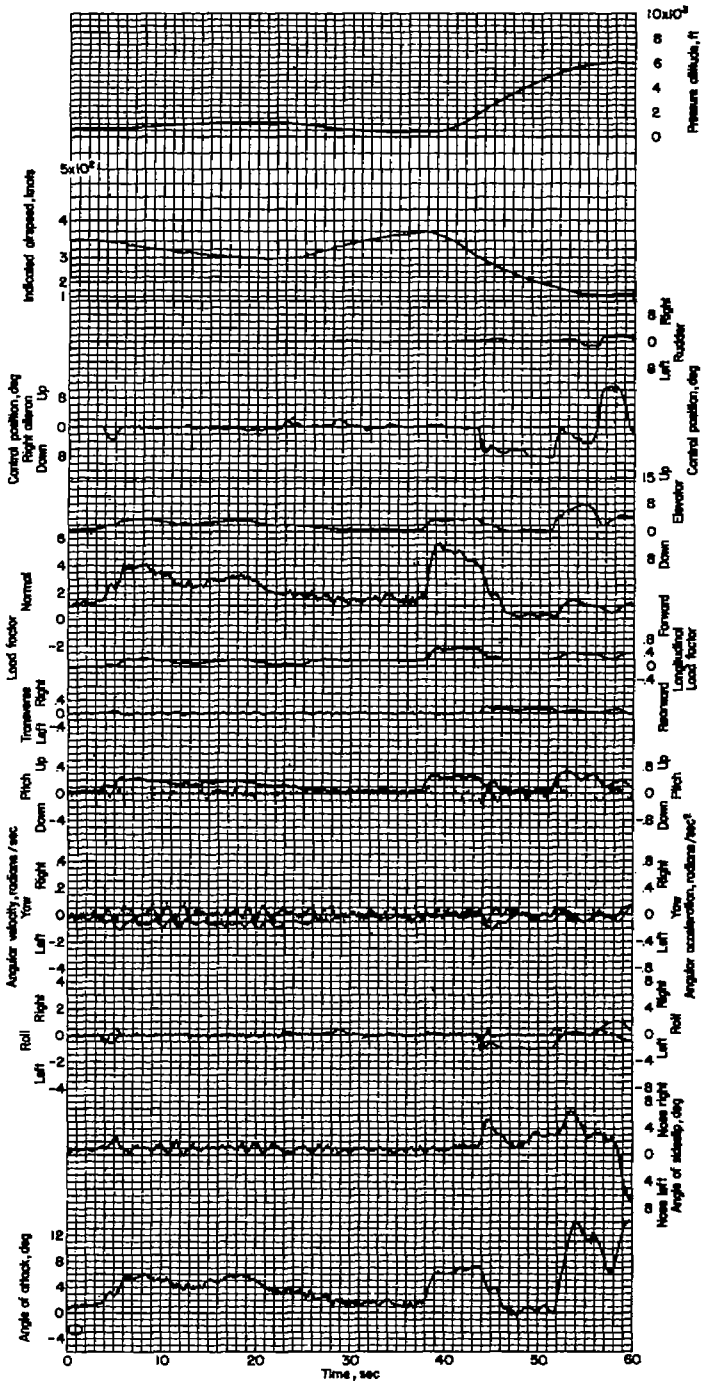


Figure 313.- Ground-gunnery run. Airplane weight, 14,980 pounds; center of gravity at 24.4 percent M.A.C.; flight 6.

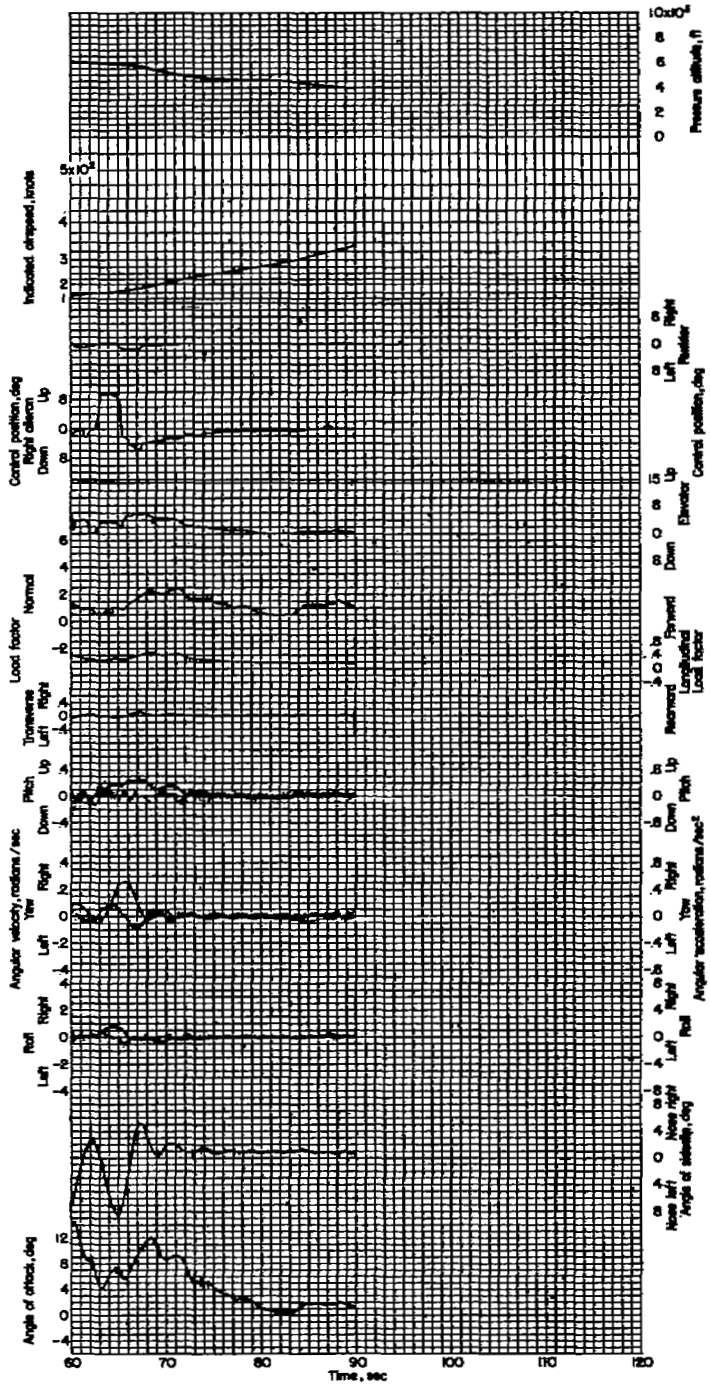
[redacted]



(a)

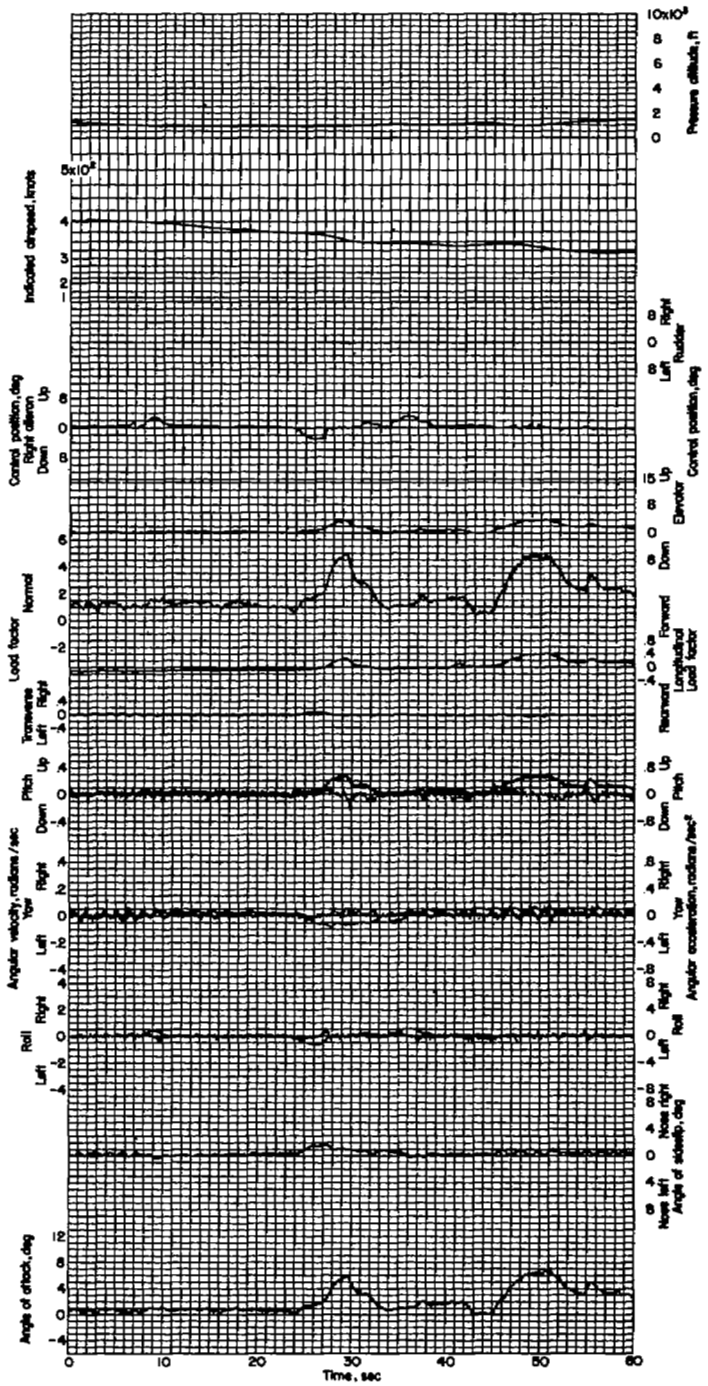
Figure 314.- Ground-gunnery run followed by pull-up into steep climb with one and one-half left aileron rolls and roll-out to the right. Airplane weight, 15,680 pounds; center of gravity at 23.9 percent M.A.C.; flight 7.

[redacted]



(b)

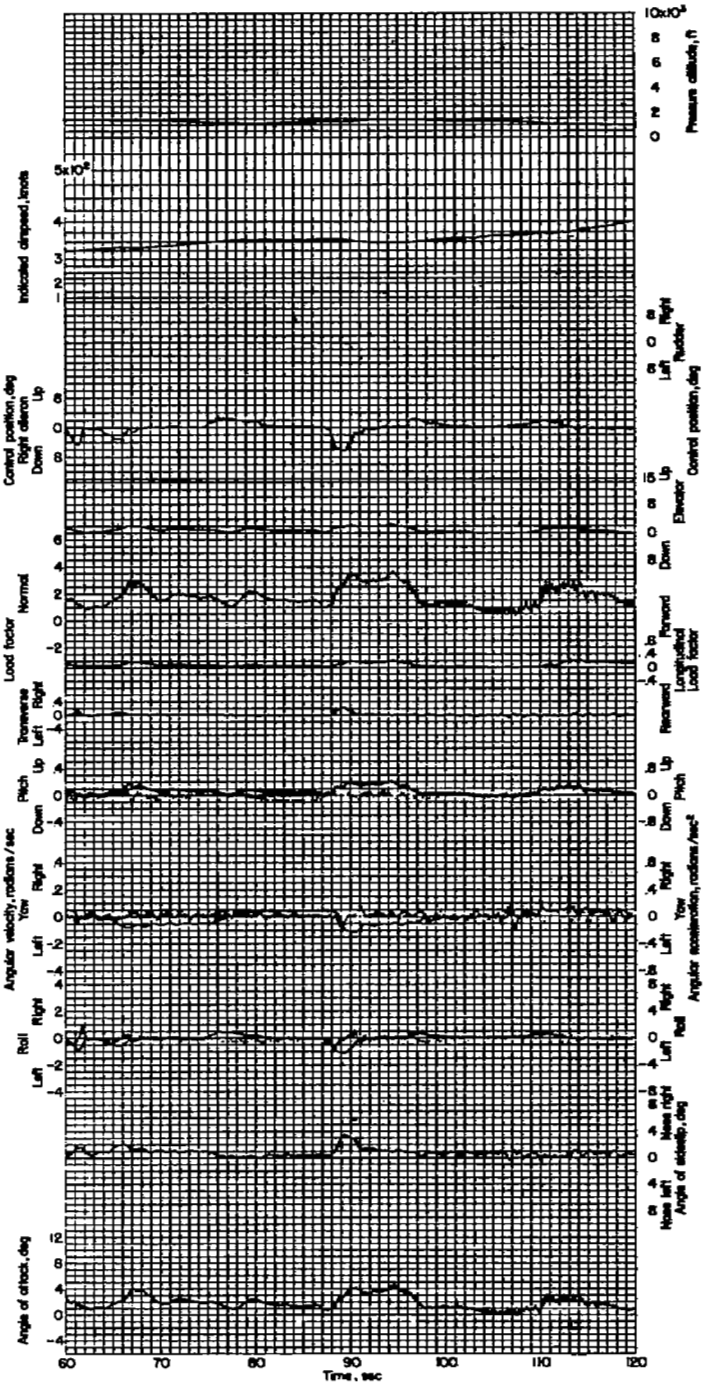
Figure 314.- Concluded.



(a)

Figure 315.- Ground-gunnery run including series of turns. Airplane weight, 15,490 pounds; center of gravity at 23.8 percent M.A.C.; flight 7.

[redacted]



(b)

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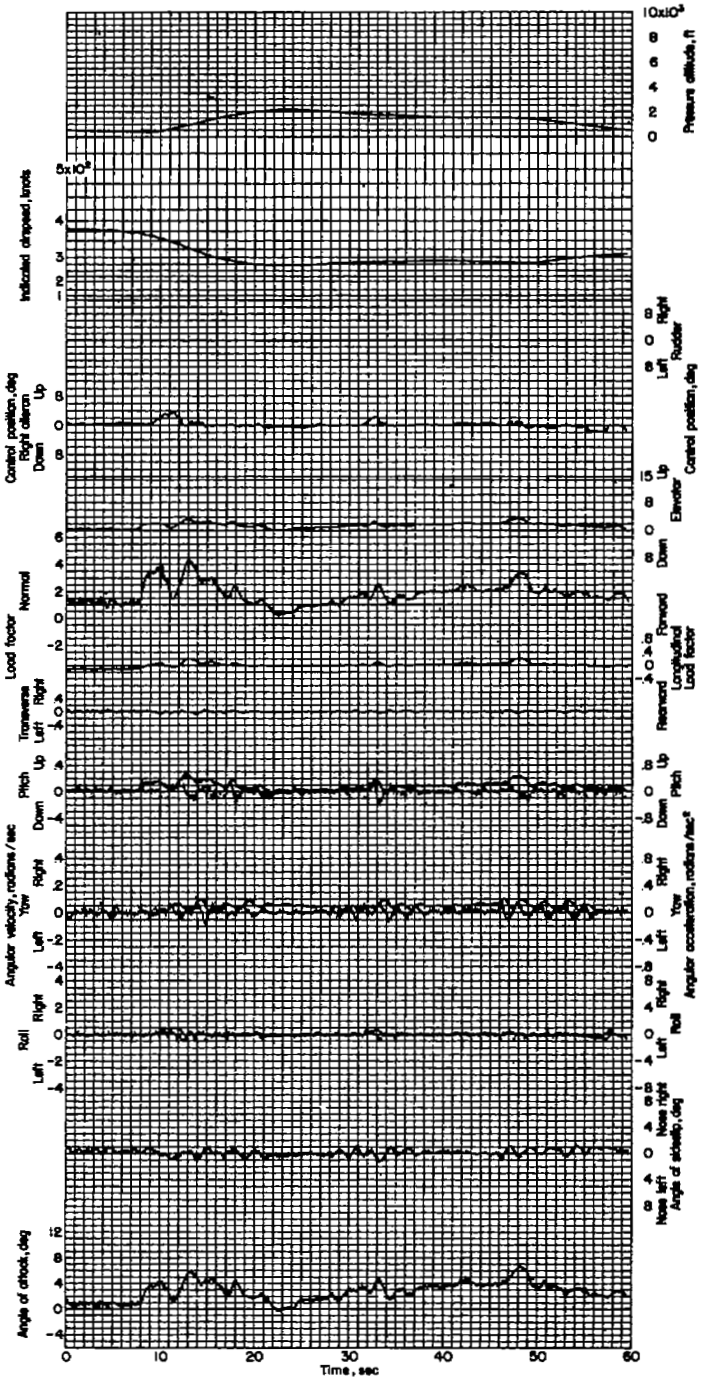
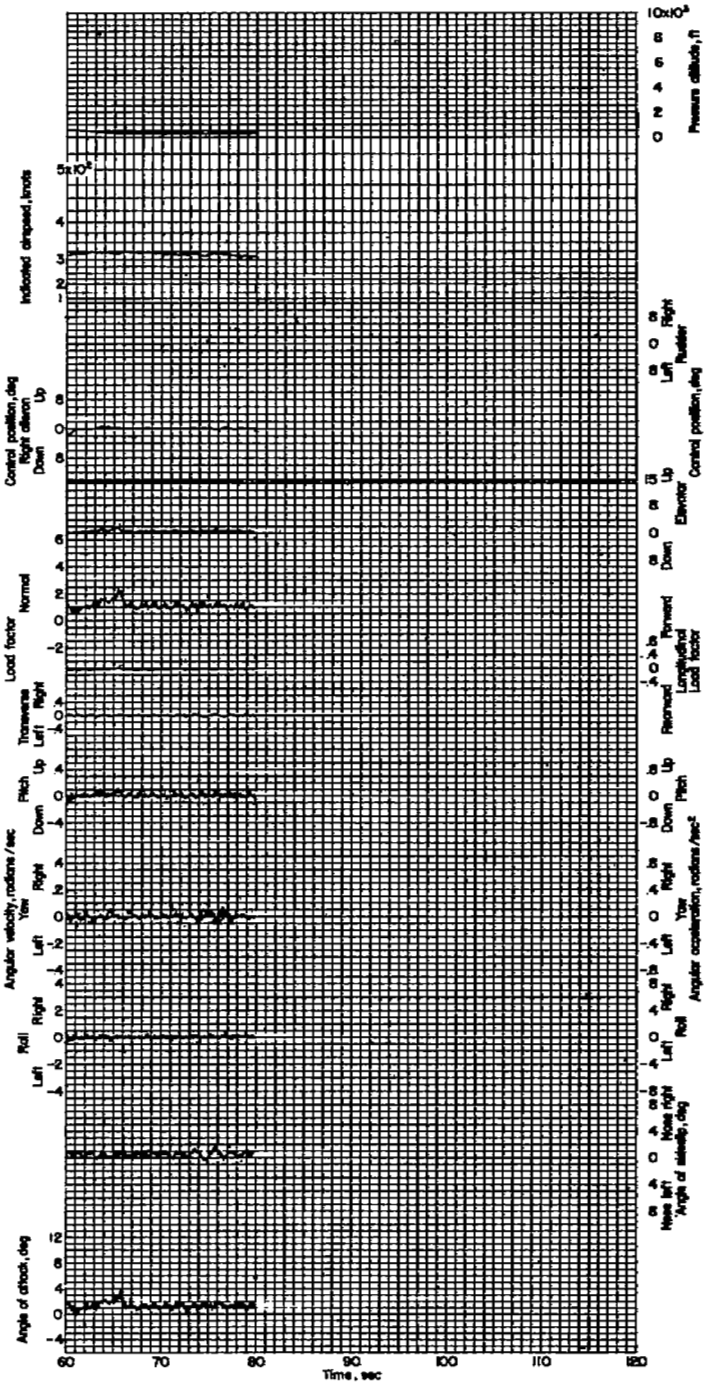


(a)

Figure 316.- Ground-gunnery run. Airplane weight, 14,630 pounds; center of gravity at 24.9 percent M.A.C.; flight 7.

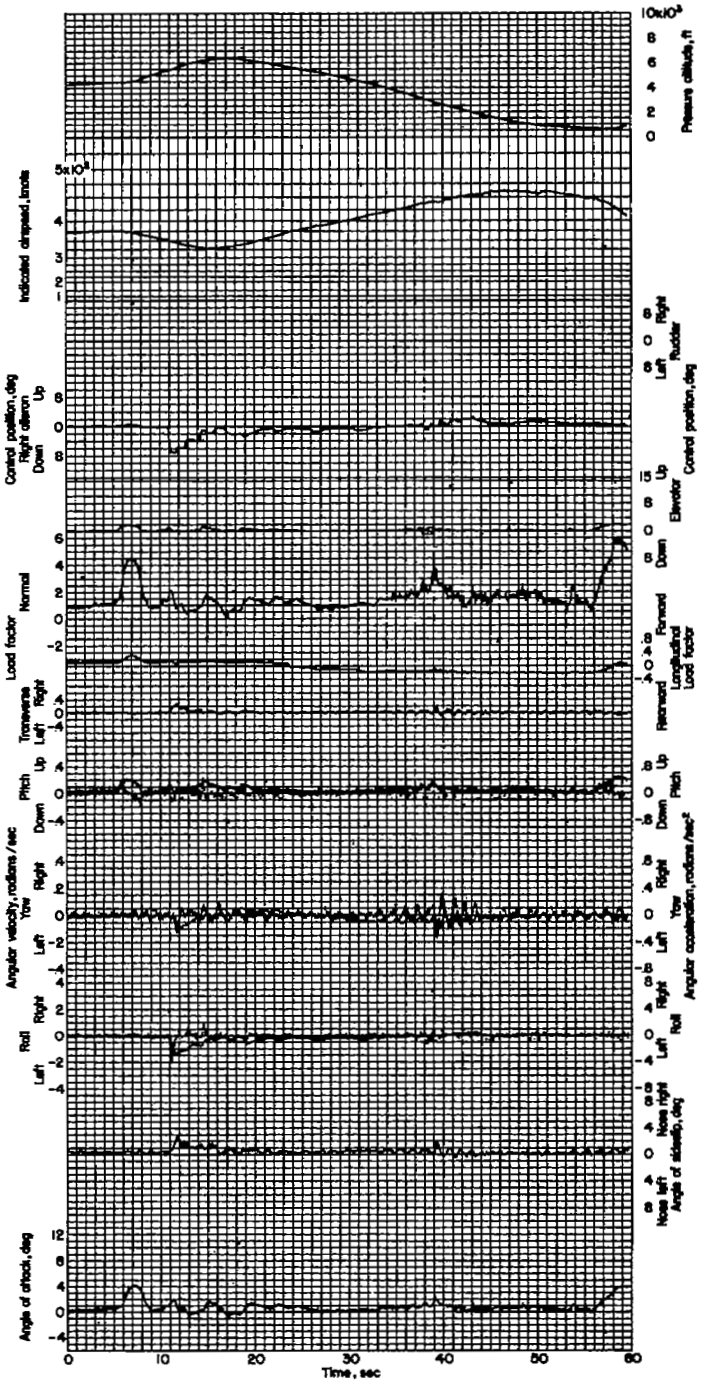
[redacted]



(b)

Figure 316.- Concluded.

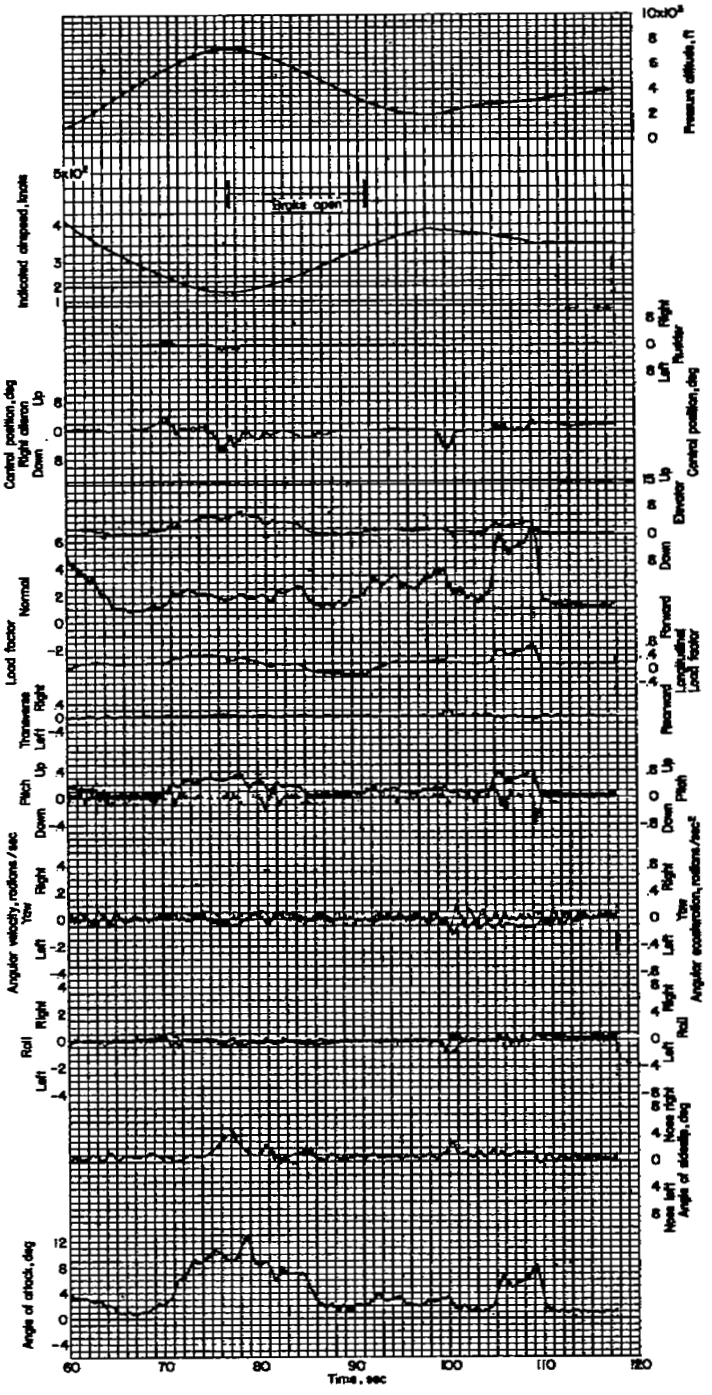
[redacted]



(a)

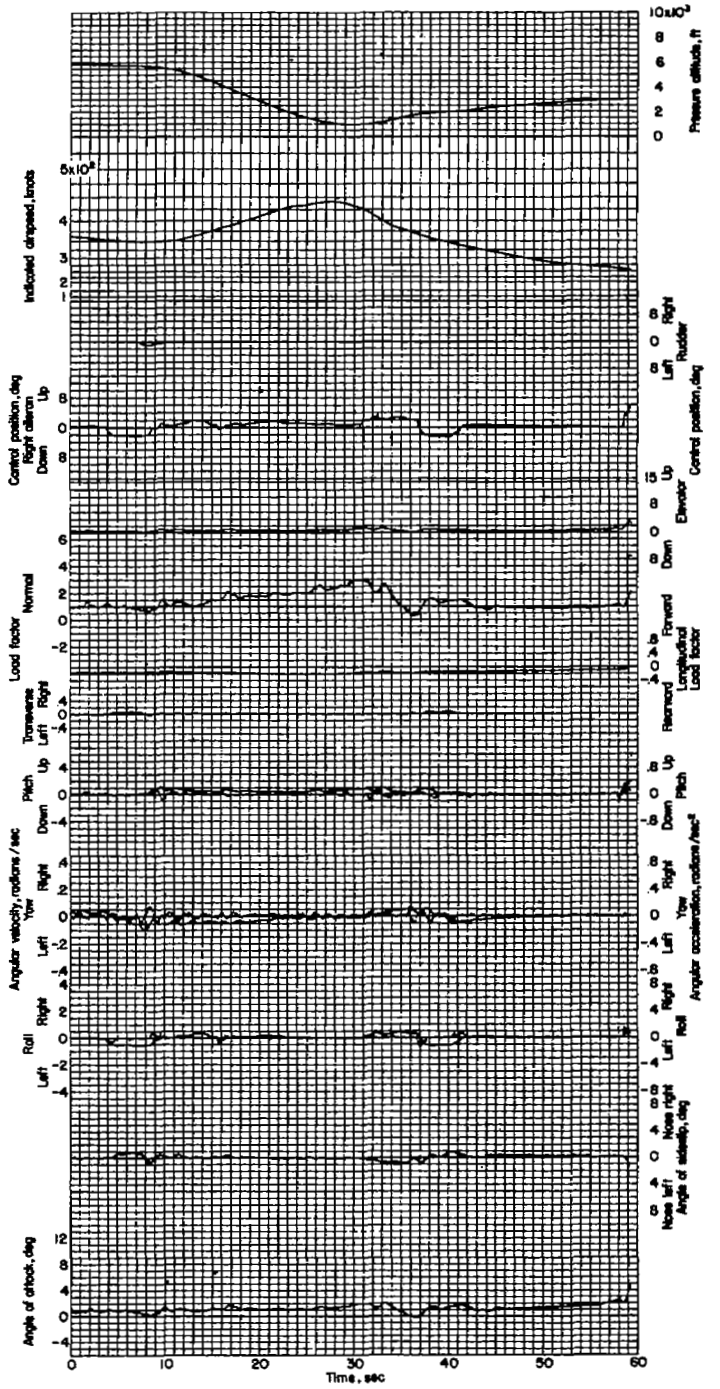
Figure 317.- Peel-off into ground-gunnery run followed by wing-over into dive-bombing run with left-turn recovery. Airplane weight, 14,430 pounds; center of gravity at 25.1 percent M.A.C.; flight 7.

[redacted]



(b)

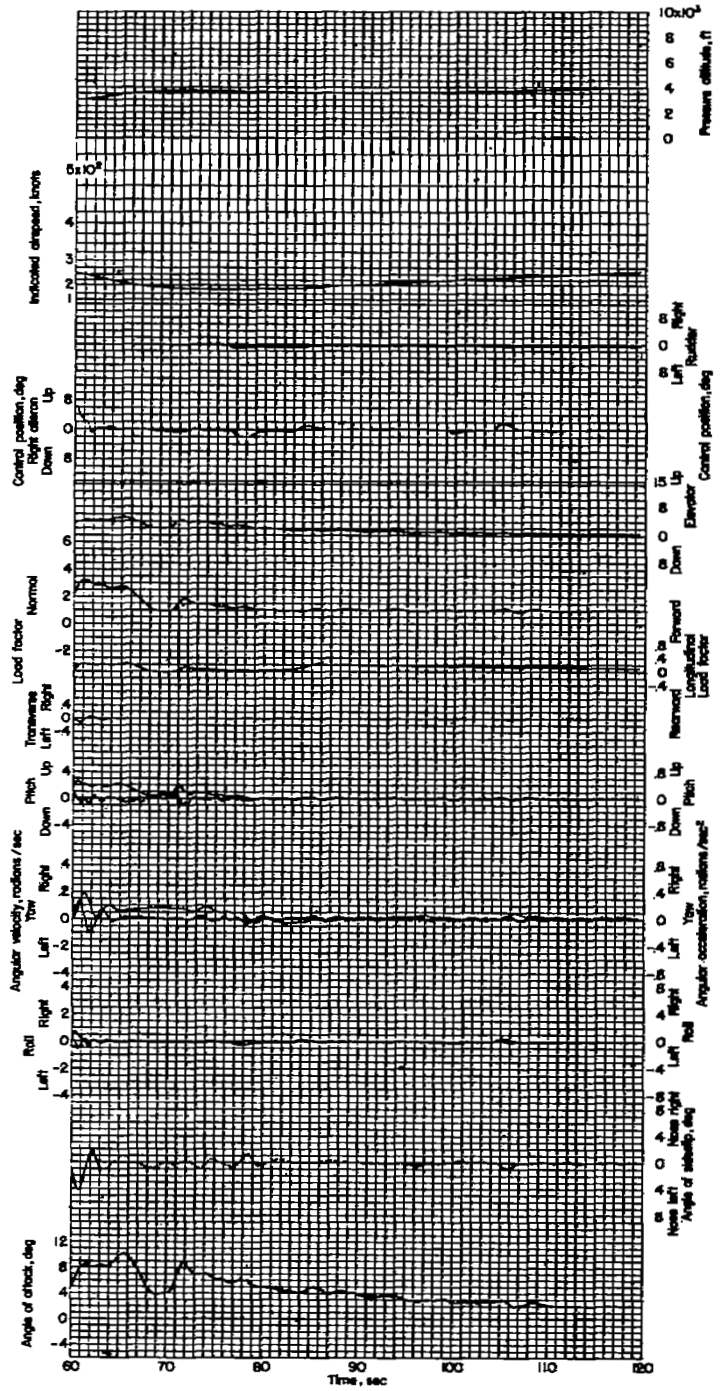
Figure 317.- Concluded.



(a)

Figure 318.- Peel-off into ground-gunnery run followed by series of turns. Airplane weight, 14,390 pounds; center of gravity at 25.2 percent M.A.C.; flight 8.

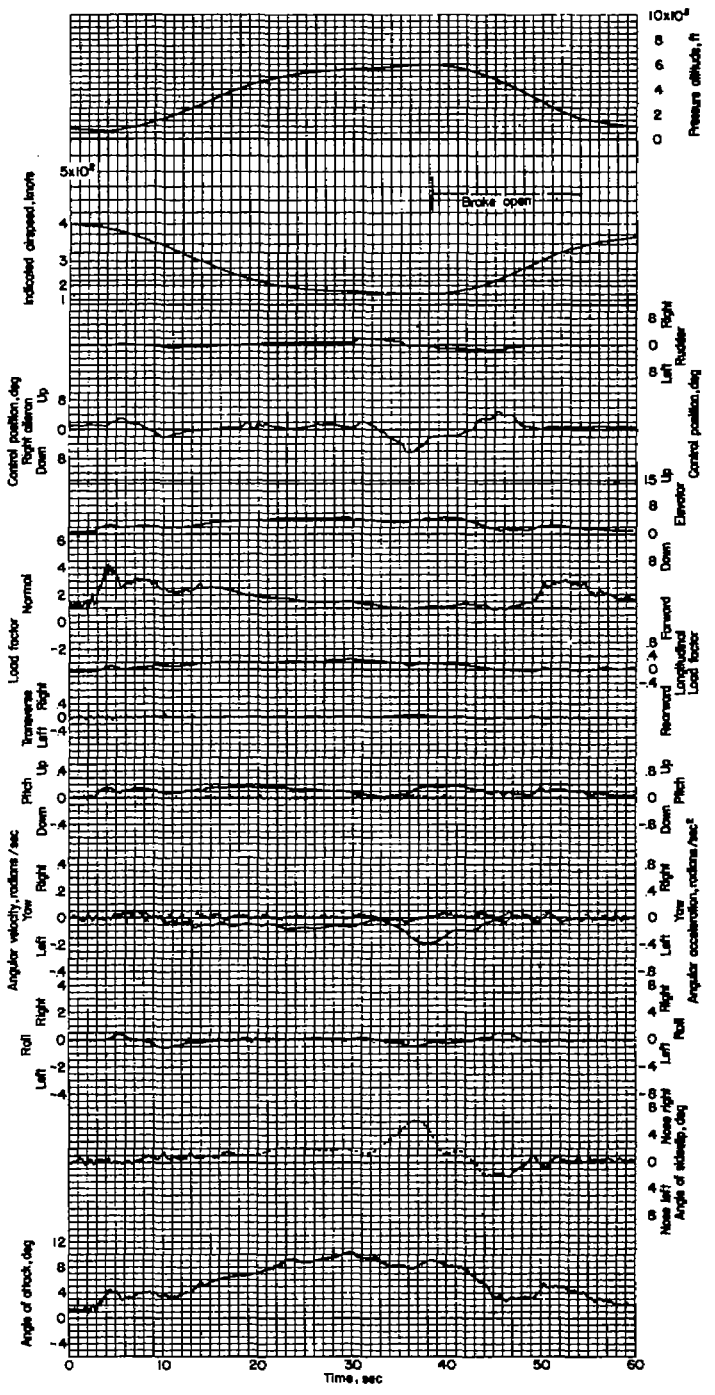
[redacted]



(b)

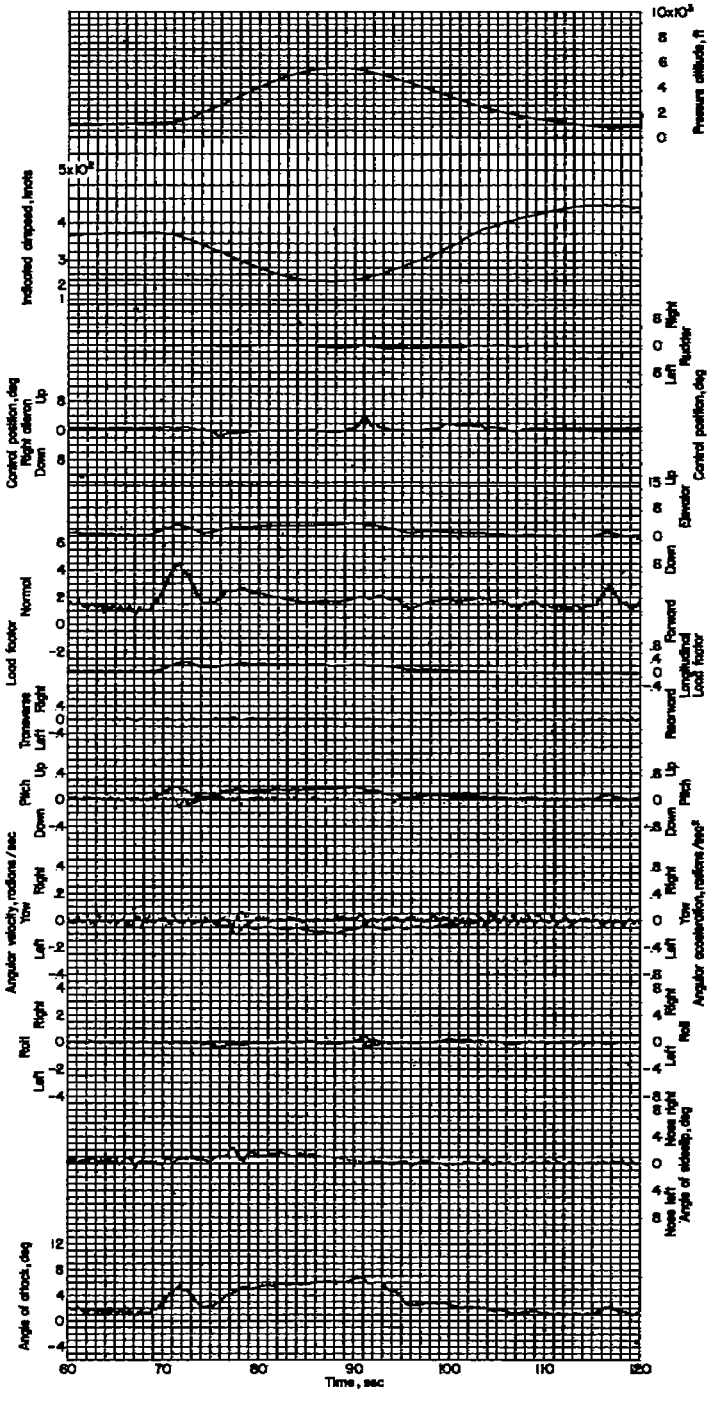
Figure 318.- Concluded.

[redacted]



(a)

Figure 319.- Chandelle followed by two strafing runs. Airplane weight, 15,680 pounds; center of gravity at 23.9 percent M.A.C.; flight 11.

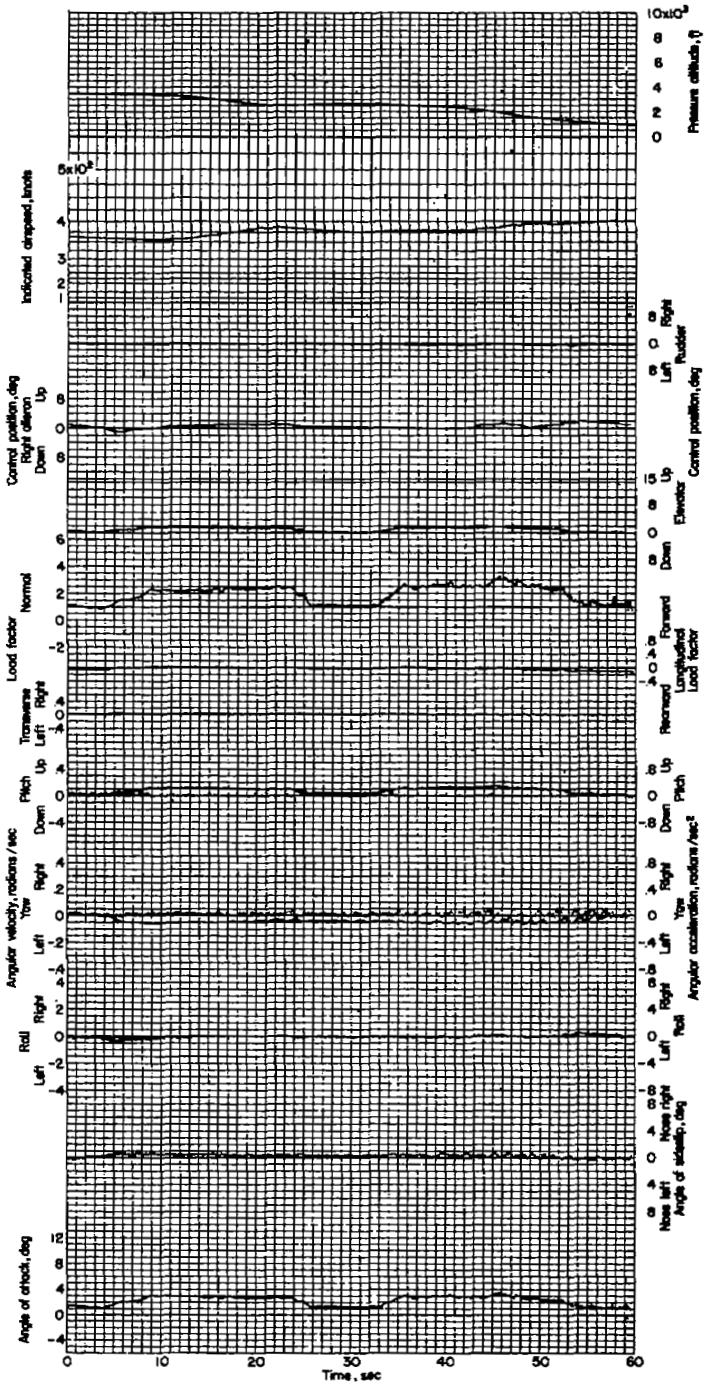


(b)

NACA

Figure 319.- Concluded.

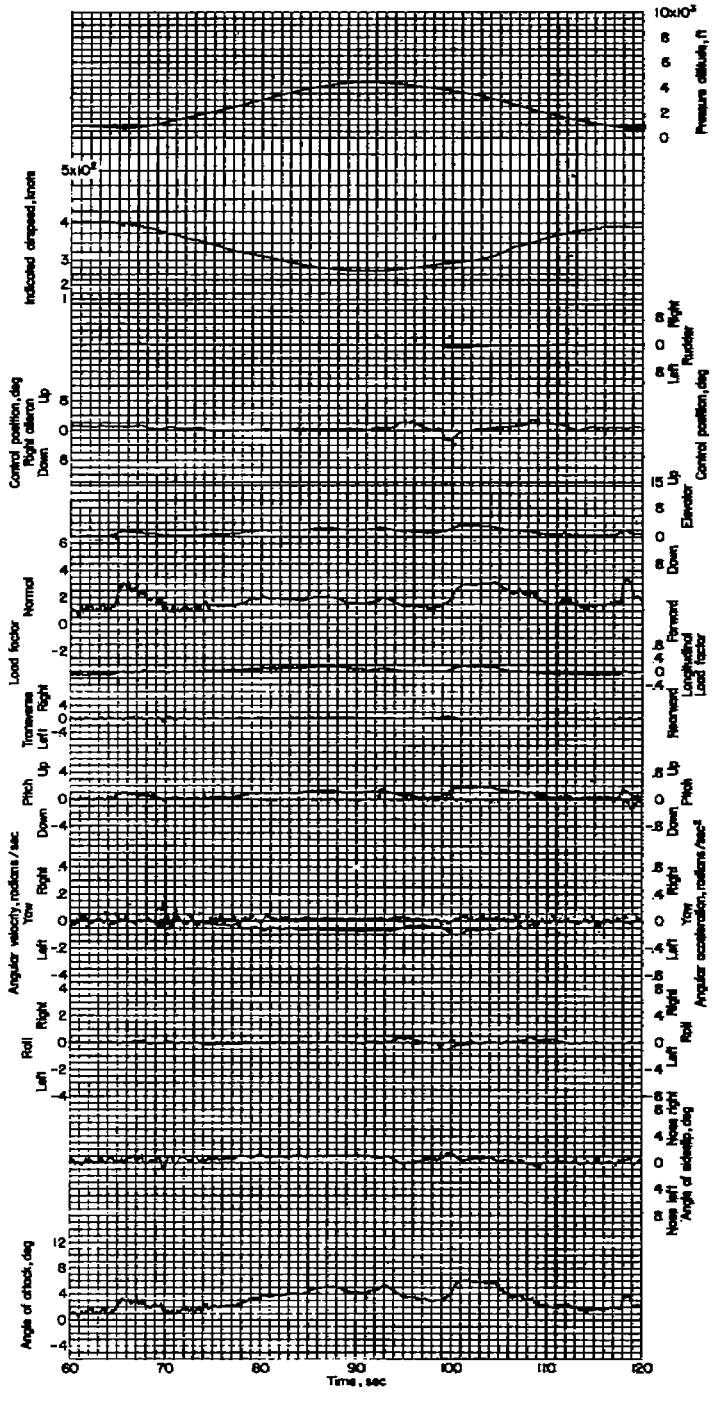
[redacted]



(a)

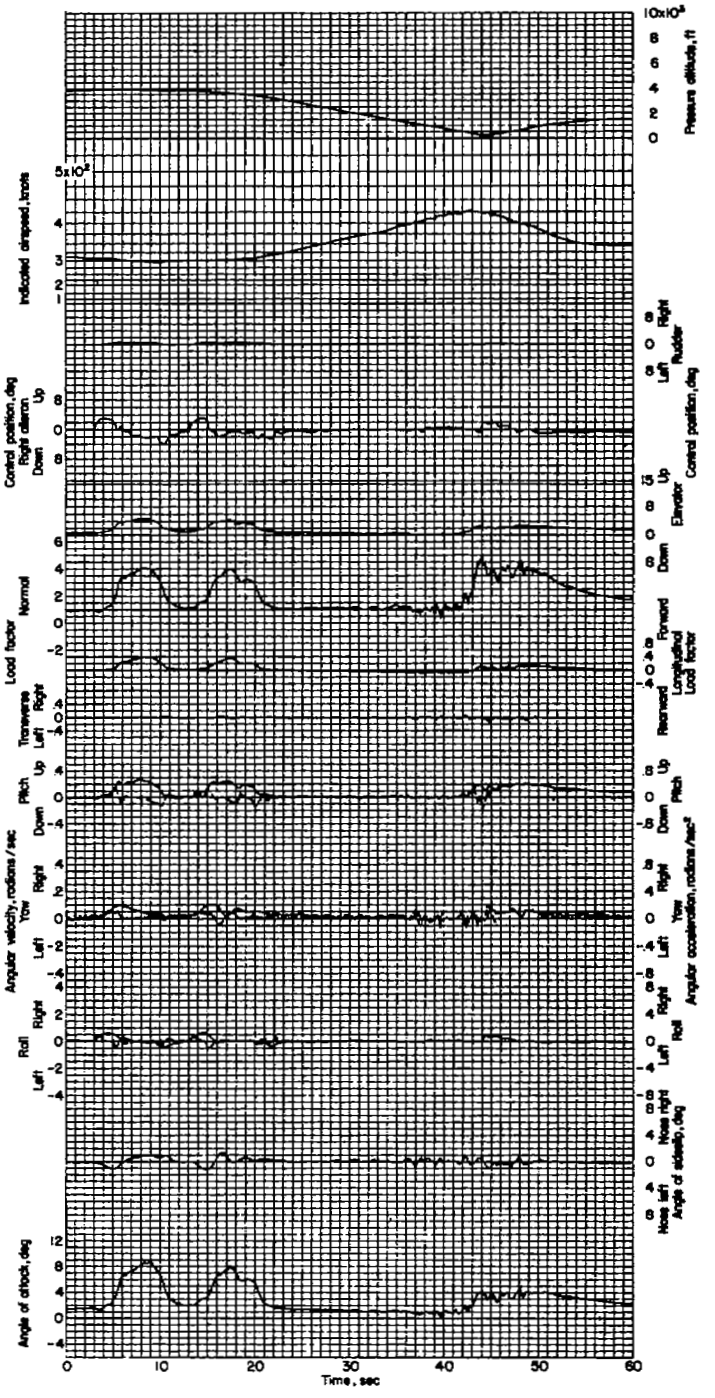
Figure 320.- Two strafing runs. Airplane weight, 15,360 pounds; center of gravity at 23.9 percent M.A.C.; flight 11.

[redacted]



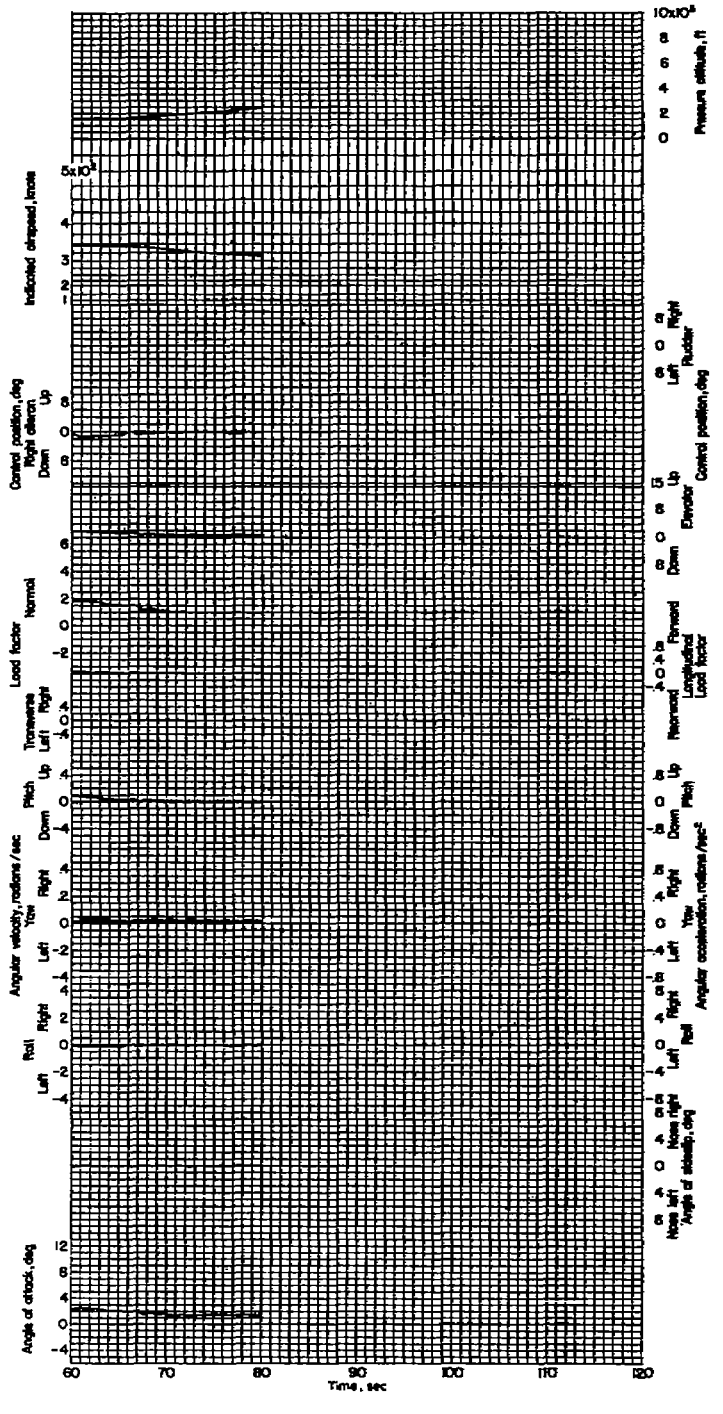
(b)

Figure 320.- Concluded.



(a)

Figure 321.- Two right turns into ground-gunnery run. Airplane weight, 16,300 pounds; center of gravity at 24.3 percent M.A.C.; flight 13.



(b)

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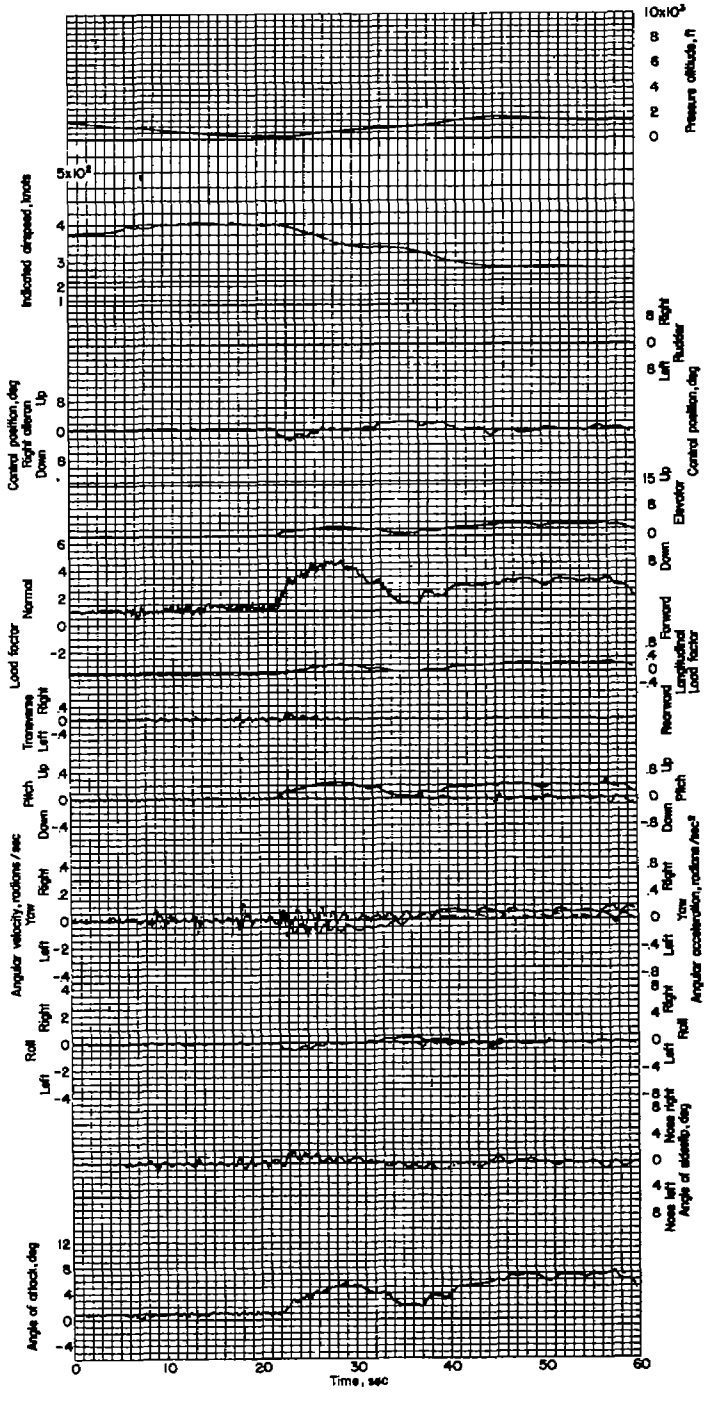
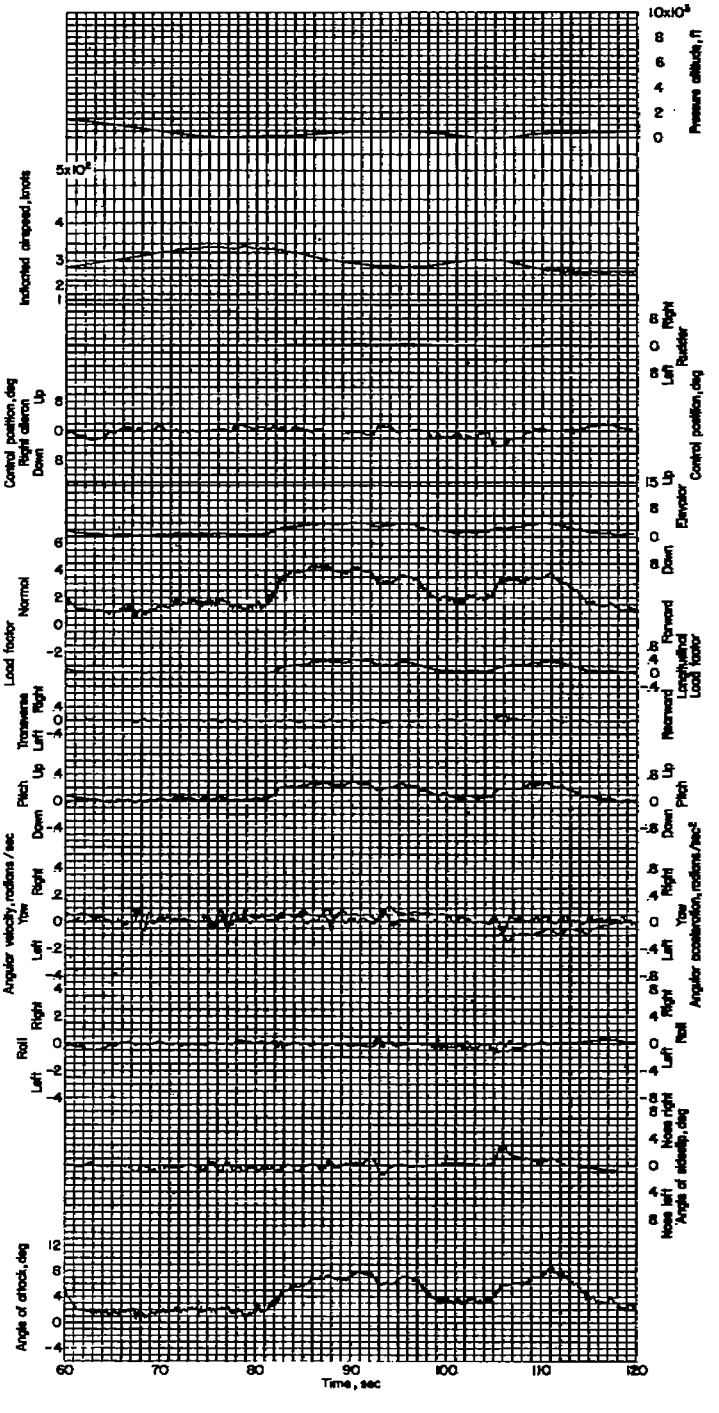


(a)

Figure 322.- Strafing runs. Airplane weight, 14,570 pounds; center of gravity at 24.9 percent M.A.C.; flight 13.



(b)

Figure 322.- Concluded.

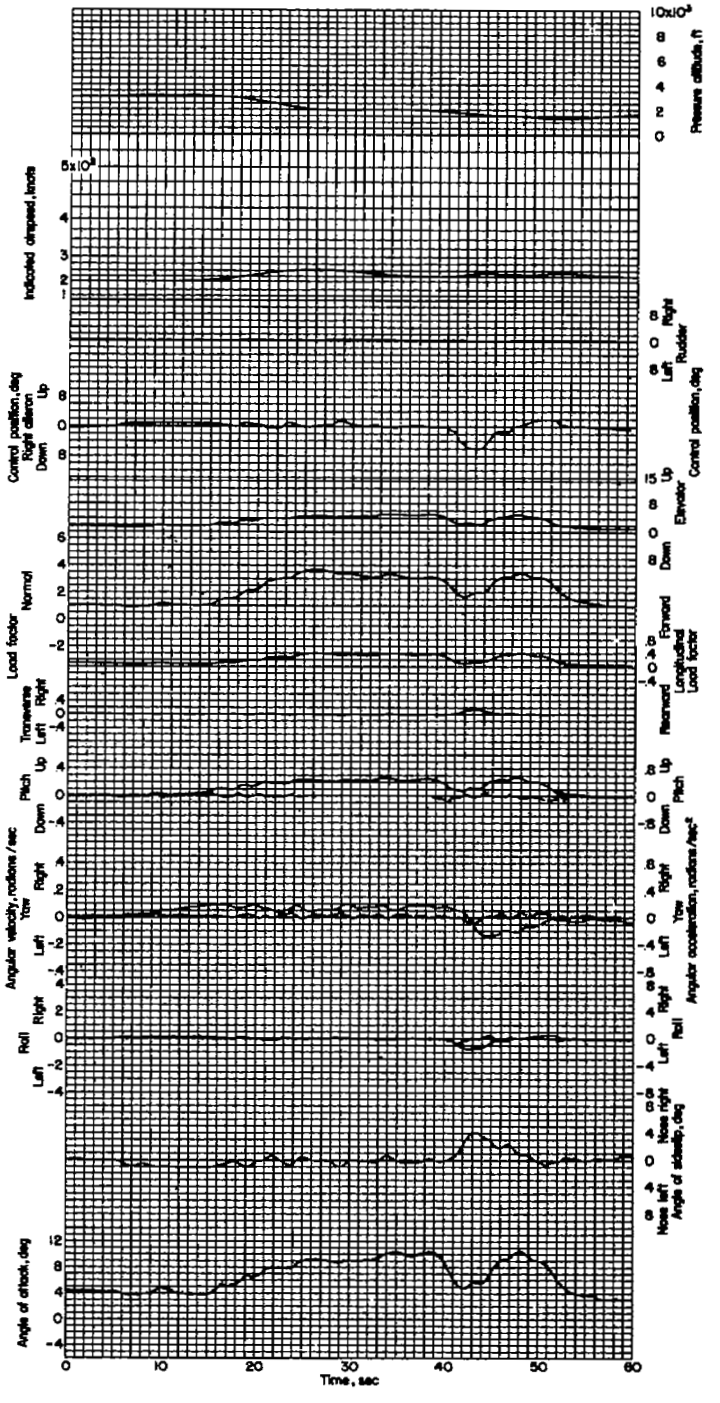
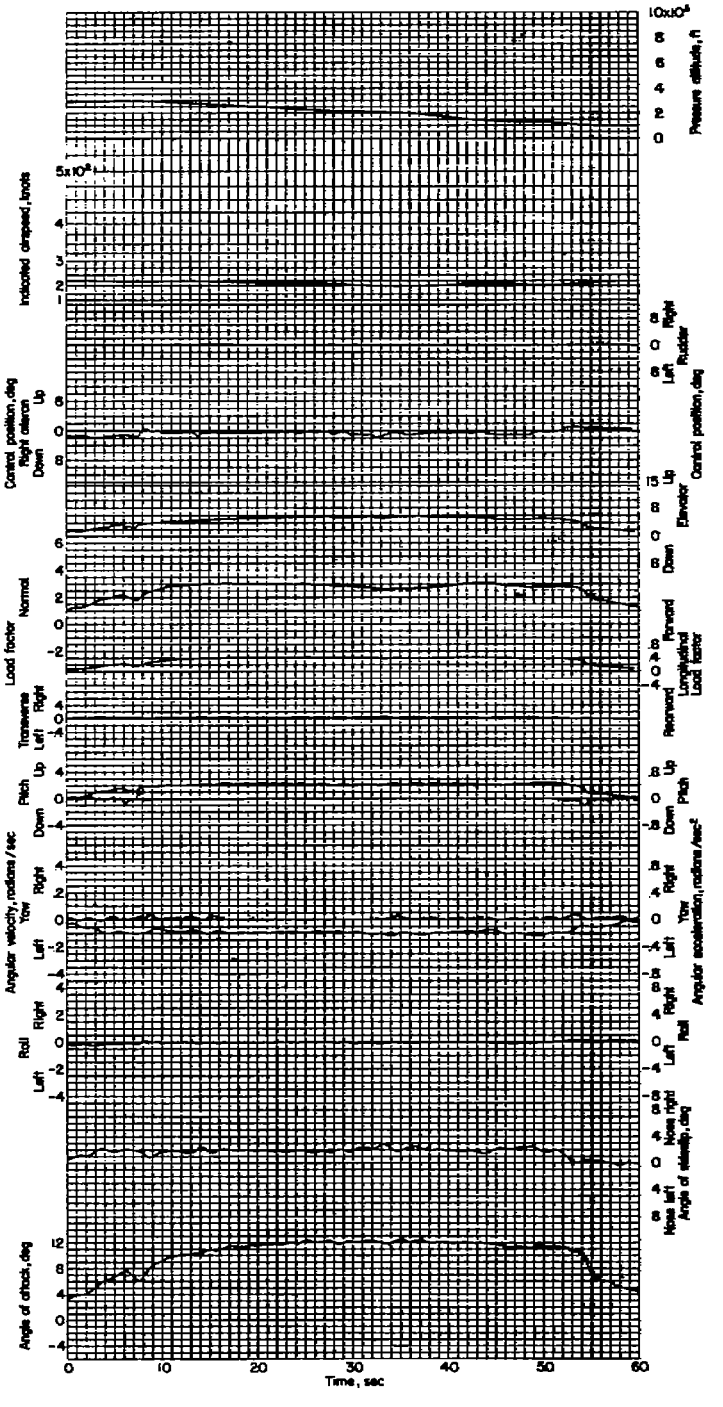


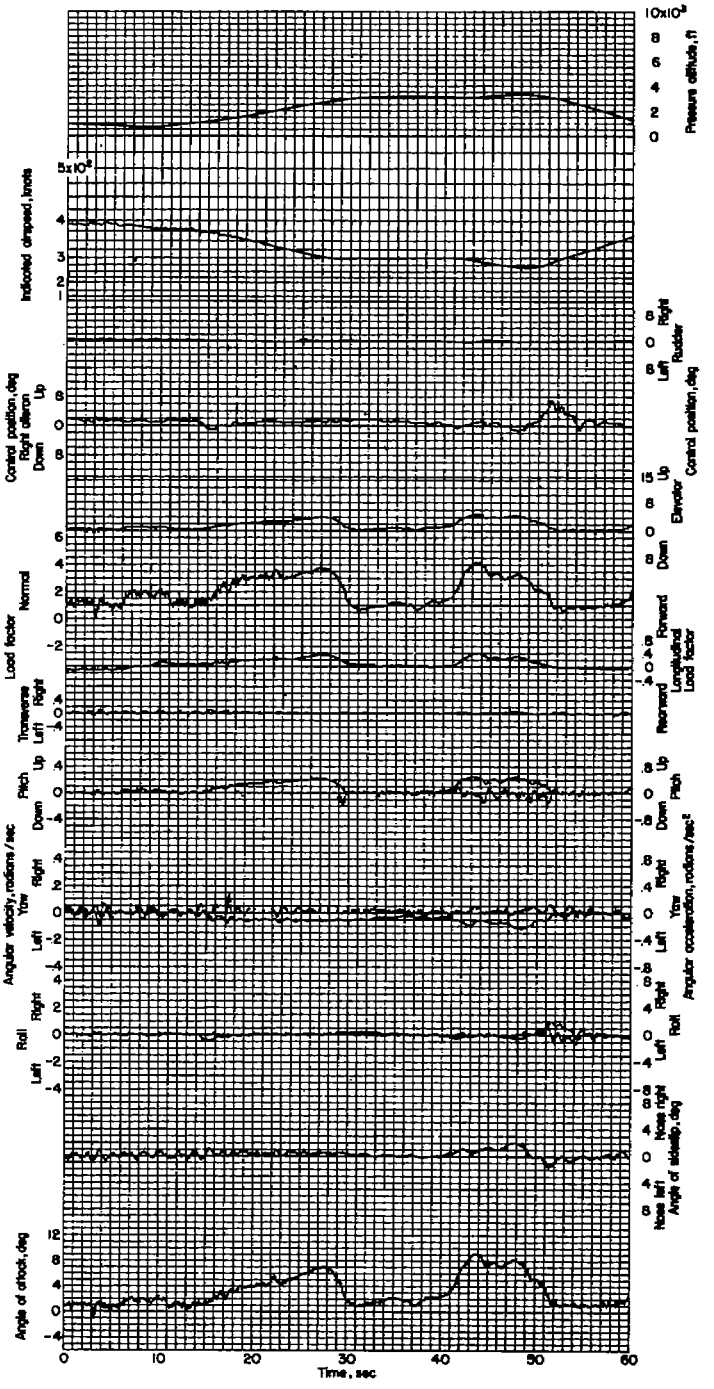
Figure 323.- Ground-gunnery run. Airplane weight, 14,440 pounds; center of gravity at 25.1 percent M.A.C.; flight 13.

[redacted]



NACA

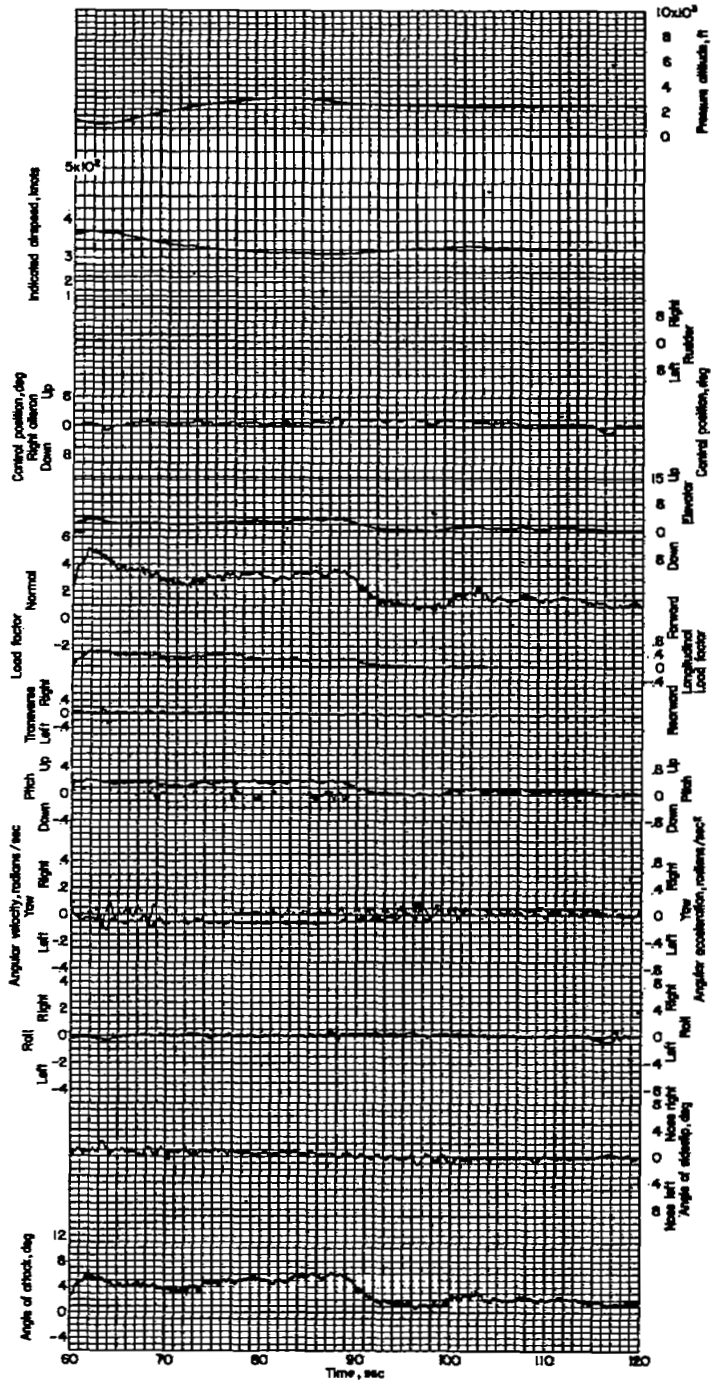
Figure 324.- Ground-gunnery run. Airplane weight, 14,330 pounds; center of gravity at 25.3 percent M.A.C.; flight 13.



(a)

Figure 325.- Two strafing runs. Airplane weight, 14,910 pounds; center of gravity at 24.5 percent M.A.C.; flight 16.

[redacted]



(b)

Figure 325.- Concluded.

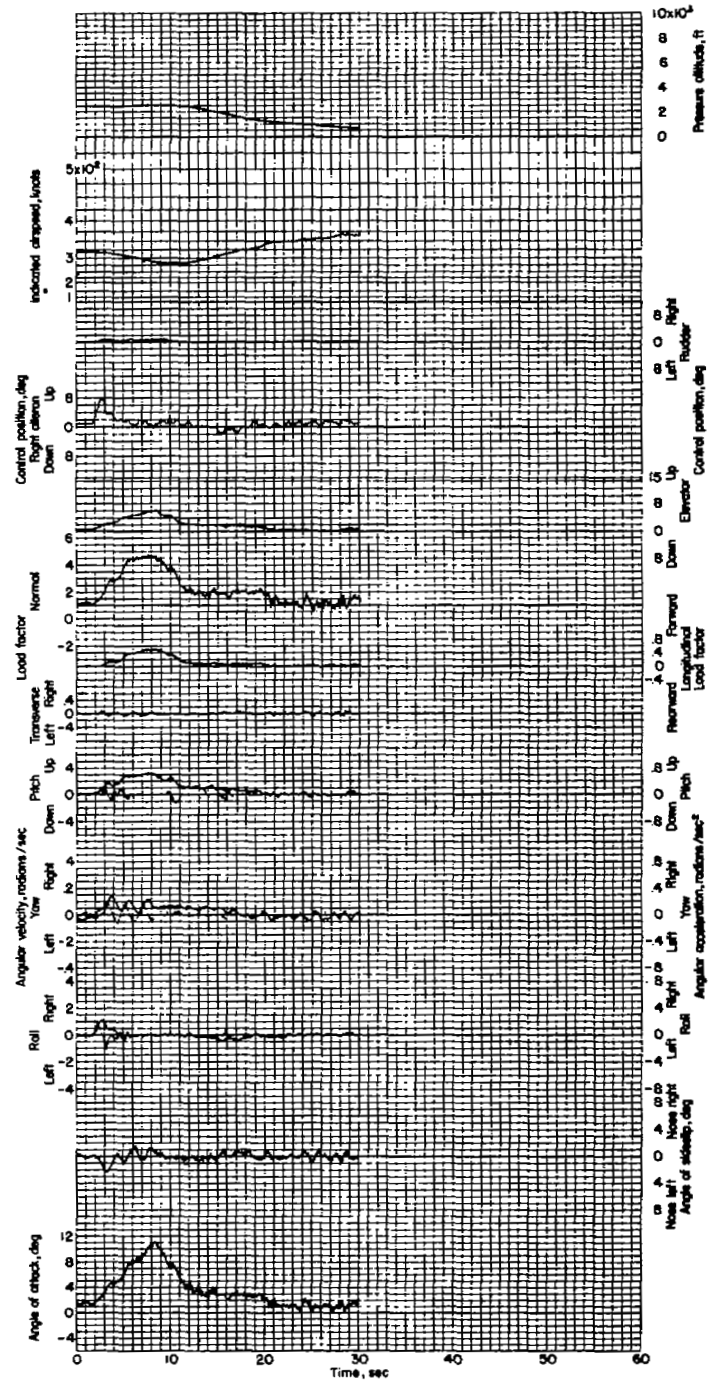
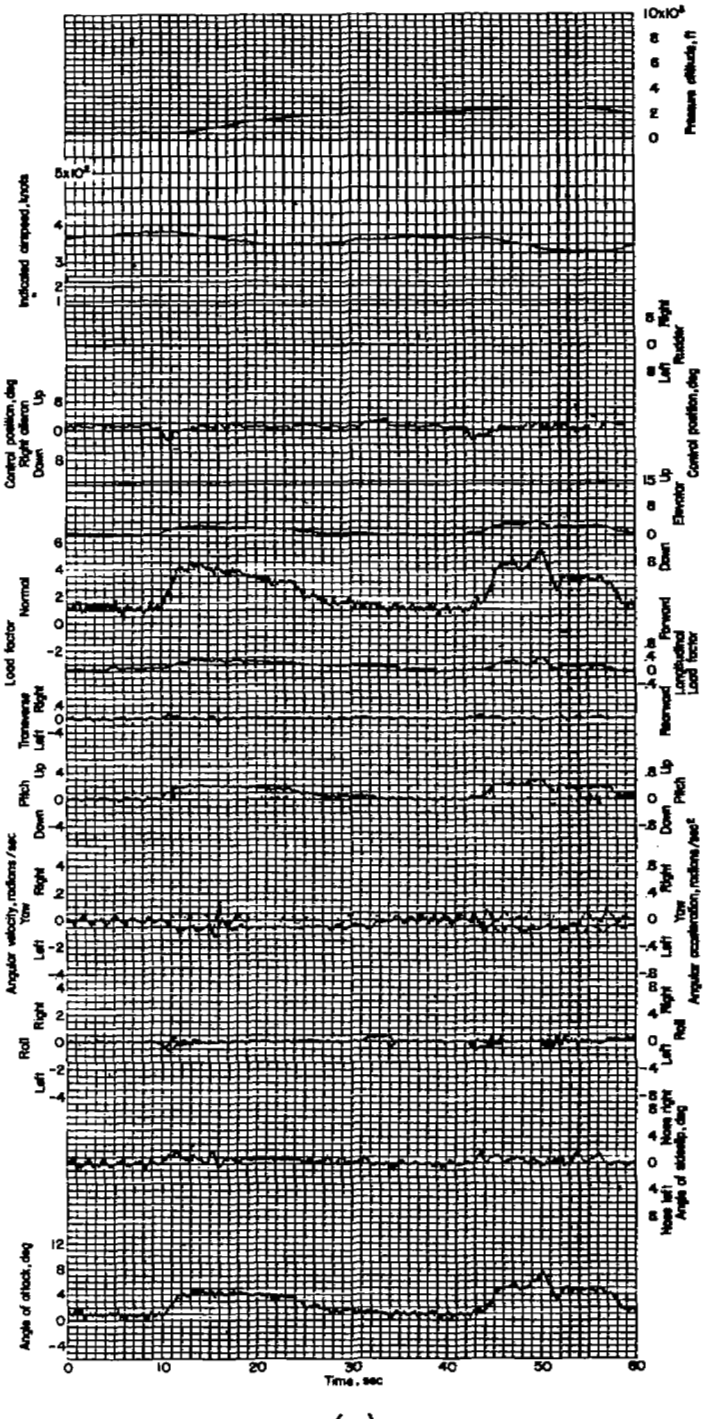
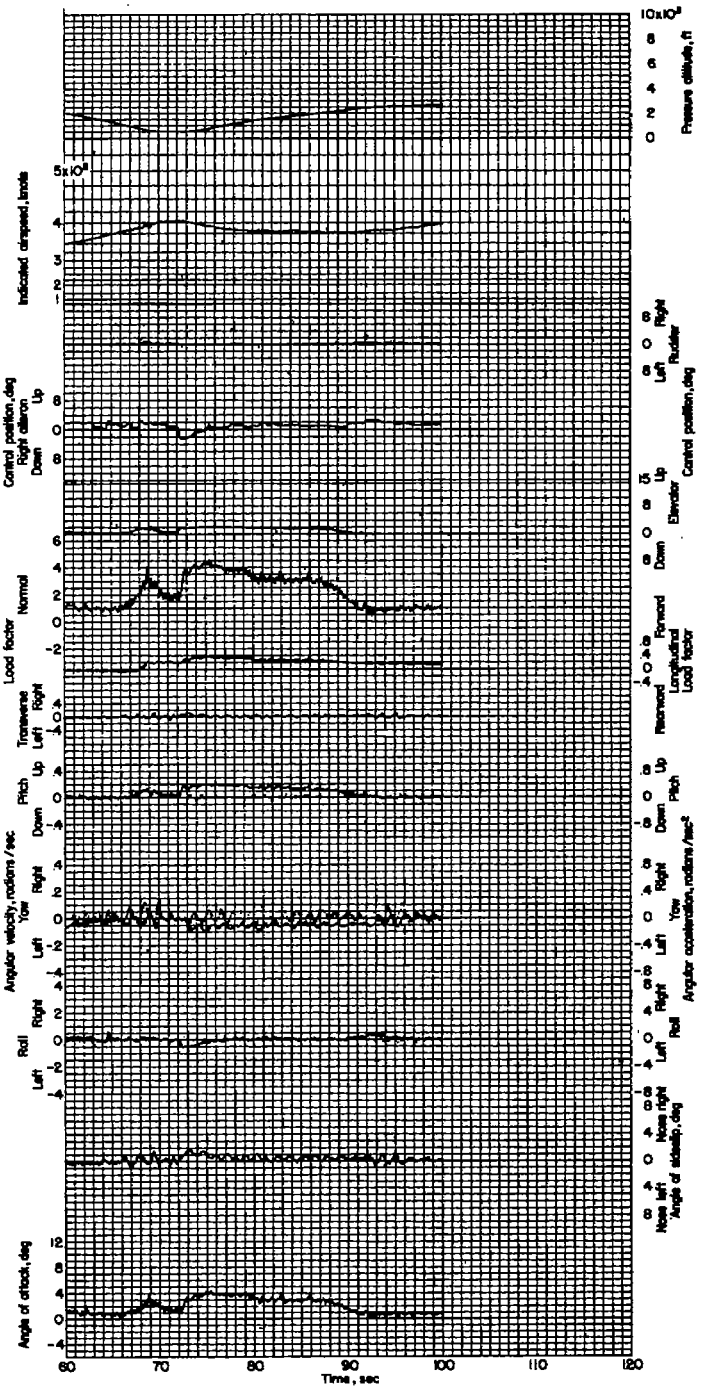


Figure 326.- Peel-off into strafing run. Airplane weight, 14,740 pounds; center of gravity at 24.7 percent M.A.C.; flight 16.



(a)

Figure 327.- Two strafing runs. Airplane weight, 14,690 pounds; center of gravity at 24.8 percent M.A.C.; flight 16.



(b)

Figure 327.- Concluded.

[redacted]

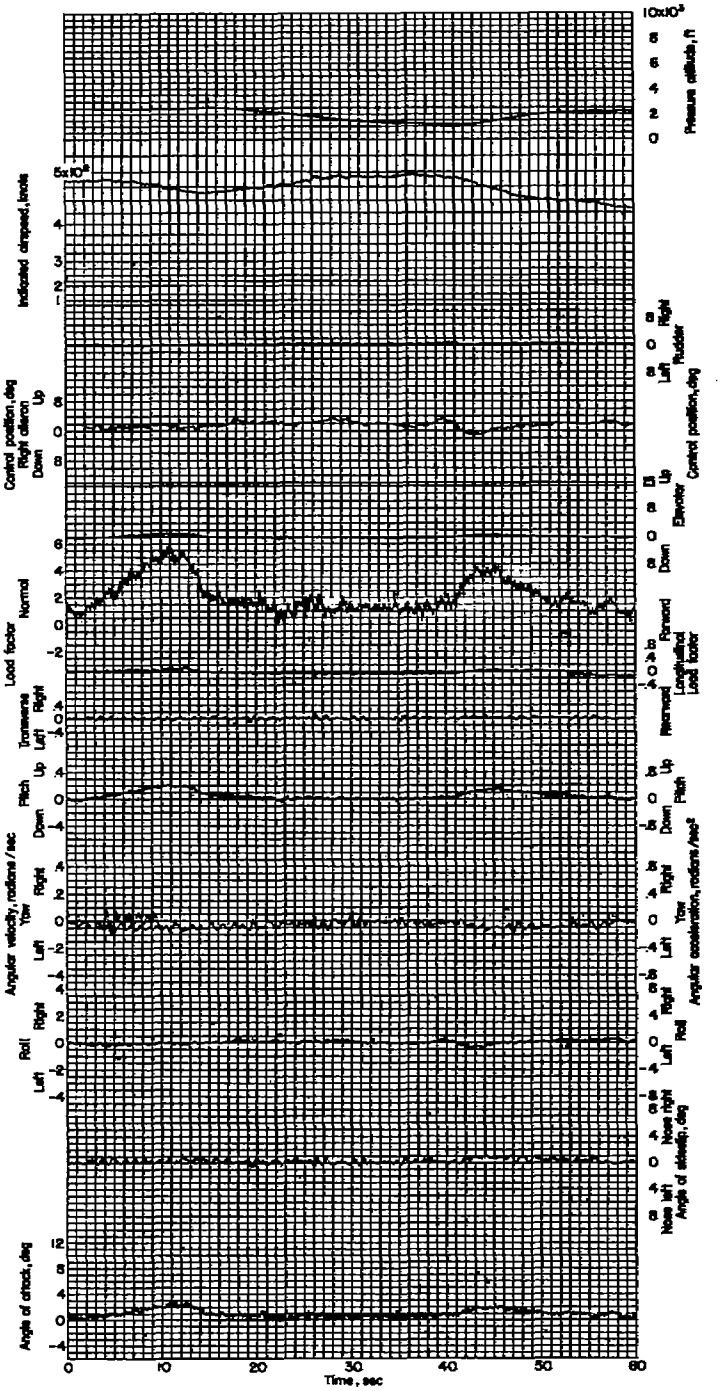


Figure 328.- Strafing run. Airplane weight, 14,180 pounds; center of gravity at 25.5 percent M.A.C.; flight 16.

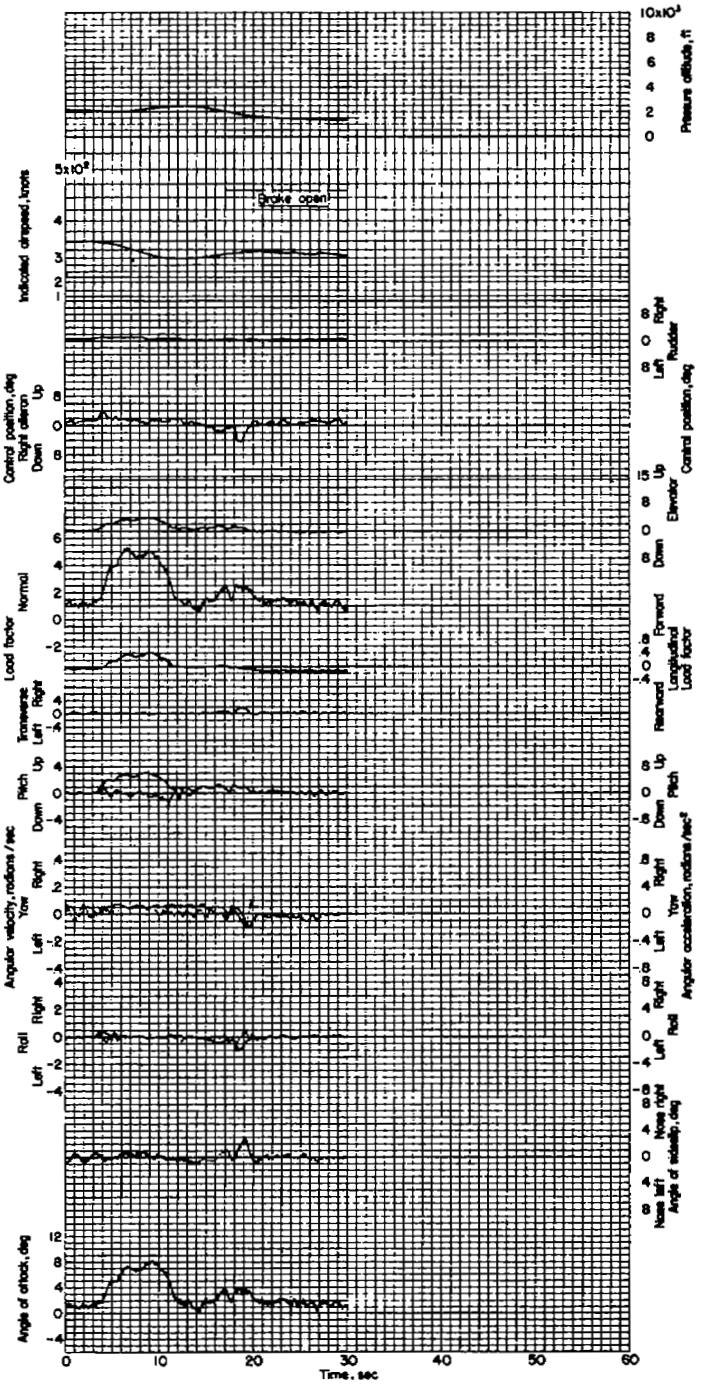
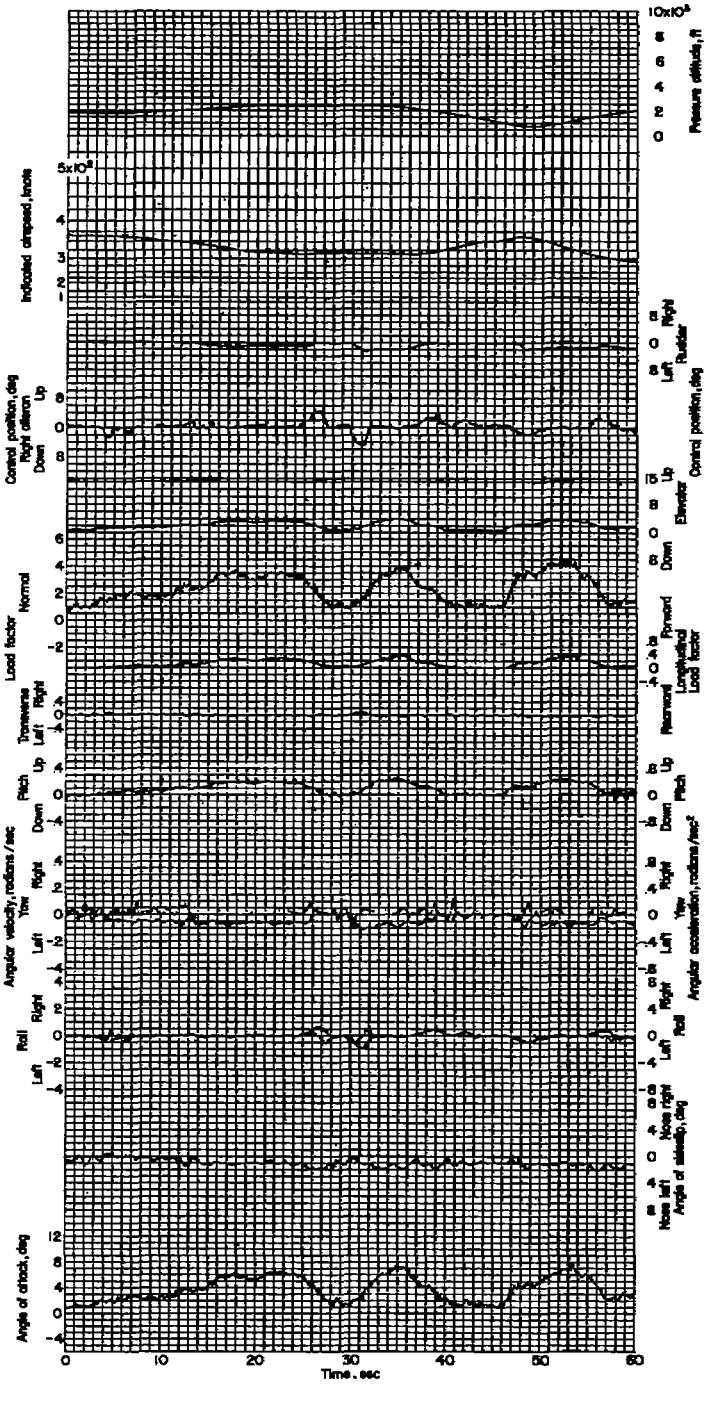
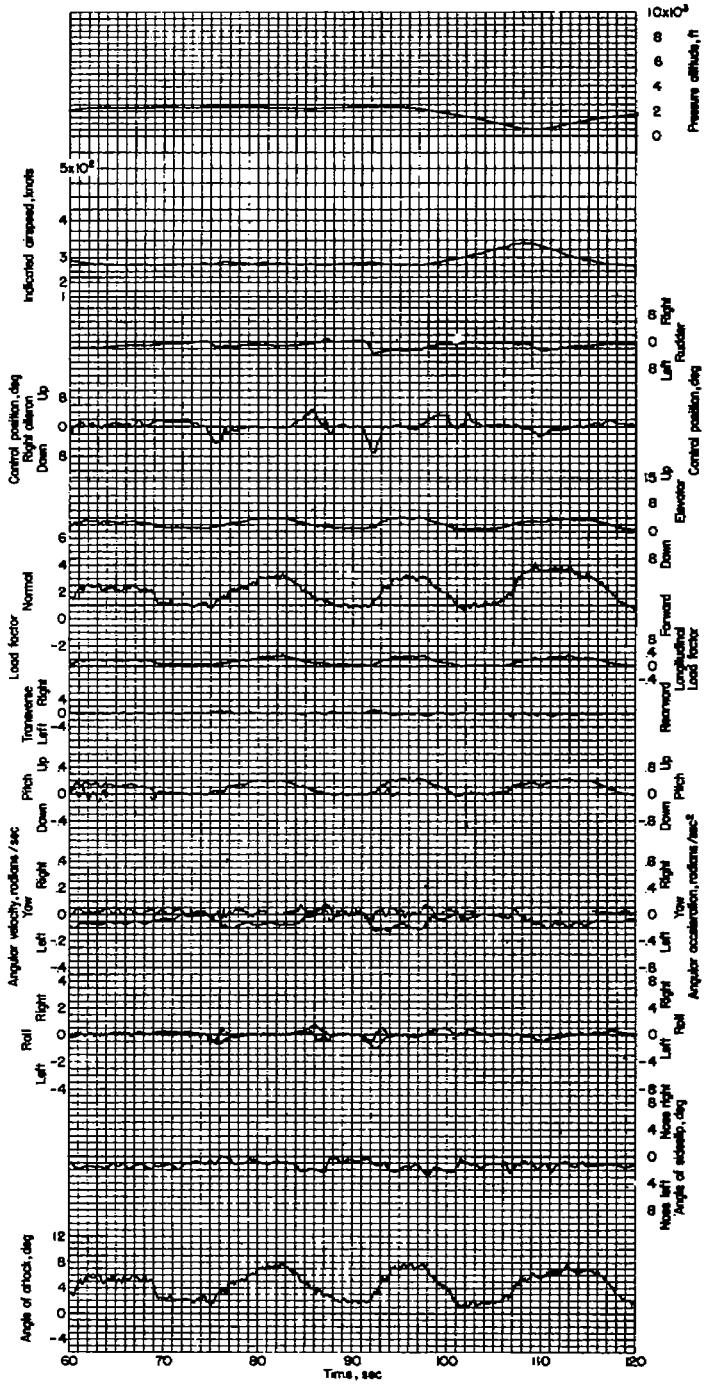


Figure 329.- Strafing run. Airplane weight, 14,080 pounds; center of gravity at 25.6 percent M.A.C.; flight 16.



(a)

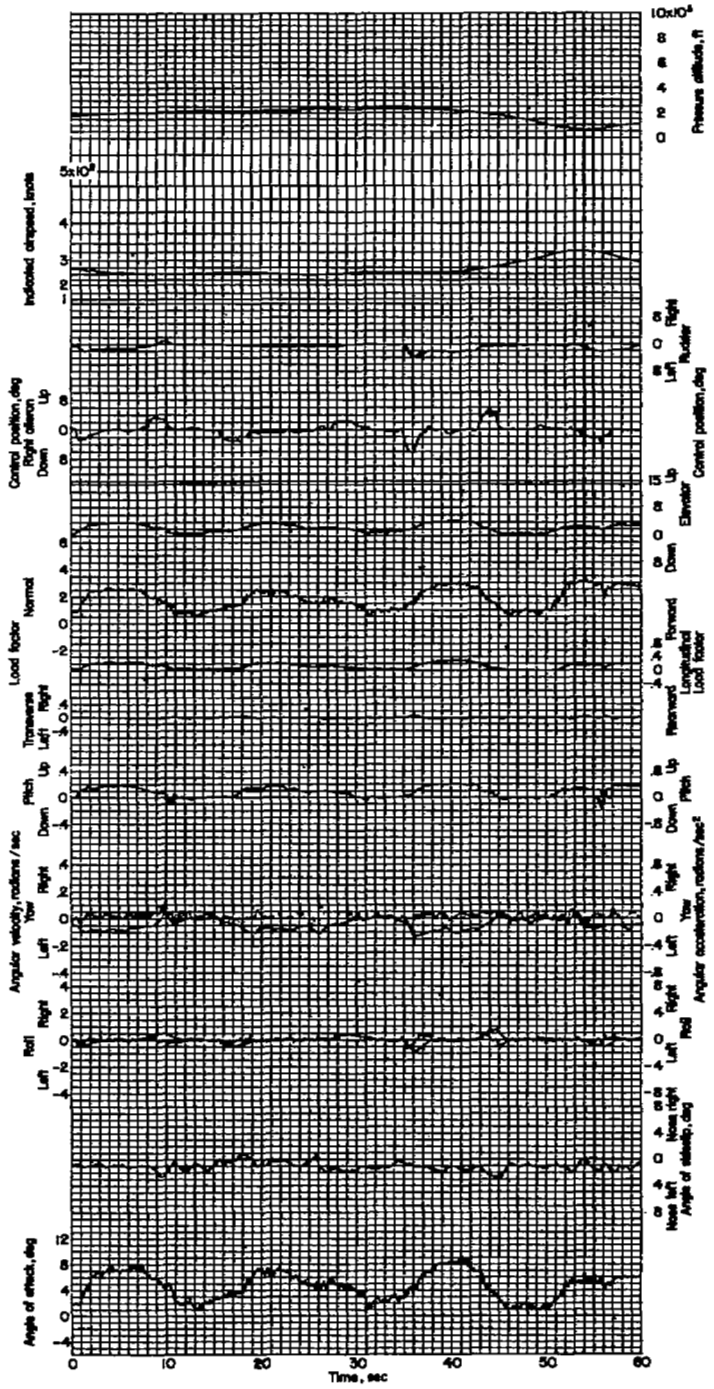
Figure 330.- Two ground-gunnery runs. Airplane weight, 16,560 pounds; center of gravity at 24.4 percent M.A.C.; flight 17.



(b)

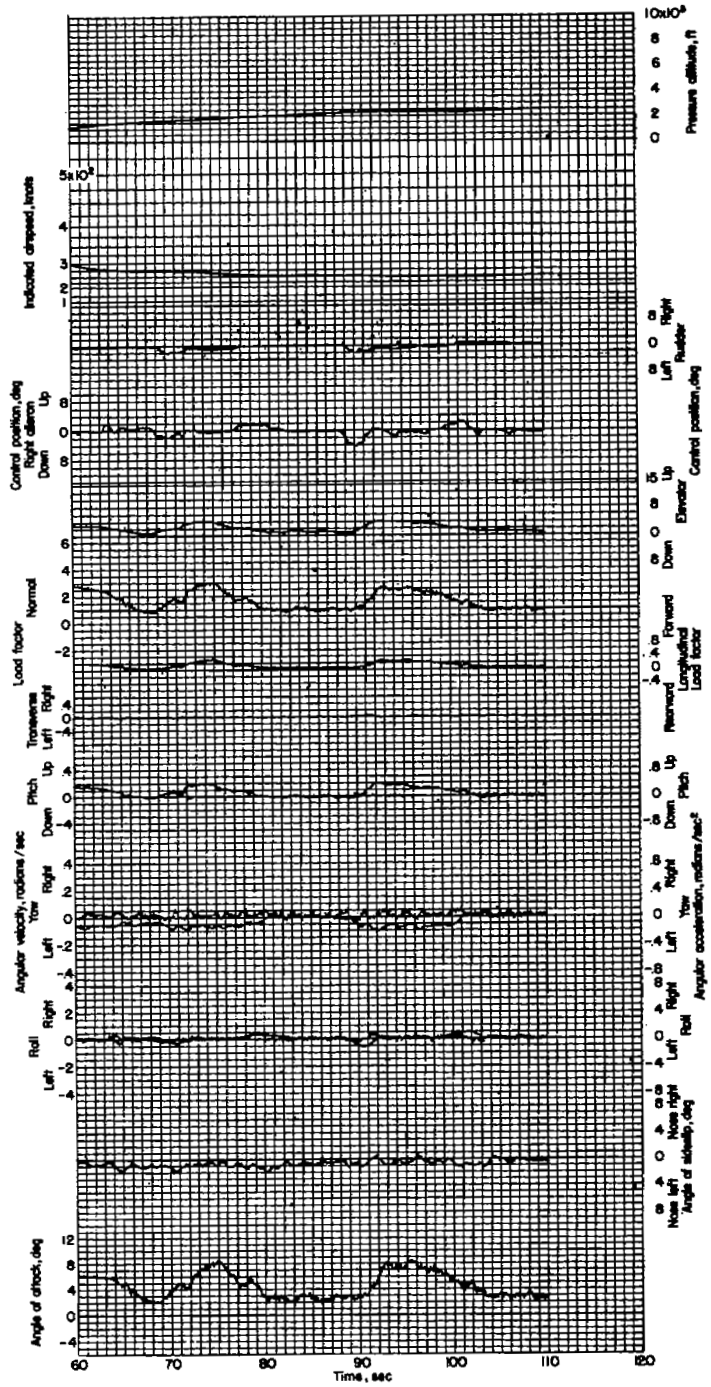
NACA

Figure 330.- Concluded.



(a)

Figure 331.- Ground-gunnery run. Airplane weight, 16,470 pounds; center of gravity at 24.4 percent M.A.C.; flight 17.



(b)

Figure 331.- Concluded.

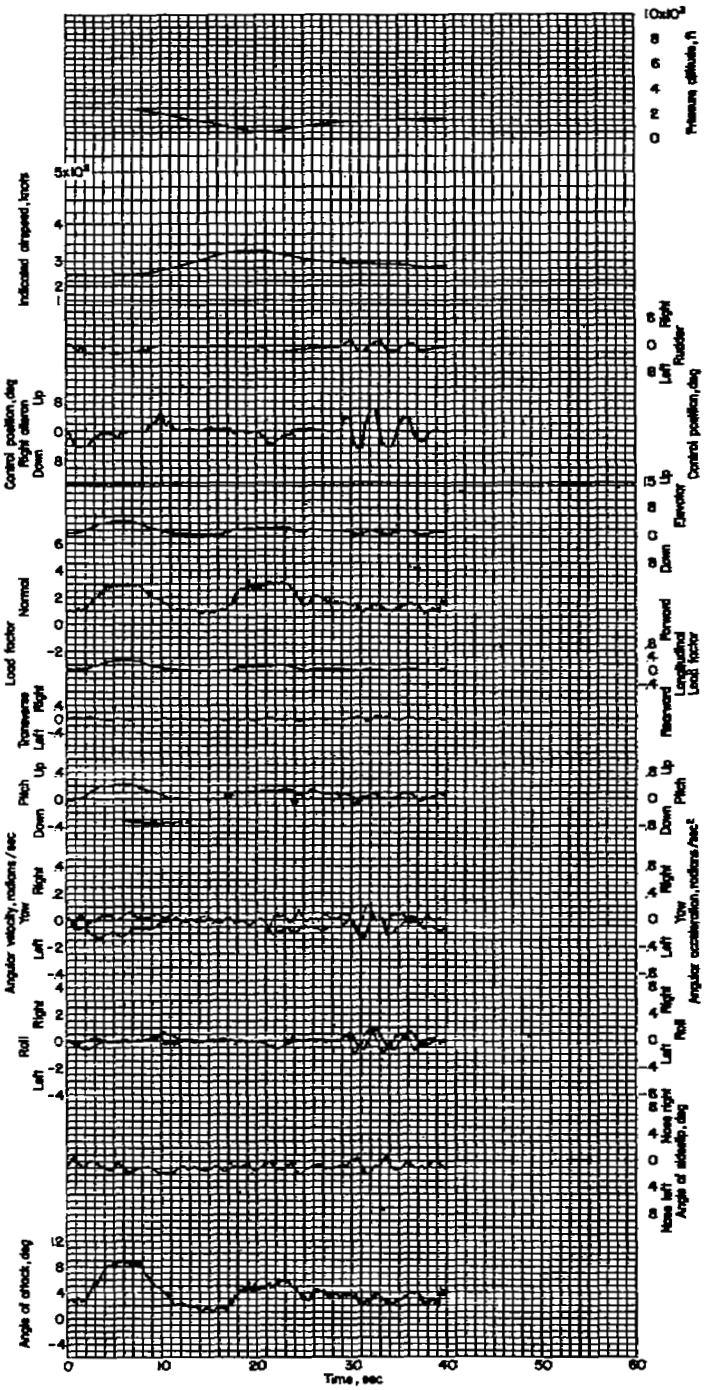


Figure 332.- Ground-gunnery run. Airplane weight, 16,410 pounds; center of gravity at 24.4 percent M.A.C.; flight 17.

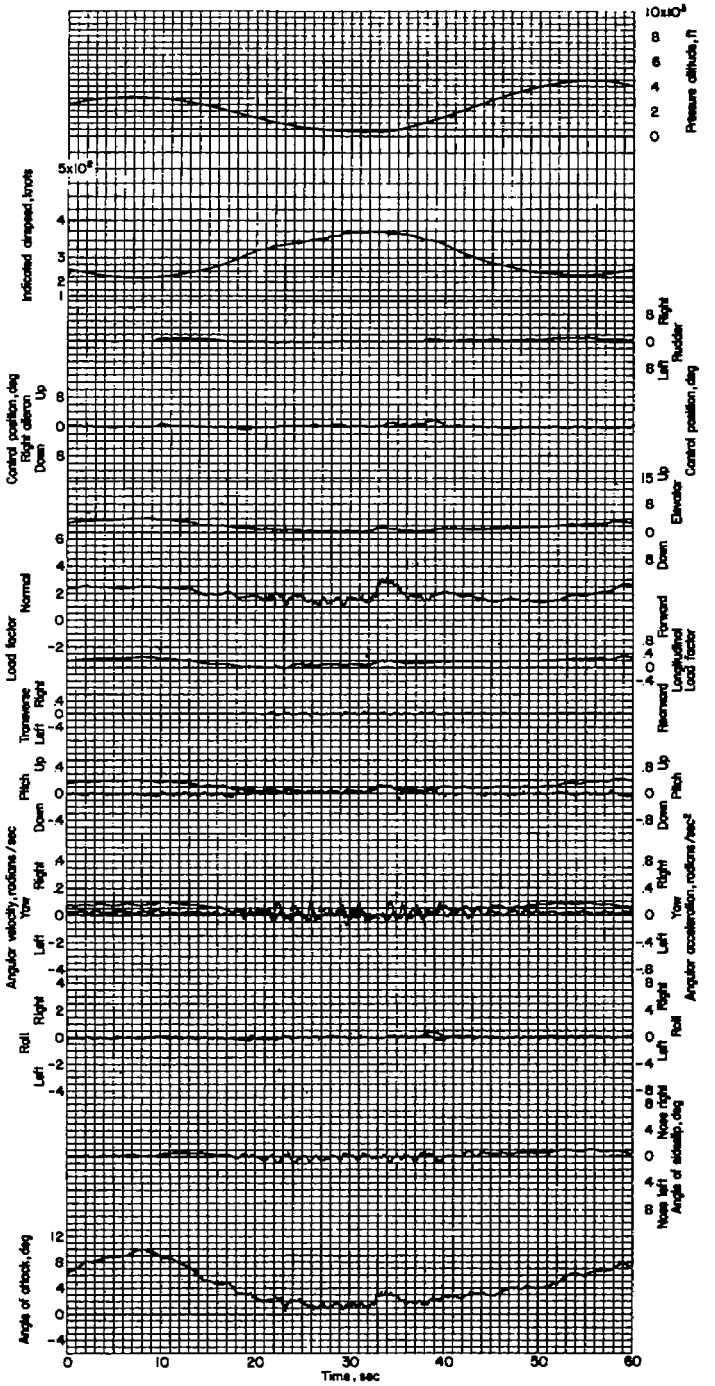
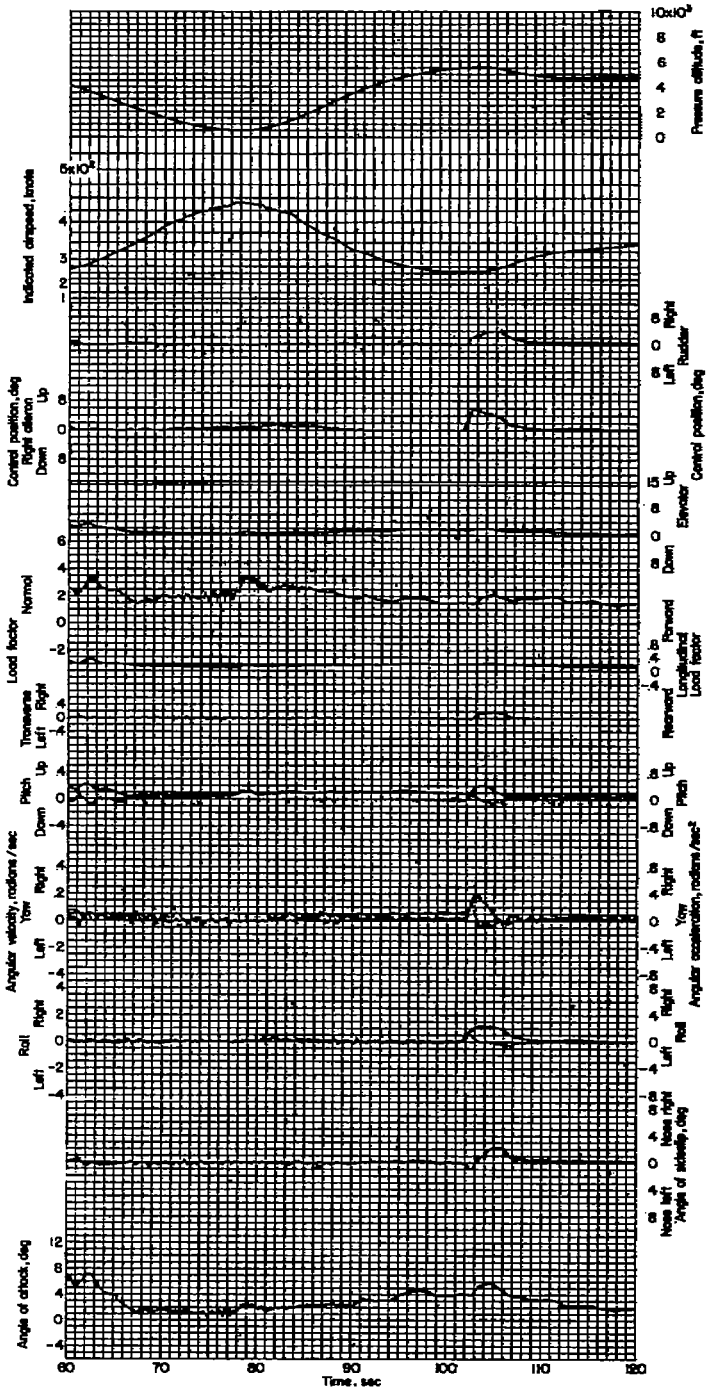


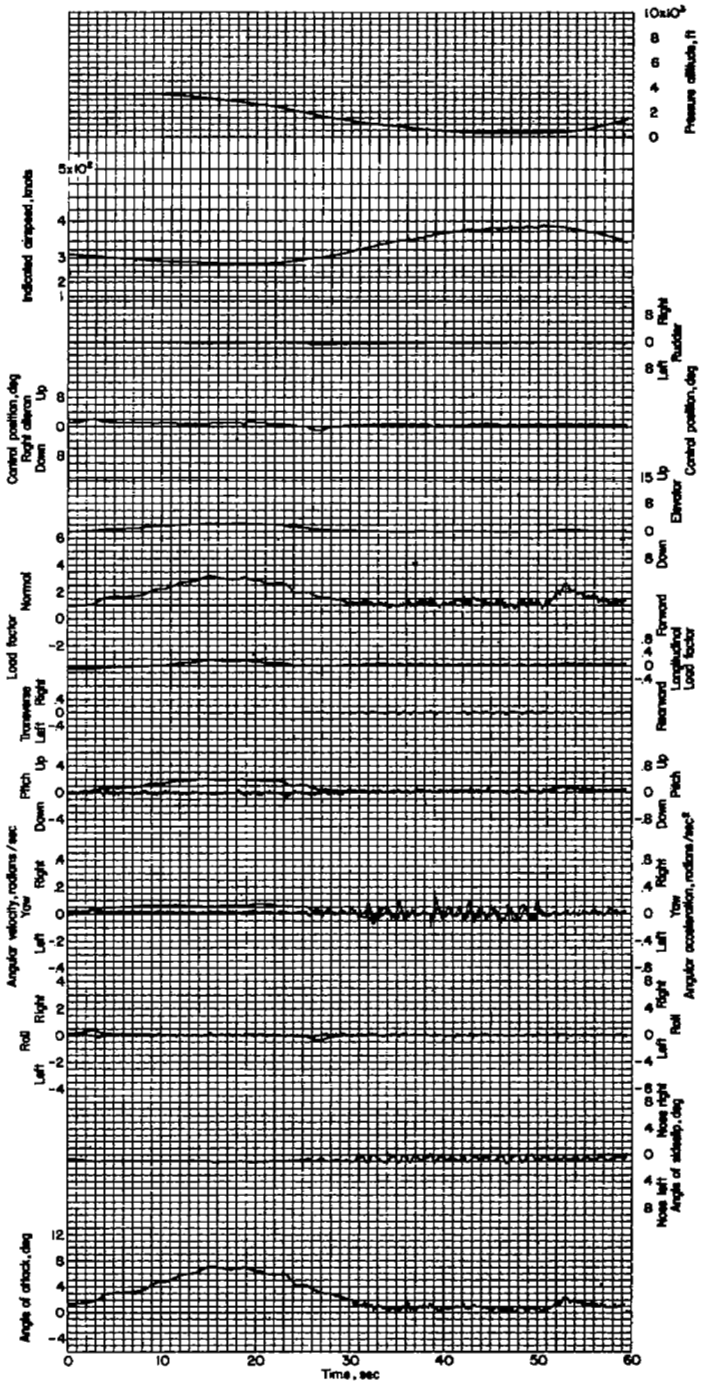
Figure 333.- Two strafing runs followed by chandelle with three-quarter right-roll recovery. Airplane weight, 14,240 pounds; center of gravity at 24.5 percent M.A.C.; flight 19.

[redacted]



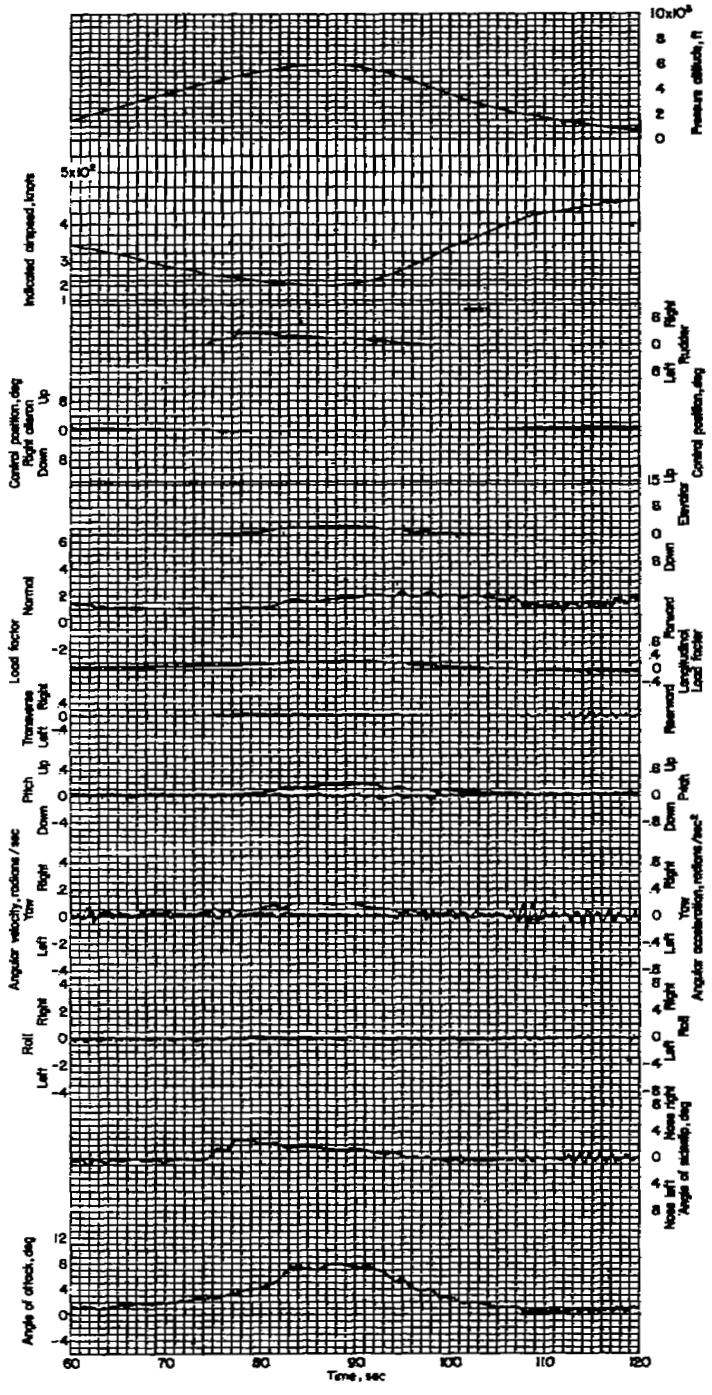
(b)

Figure 333.- Concluded.



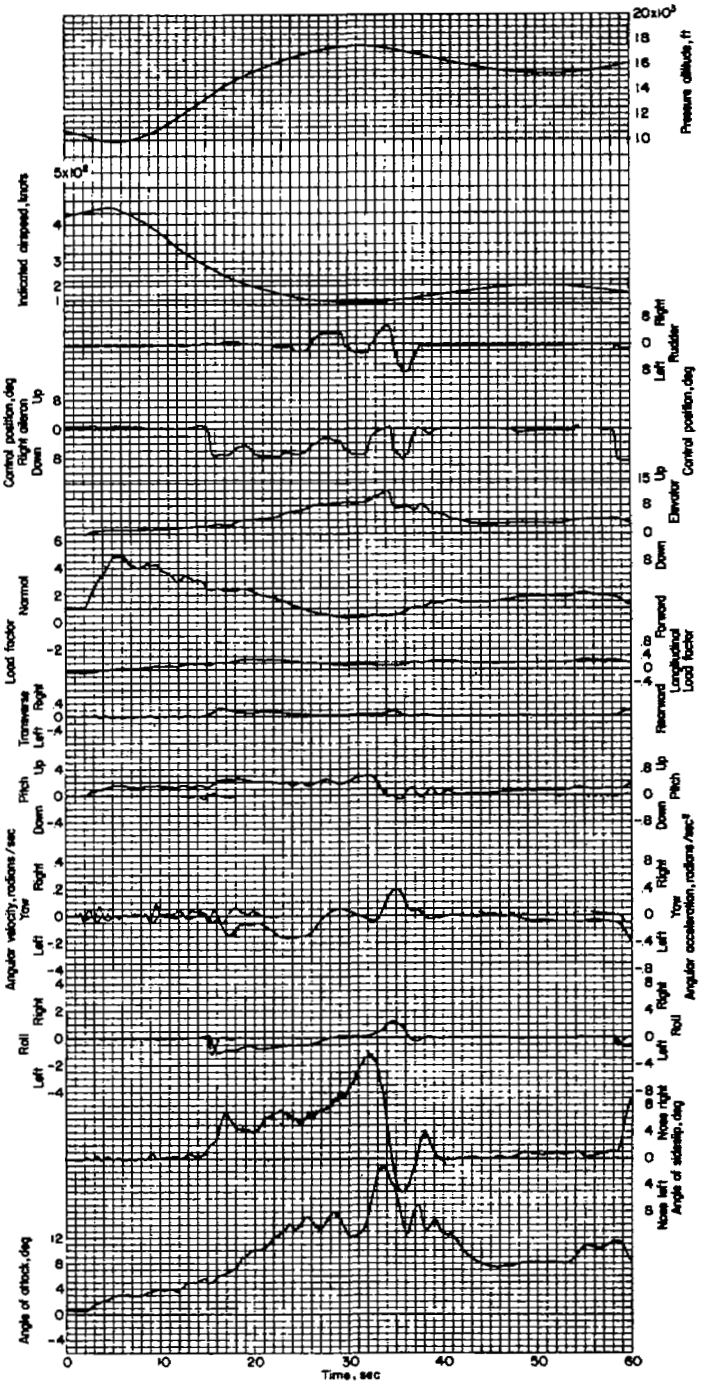
(a)

Figure 334.- Right turn into strafing run following by wing-over into strafing run. Airplane weight, 13,770 pounds; center of gravity at 25.1 percent M.A.C.; flight 19.



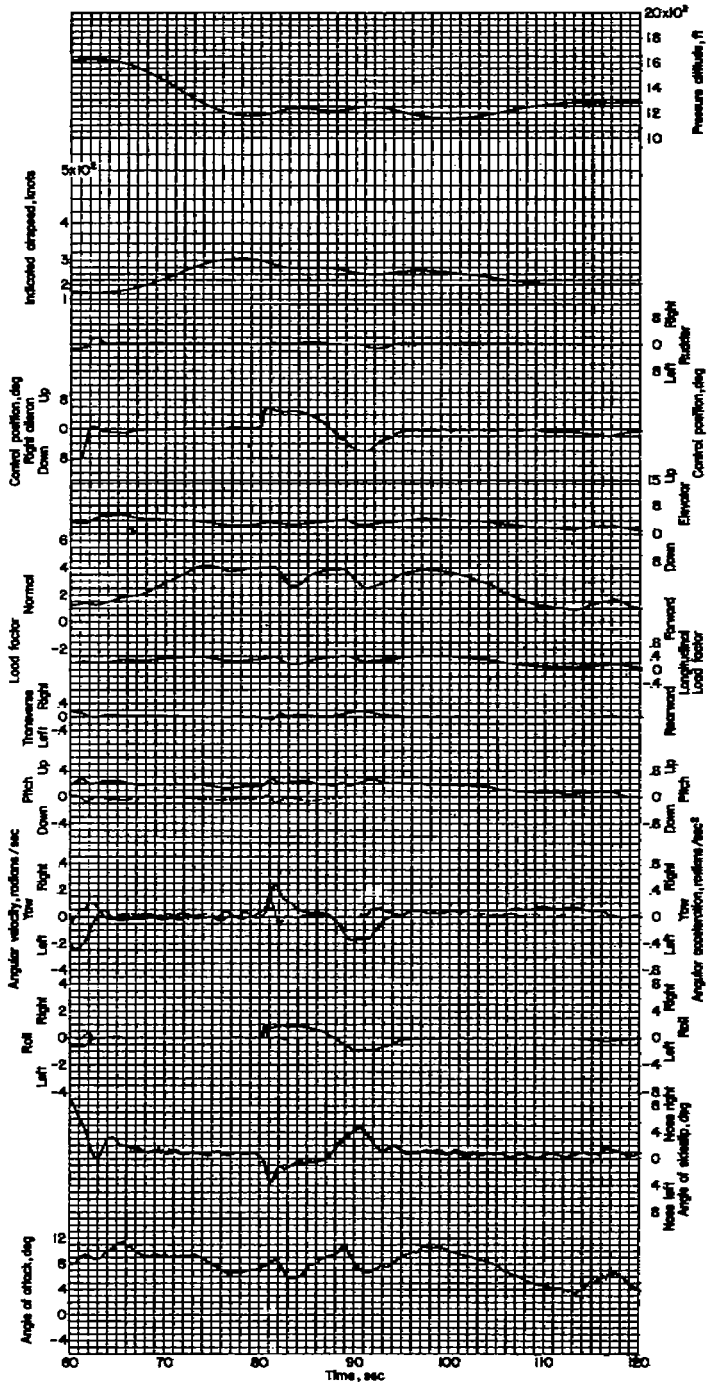
(b)

Figure 334.- Concluded.



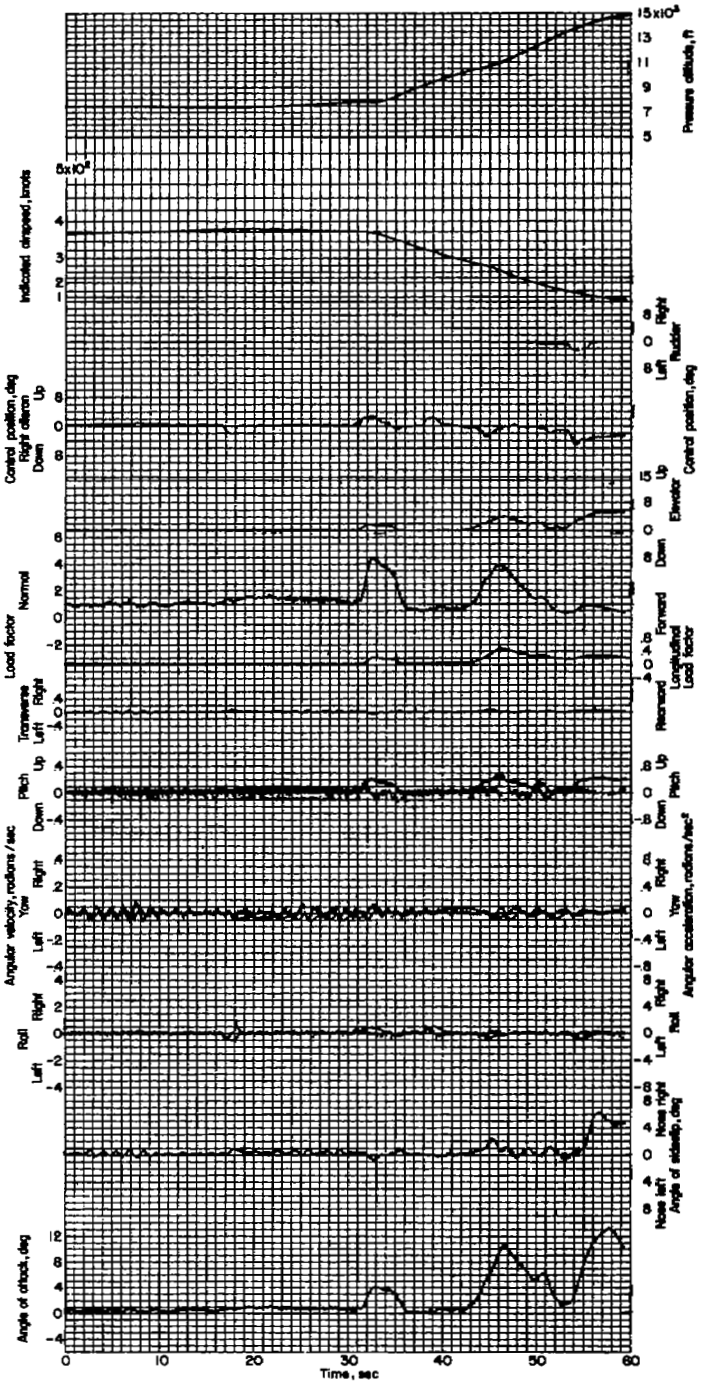
(a)

Figure 335.- Climbing left aileron roll to stall with recovery followed by split-S into right and left barrel roll. Airplane weight, 14,750 pounds; center of gravity at 24.7 percent M.A.C.; flight 3.



(b)

Figure 335.- Concluded.

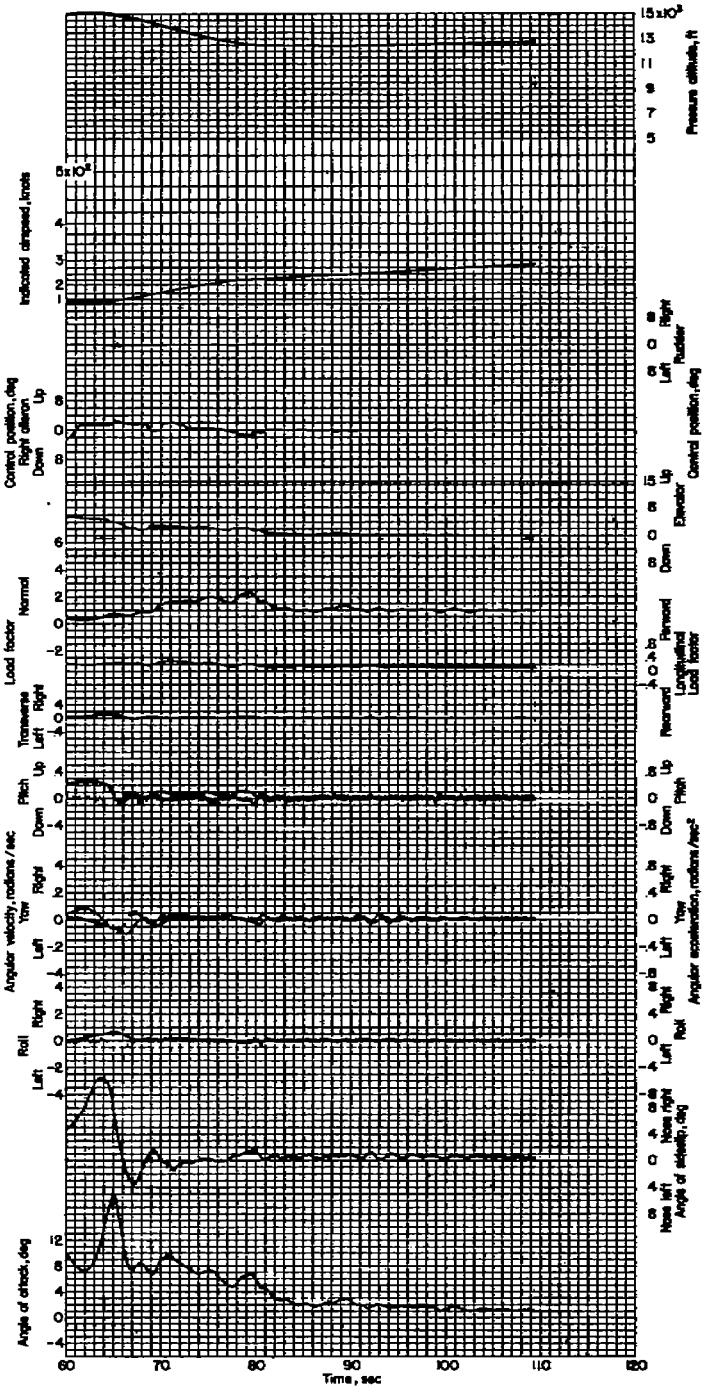


(a)

NACA

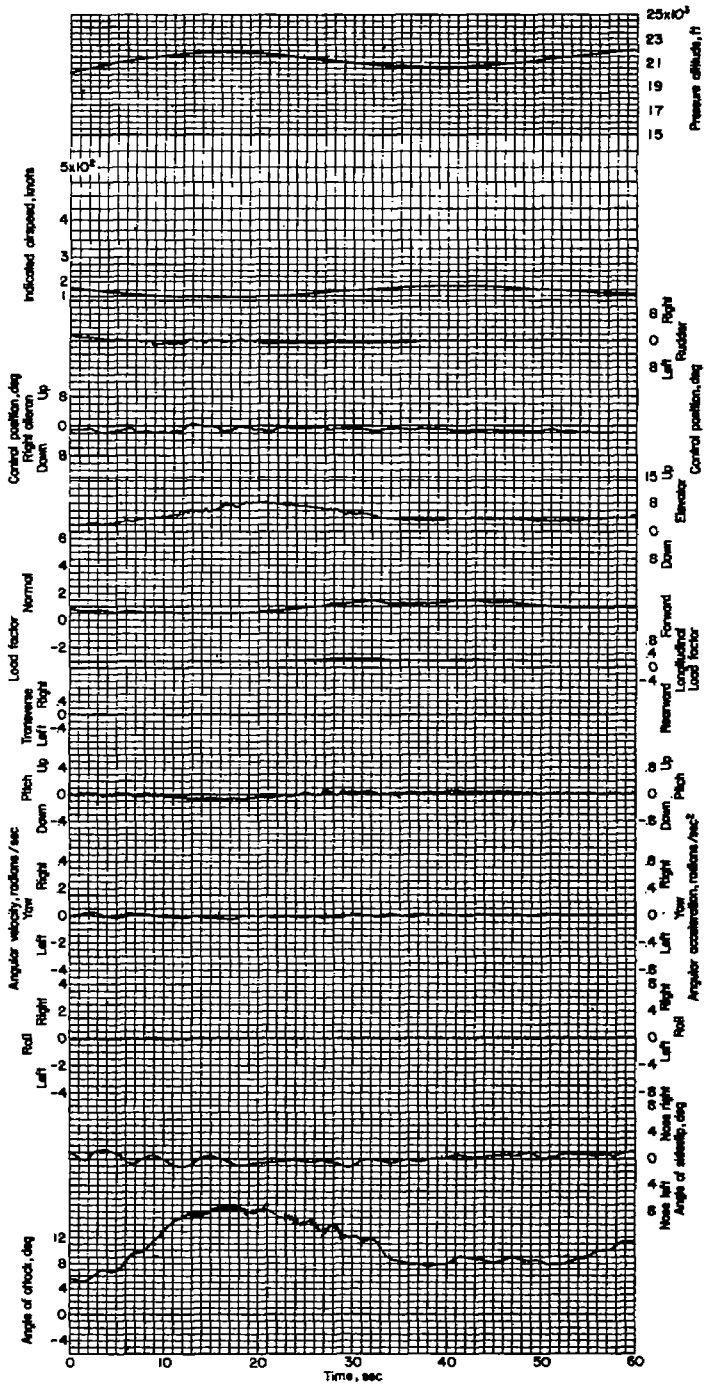
Figure 336.- Pull-up into climb followed by pull-up into inverted stall and recovery. Airplane weight, 14,220 pounds; center of gravity at 25.4 percent M.A.C.; flight 7.

[redacted]



(b)

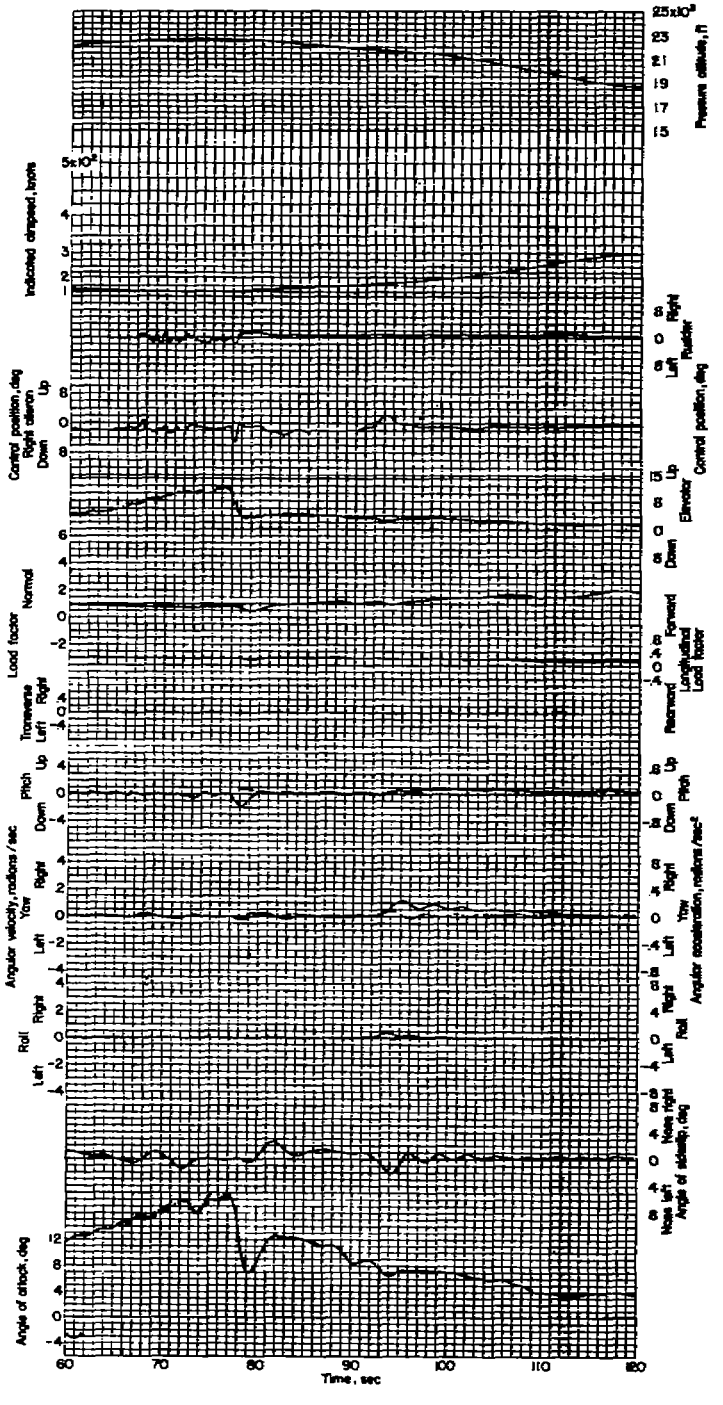
Figure 336.- Concluded.



(a)

Figure 337.- Two stalls. Airplane weight, 15,880 pounds; center of gravity at 24.1 percent M.A.C.; flight 14.

[redacted]



(b)

Figure 337.- Concluded.

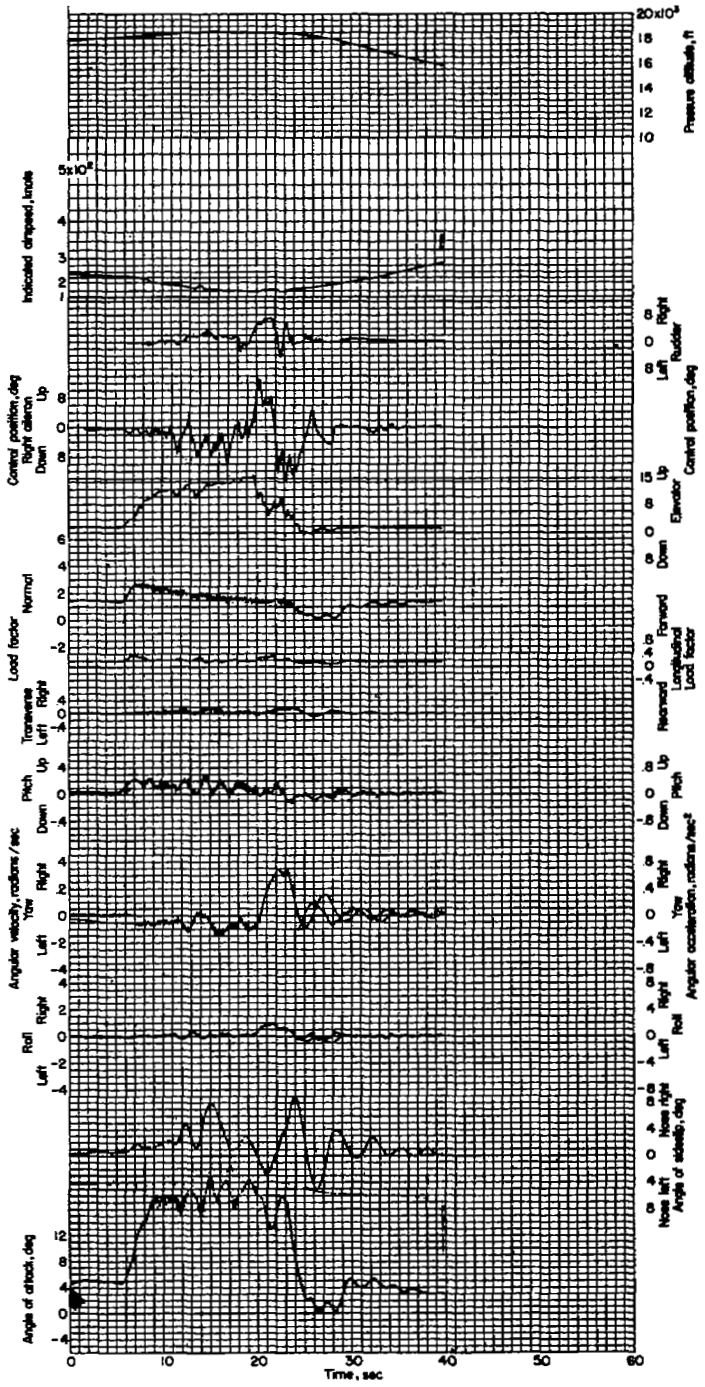


Figure 338.- Stall. Airplane weight, 16,350 pounds; center of gravity at 24.3 percent M.A.C.; flight 16.

[redacted]

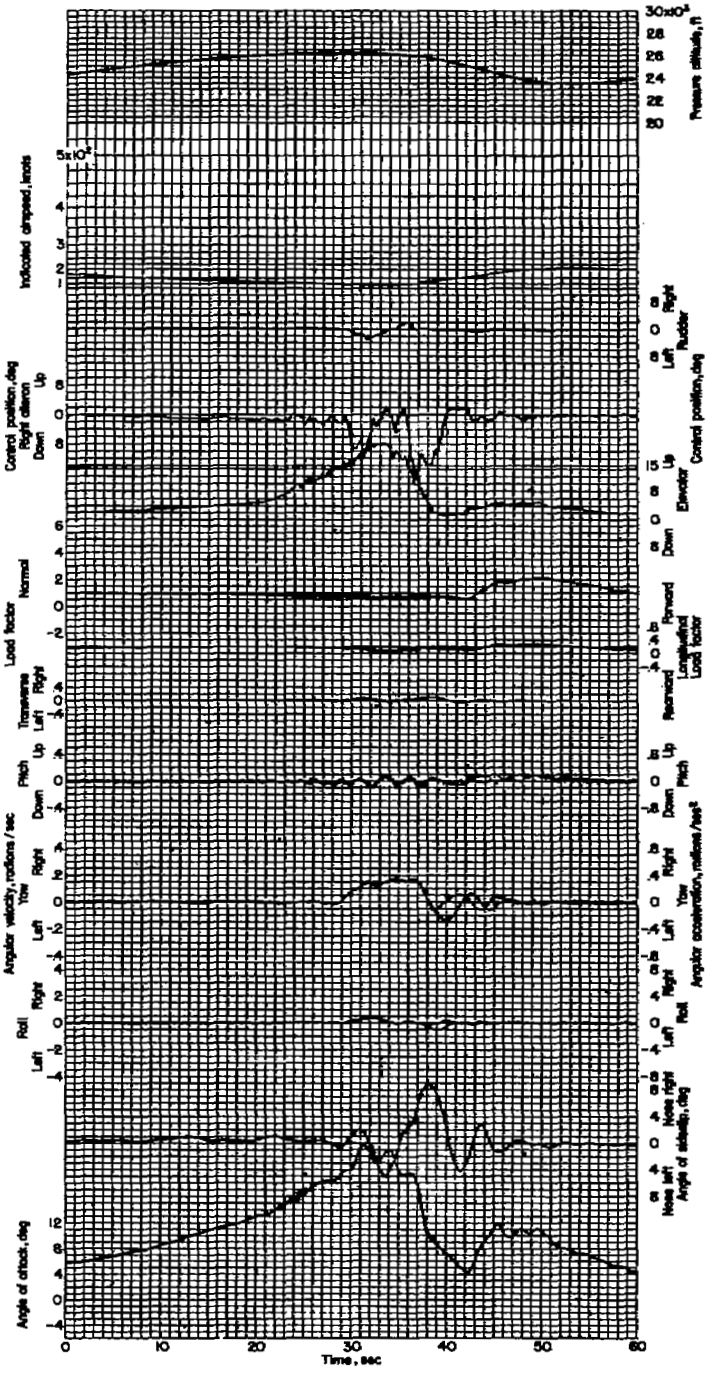


Figure 339.- Stall and recovery. Airplane weight, 15,830 pounds: center of gravity at 24.0 percent M.A.C.; flight 16.

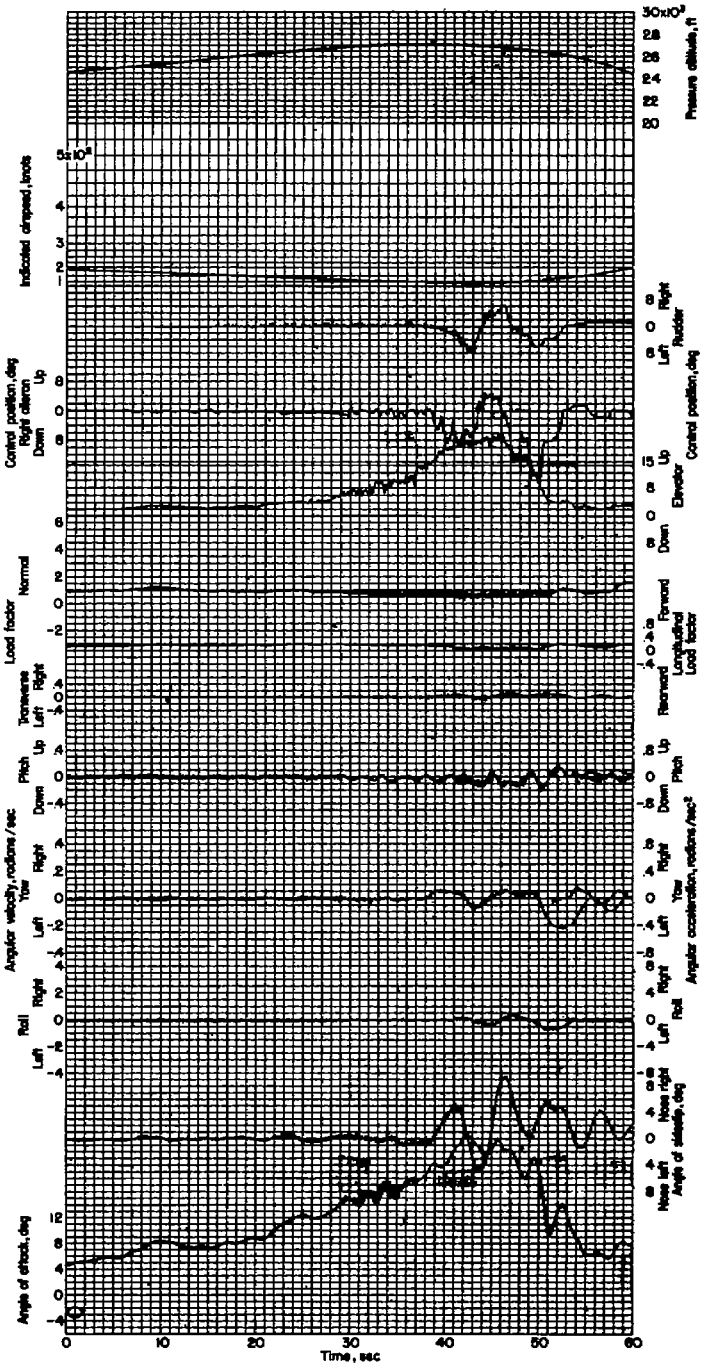
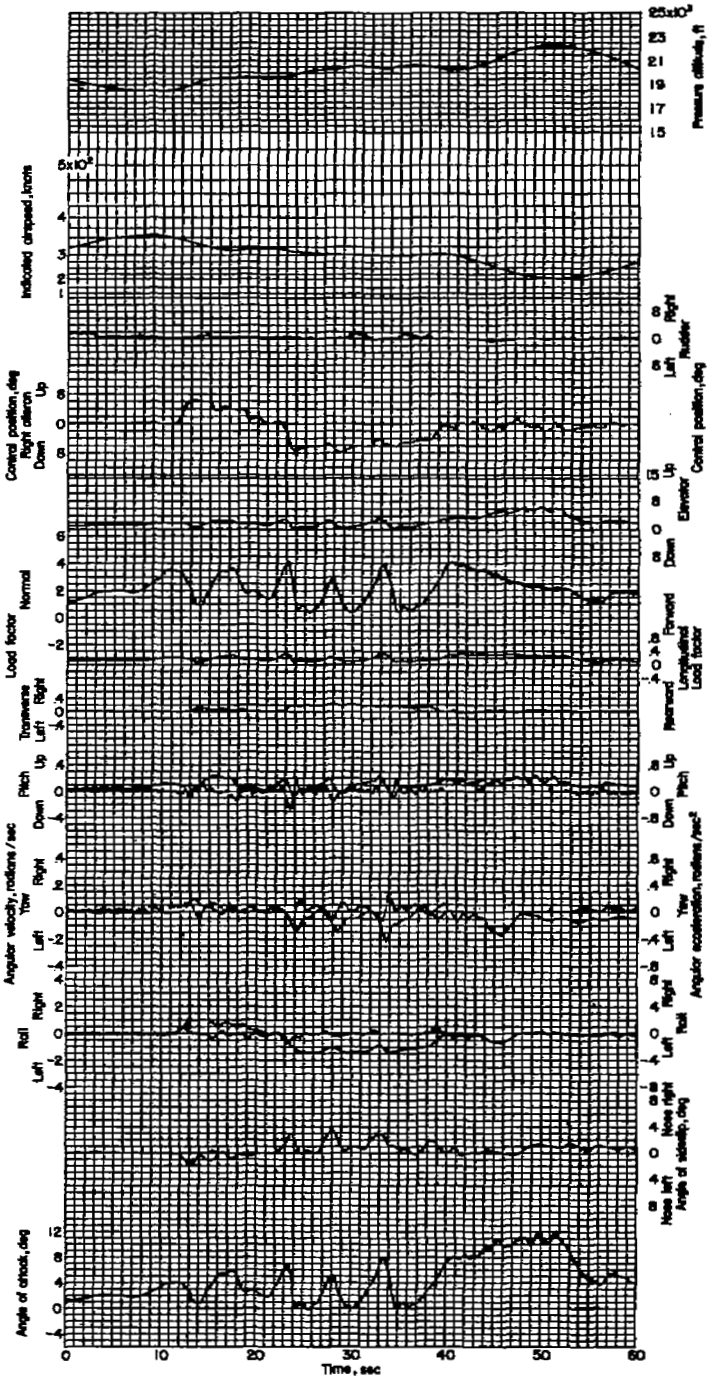


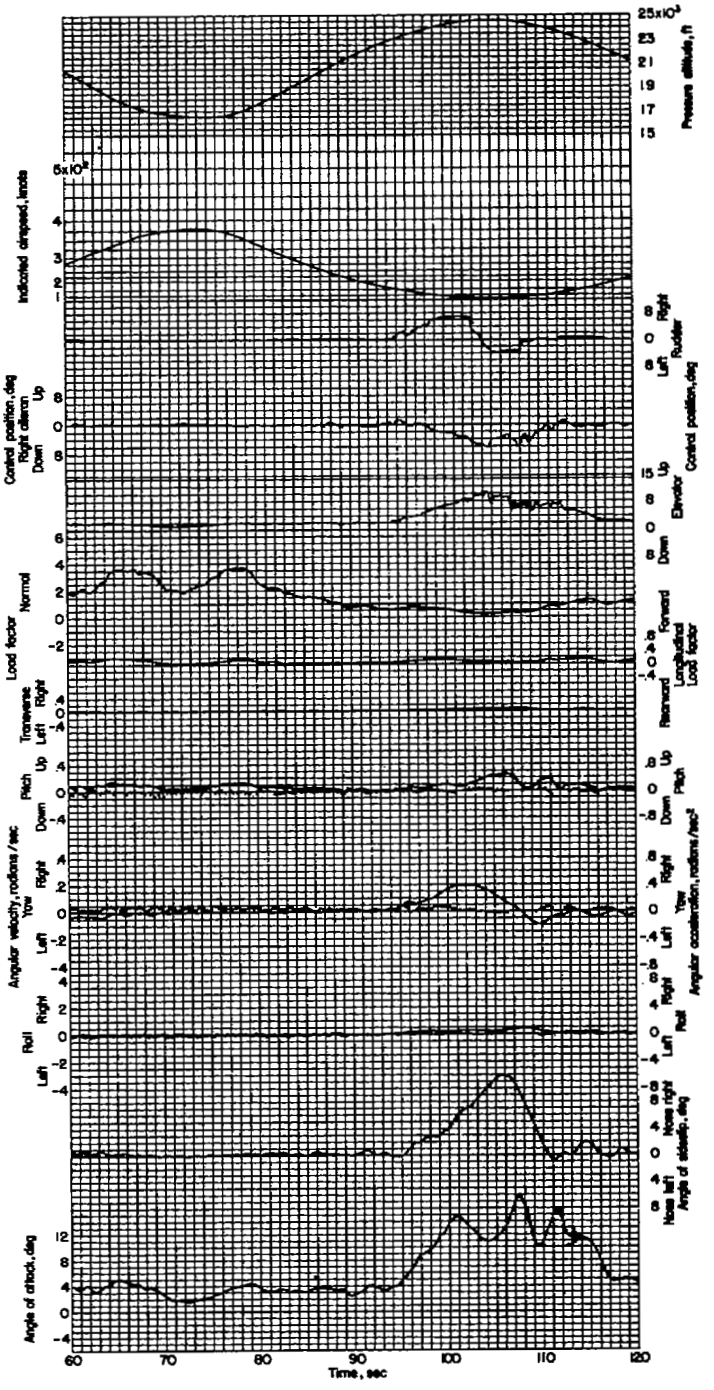
Figure 340.- Stall and recovery. Airplane weight, 15,770 pounds; center of gravity at 24.0 percent M.A.C.; flight 16.



(a)

Figure 341.- Right barrel roll and three consecutive left barrel rolls with peel-off into dive followed by climb to stall and recovery. Airplane weight, 16,040 pounds; center of gravity at 24.1 percent M.A.C.; flight 18.

[redacted]



(b)

Figure 341.- Concluded.

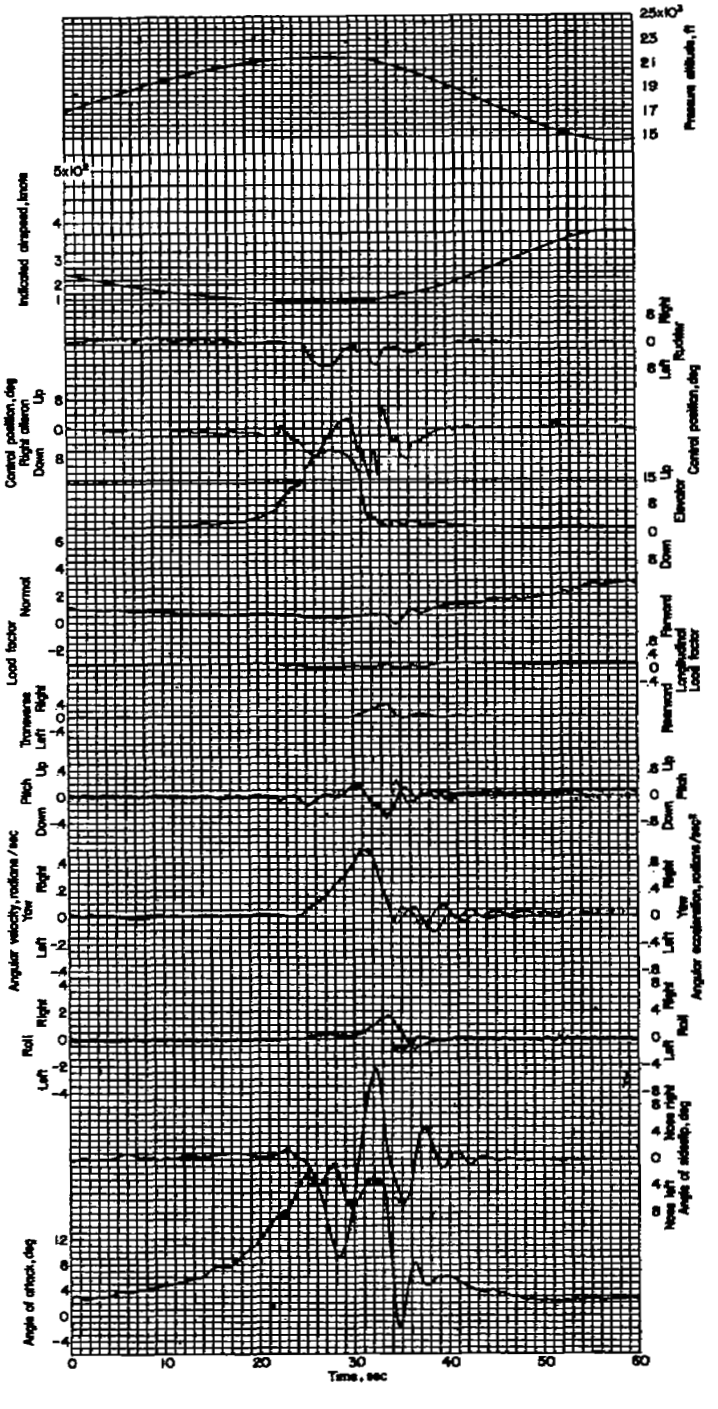
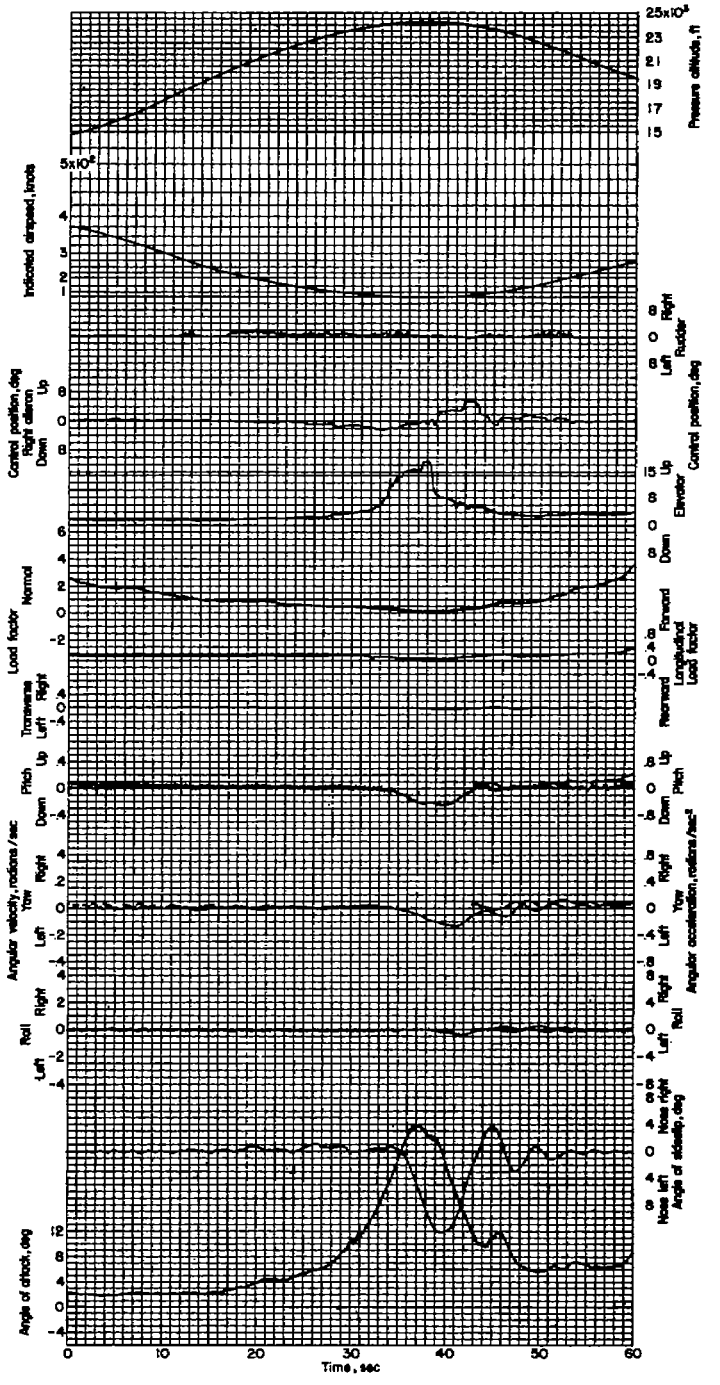


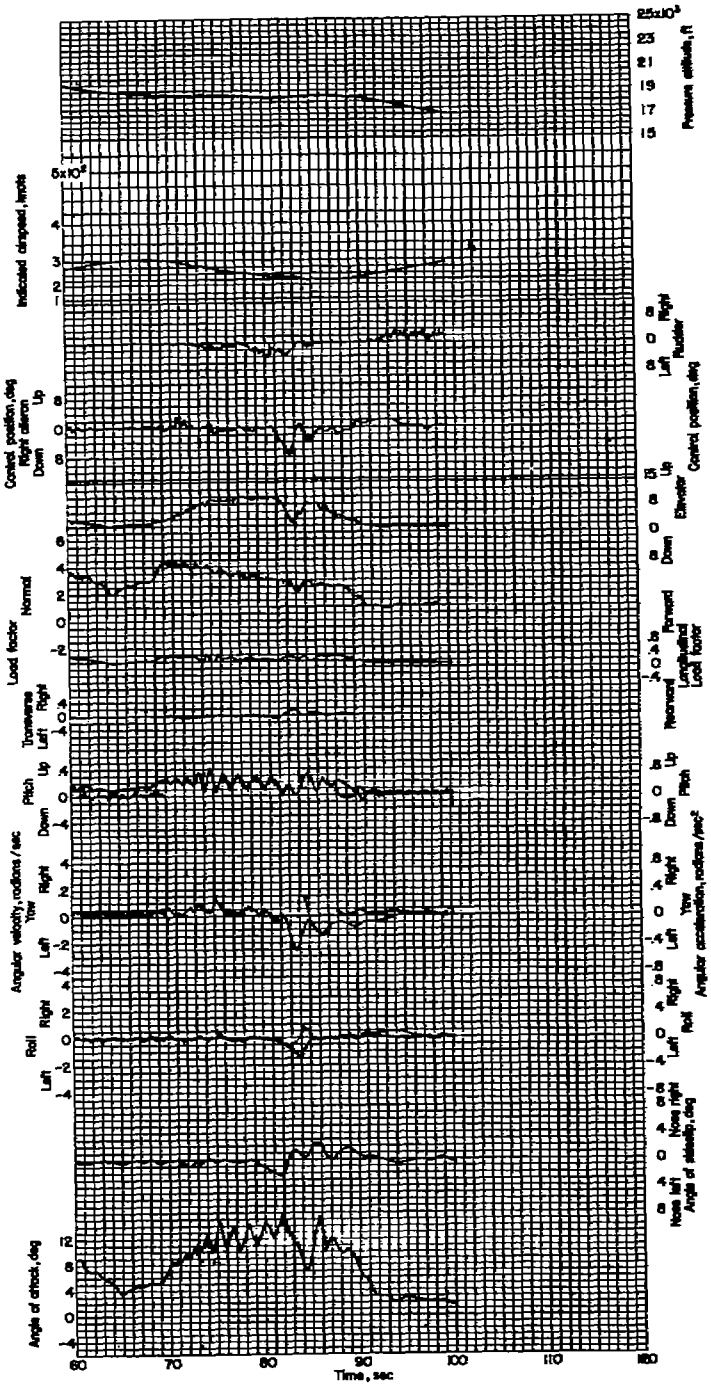
Figure 342.- Climb to stall and recovery. Airplane weight, 15,860 pounds; center of gravity at 24.0 percent M.A.C.; flight 18.



(a)

Figure 343.- Climb to stall and recovery into stall right turn. Airplane weight, 15,790 pounds; center of gravity at 24.0 percent M.A.C.; flight 18.

[redacted]



(b)

Figure 343.- Concluded.

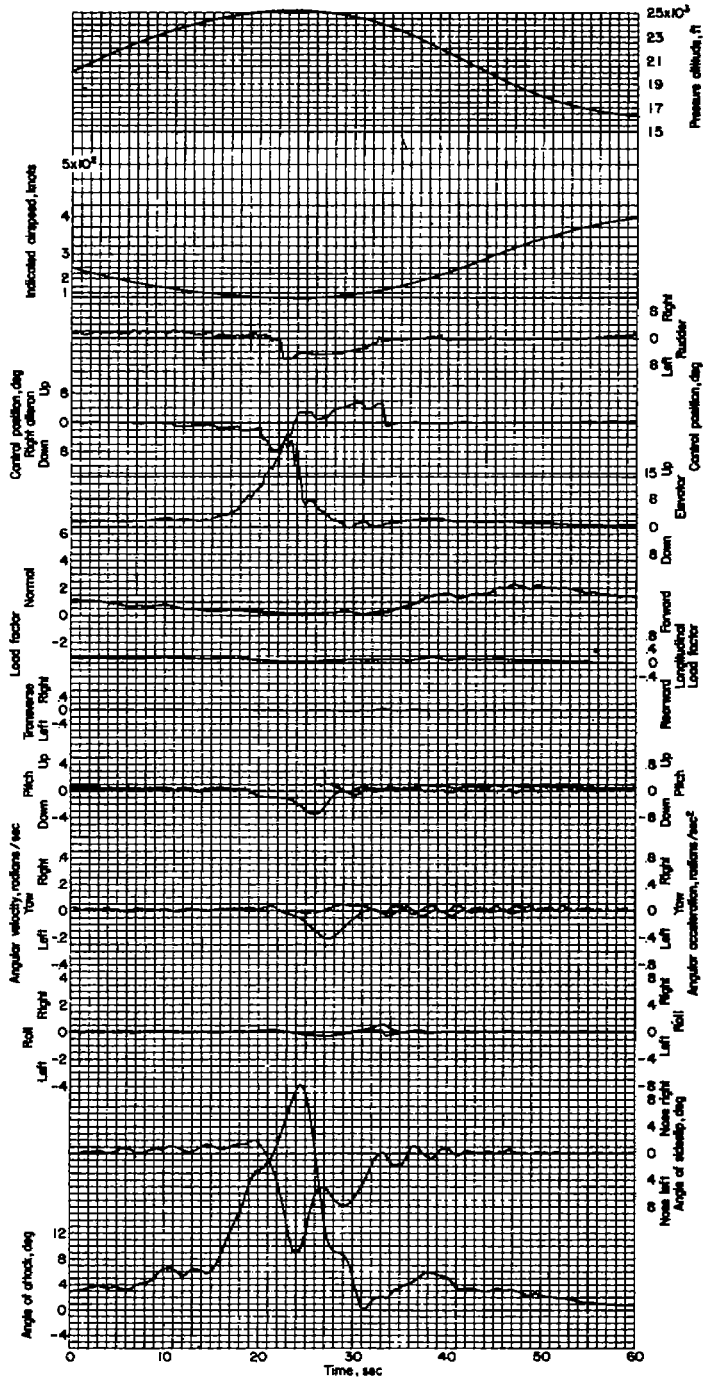
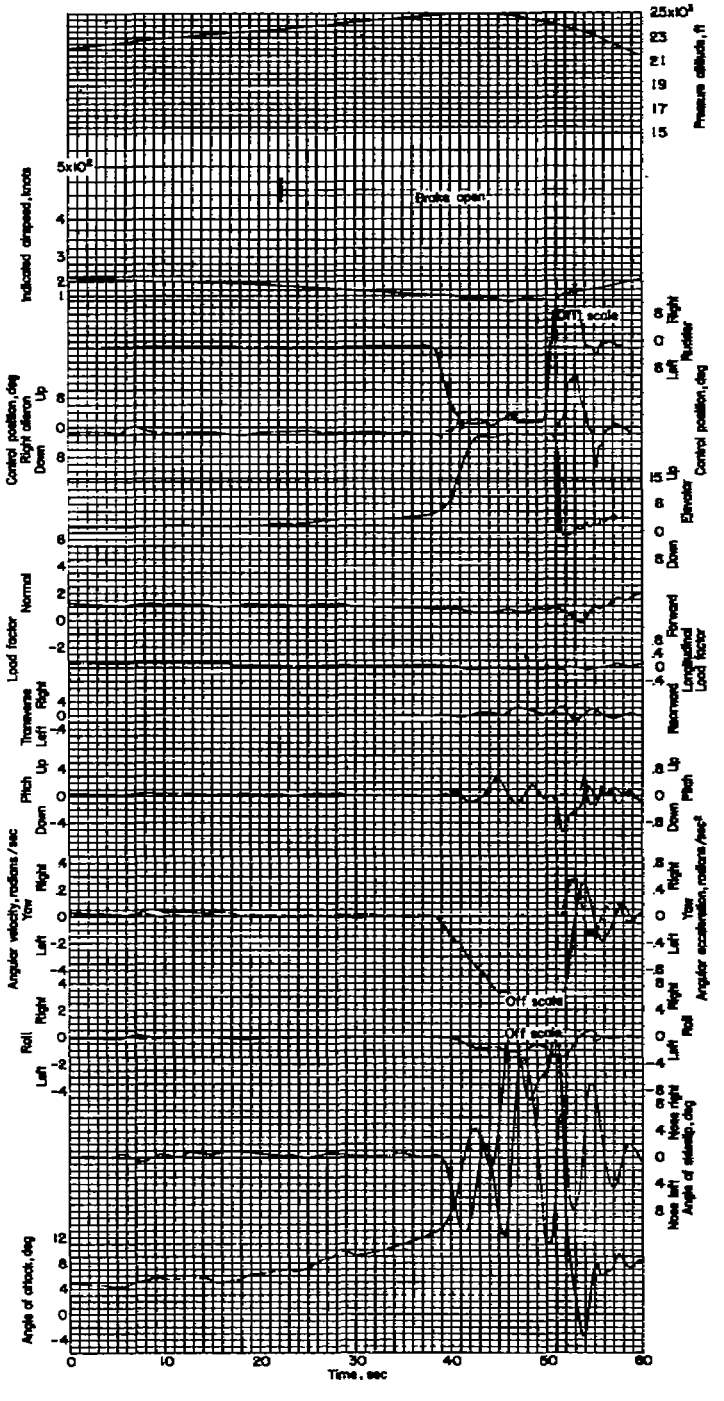
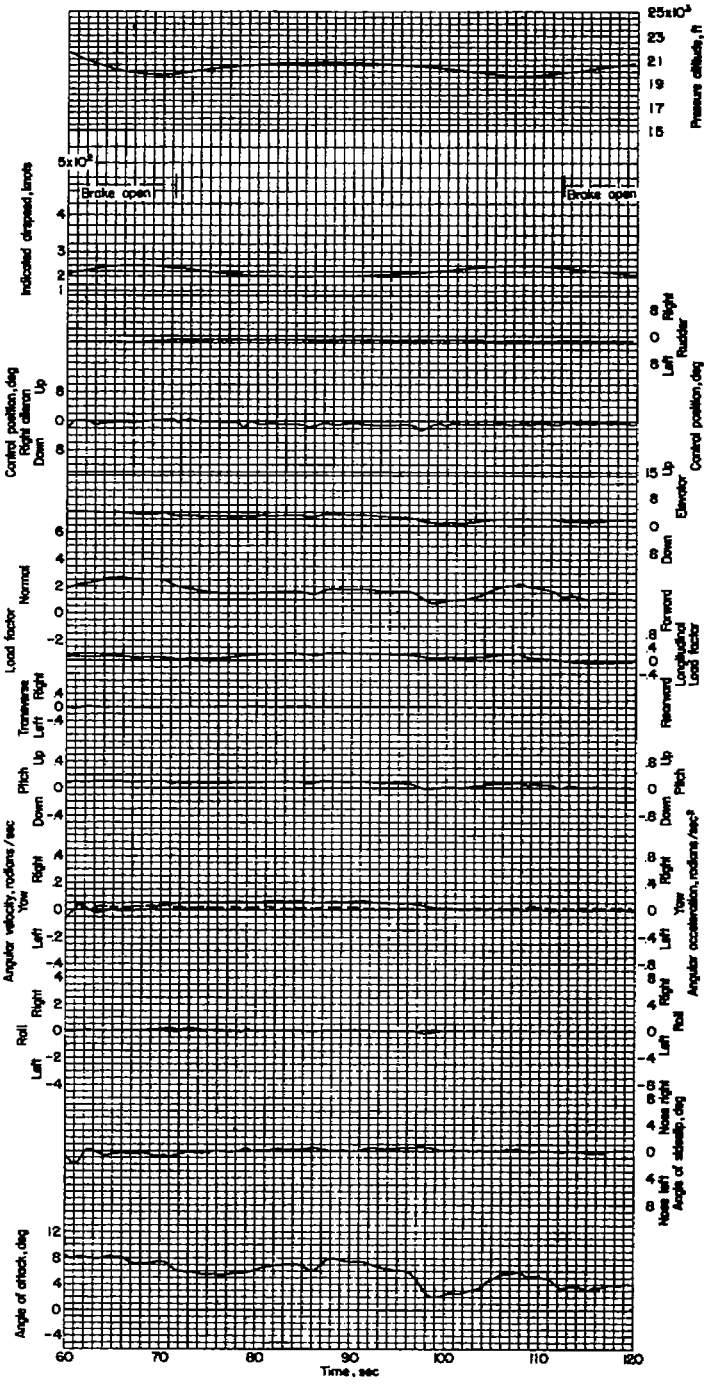


Figure 344.- Climb to stall and recovery. Airplane weight, 15,680 pounds; center of gravity at 23.9 percent M.A.C.; flight 18.



(a)

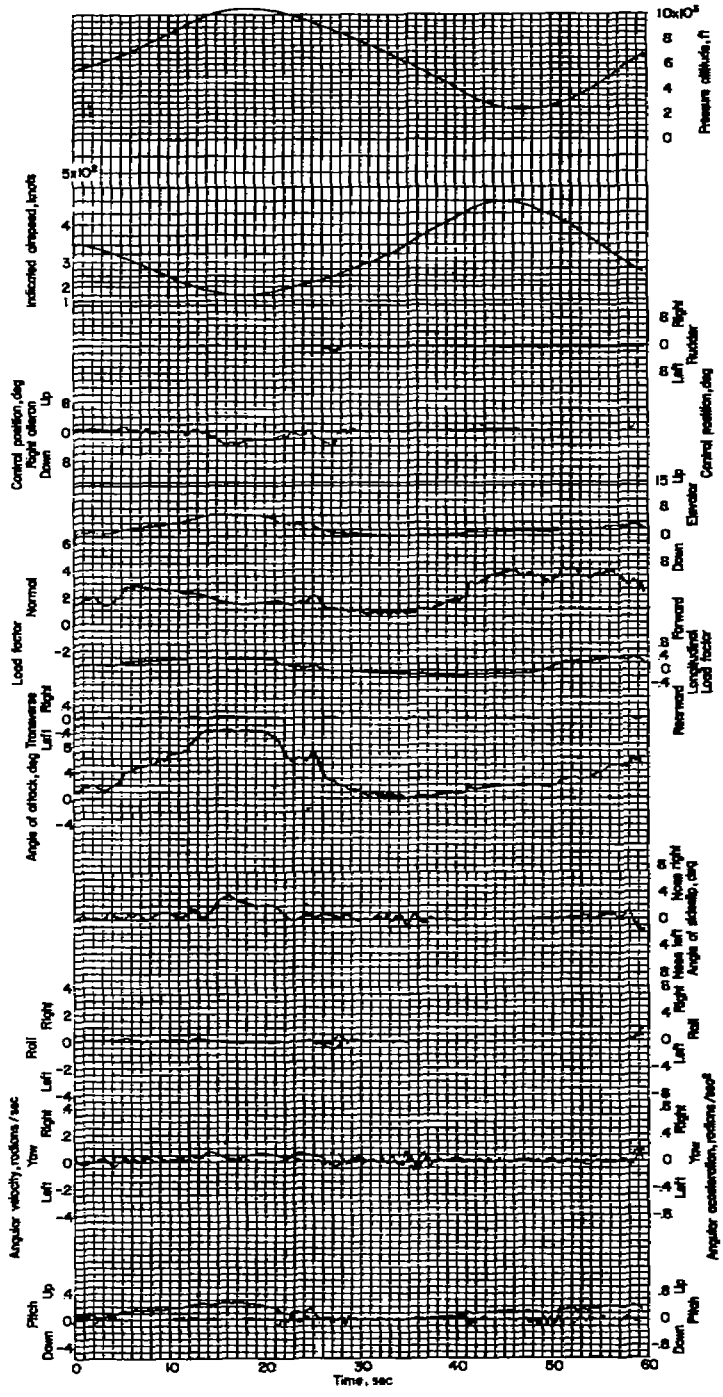
Figure 345.- Spin followed by right turn. Airplane weight, 16,810 pounds; center of gravity at 24.6 percent M.A.C.; flight 2.



(b)

Figure 345.- Concluded.

[redacted]



(a)

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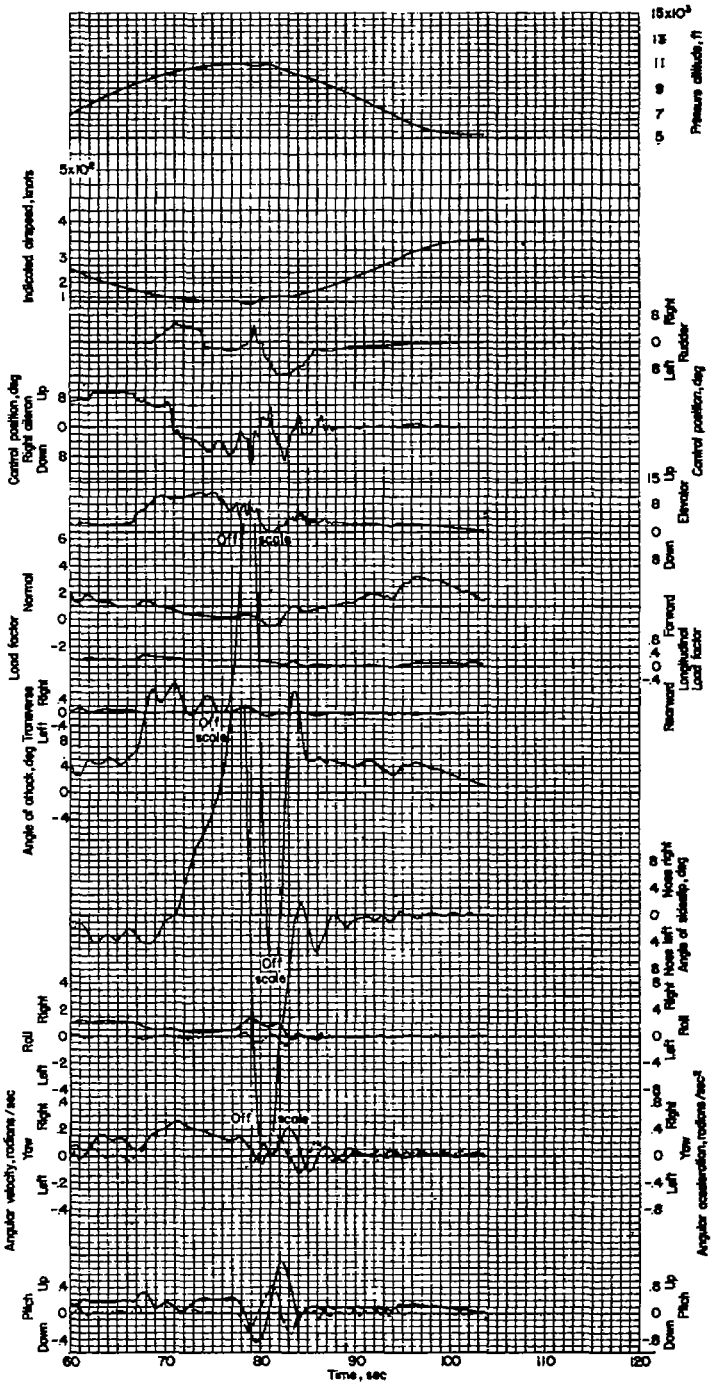
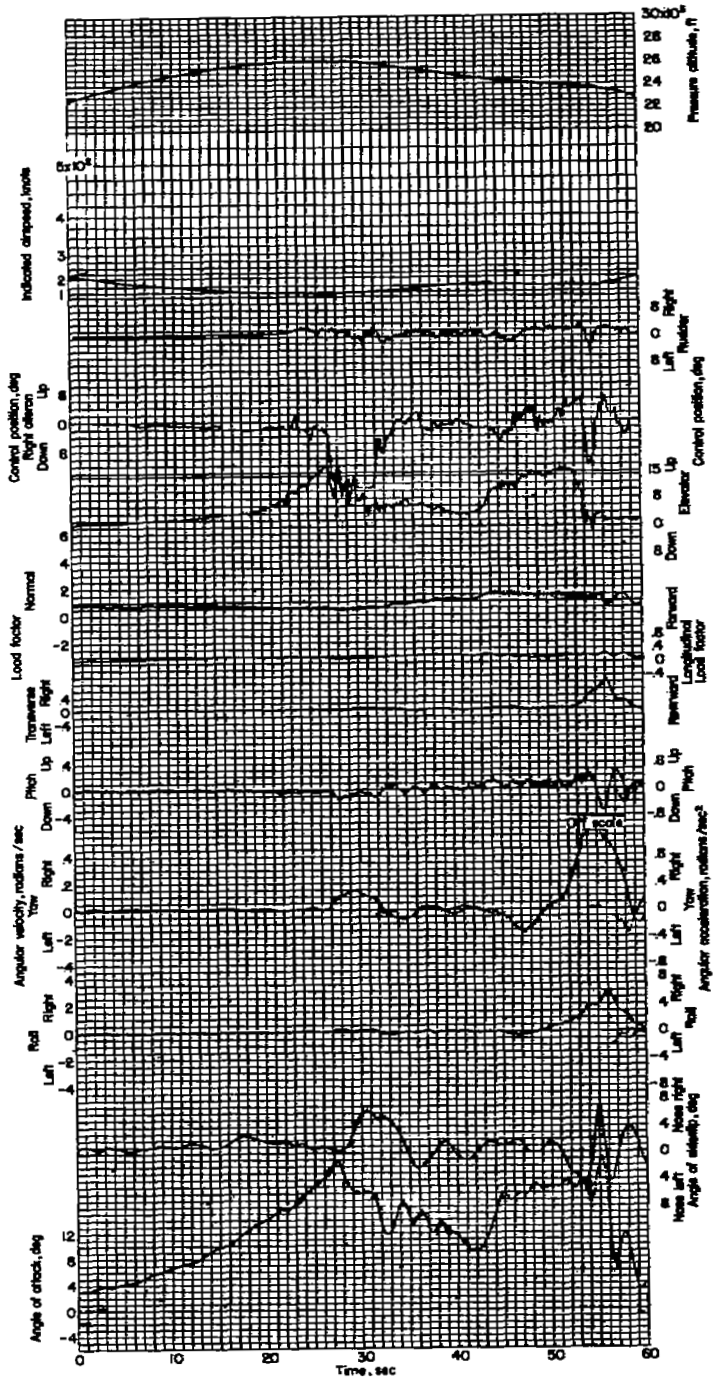
Figure 346.- Wing-over into dive-bombing run followed by climbing right barrel rolls into spin. Airplane weight, 15,570 pounds; center of gravity at 23.9 percent M.A.C.; flight 8.



(b)

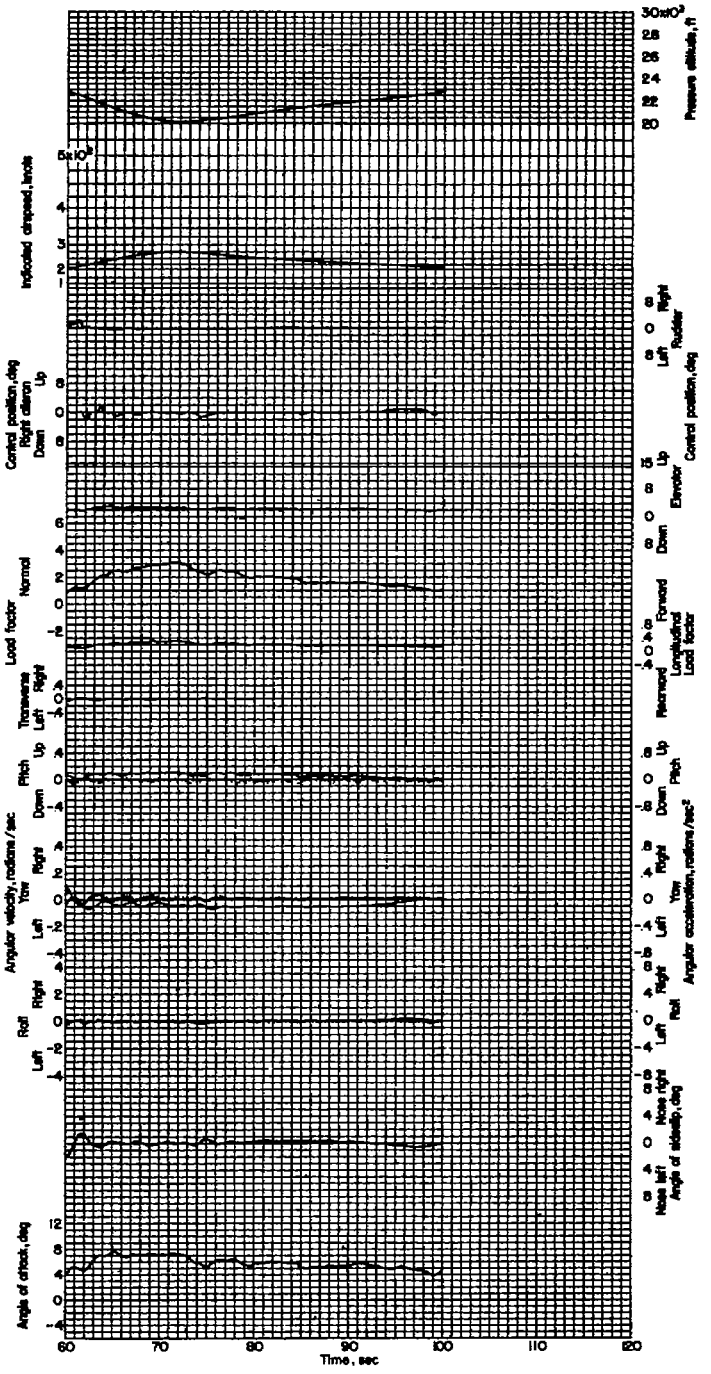
Figure 346.- Concluded.

[redacted]



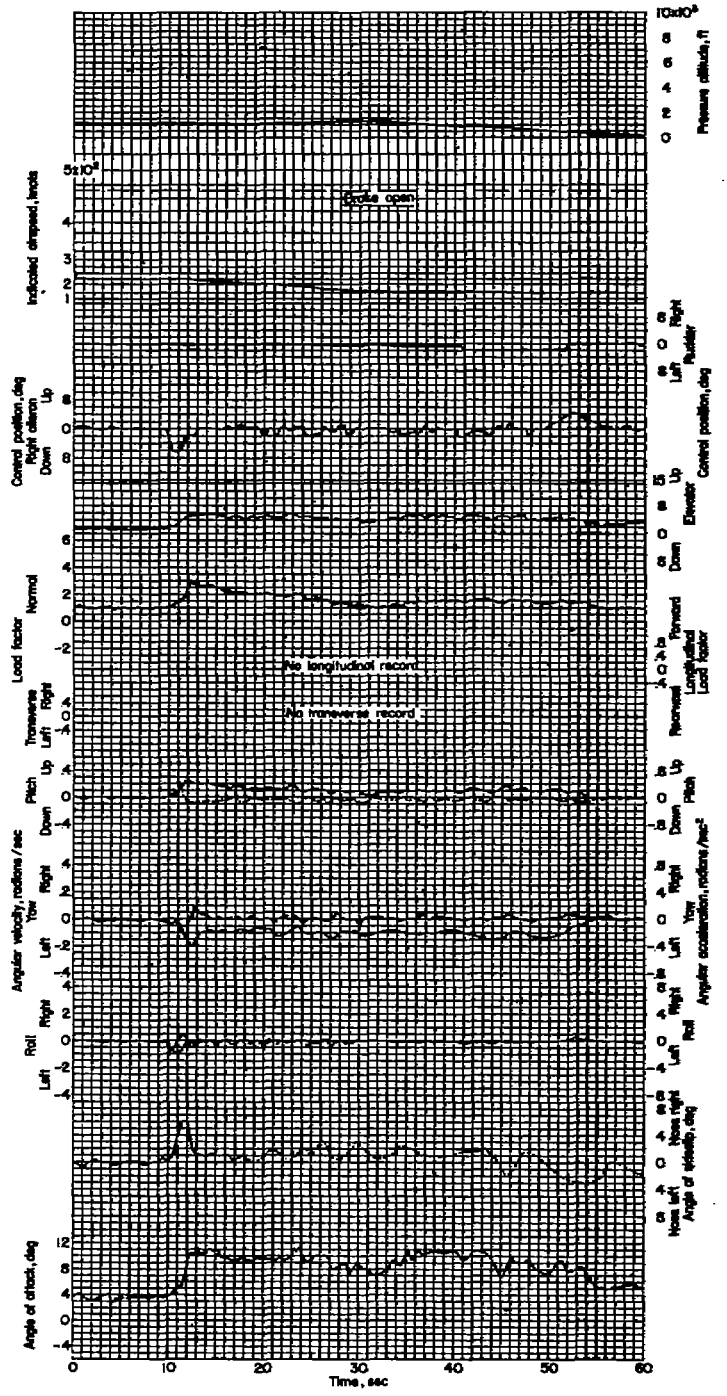
(a)

Figure 347.- Stall followed by spin and recovery. Airplane weight, 15,910 pounds; center of gravity at 24.1 percent M.A.C.; flight 16.



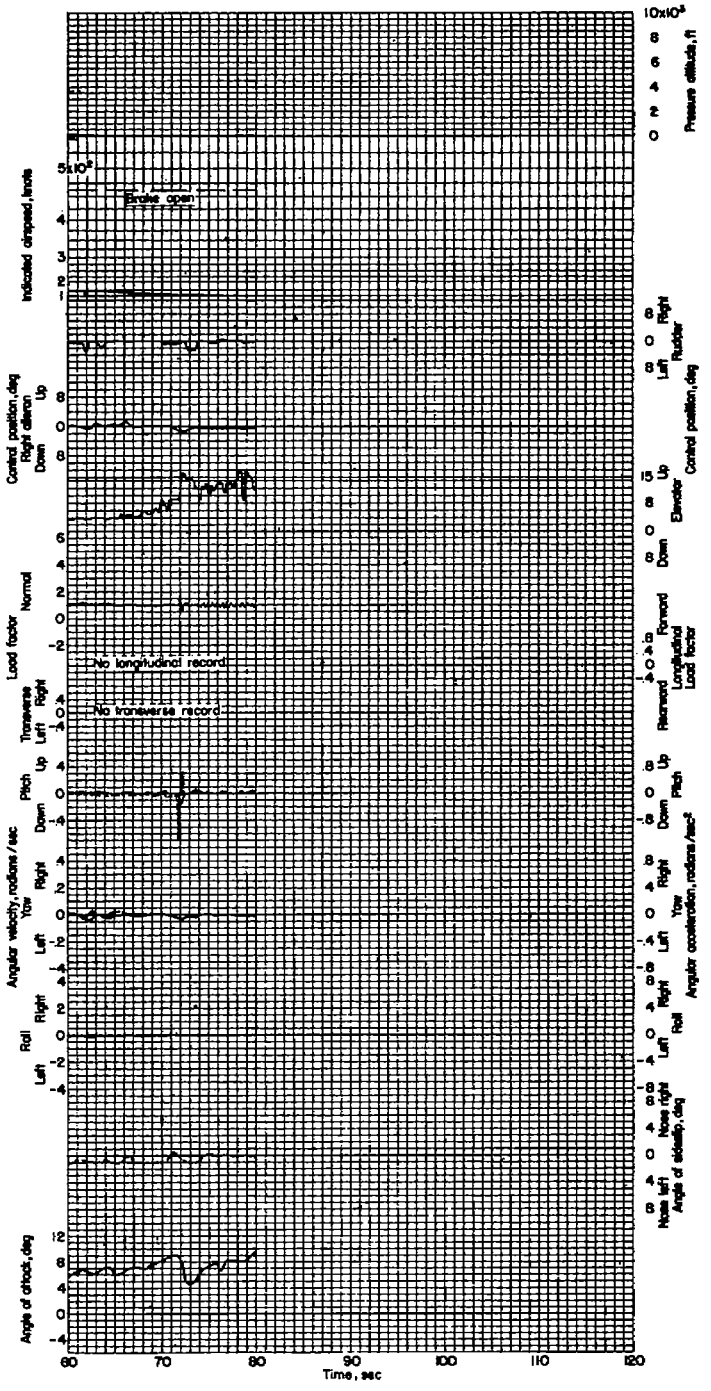
(b)

Figure 347.- Concluded.



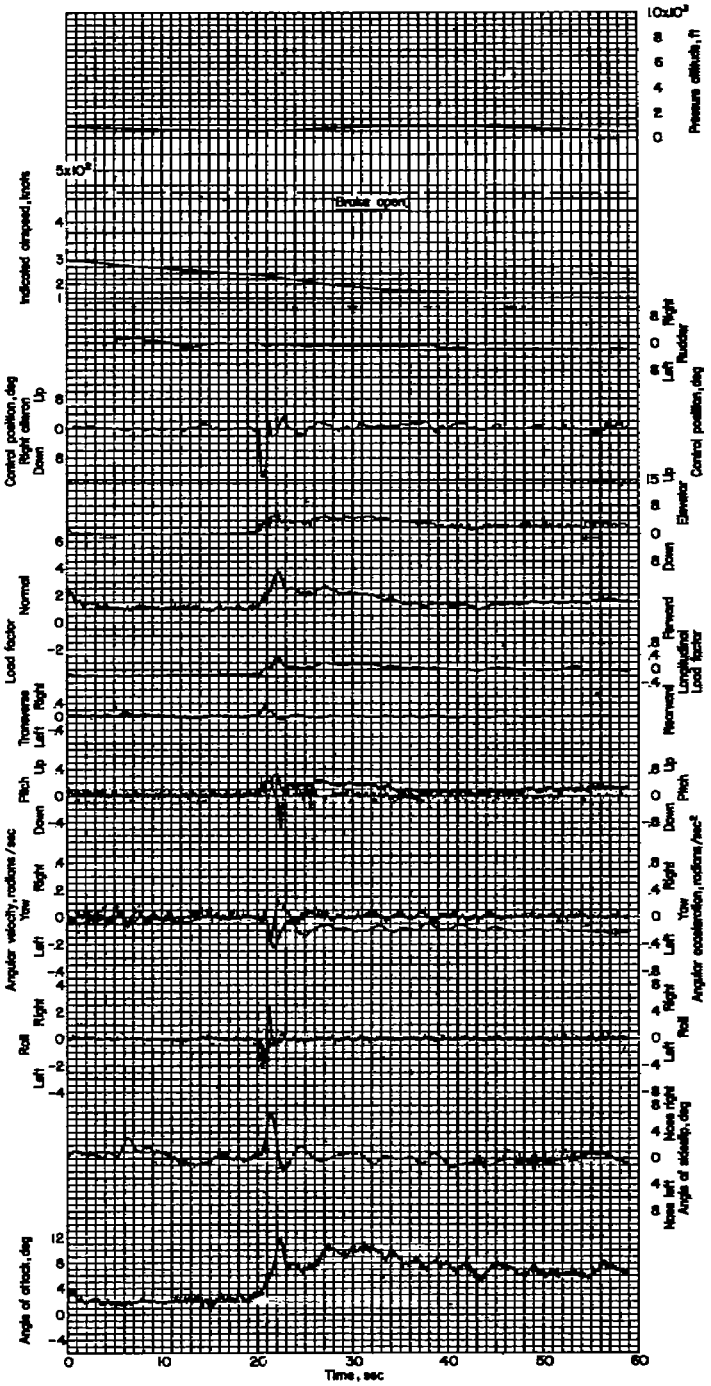
(a)

Figure 348.- Left turn and landing. Airplane weight, 14,200 pounds; center of gravity at 25.5 percent M.A.C.; flight 1.



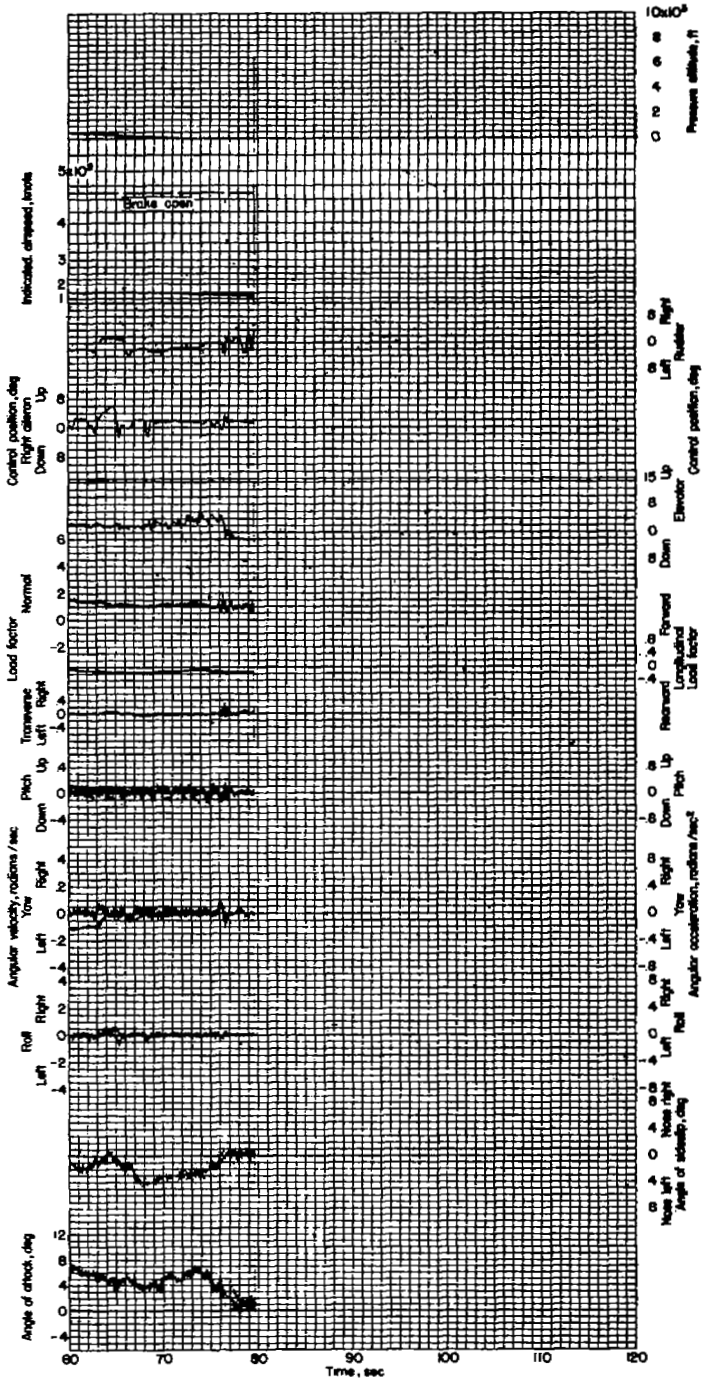
(b)

Figure 348.- Concluded.



(a)

Figure 349.- Left turn and landing. Airplane weight, 13,790 pounds; center of gravity at 26.2 percent M.A.C.; flight 7.



(b)

Figure 349.- Concluded.

[redacted]

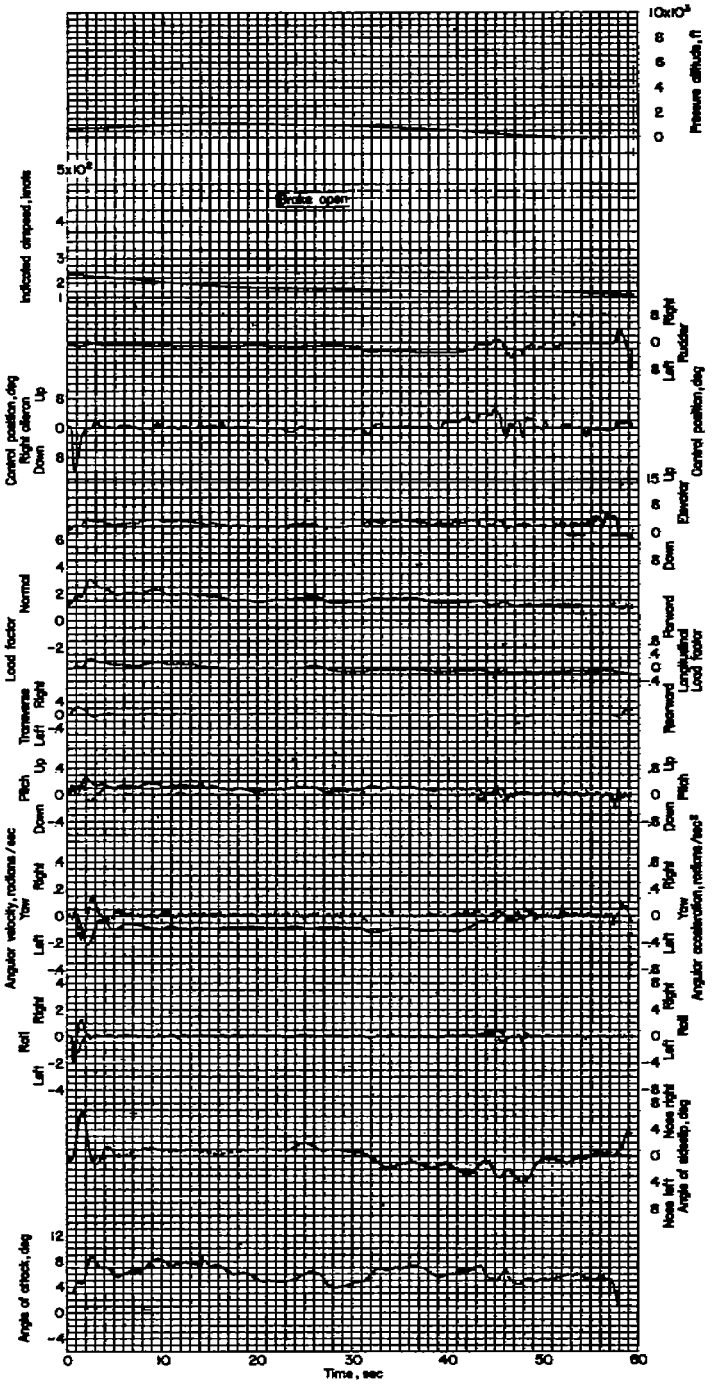
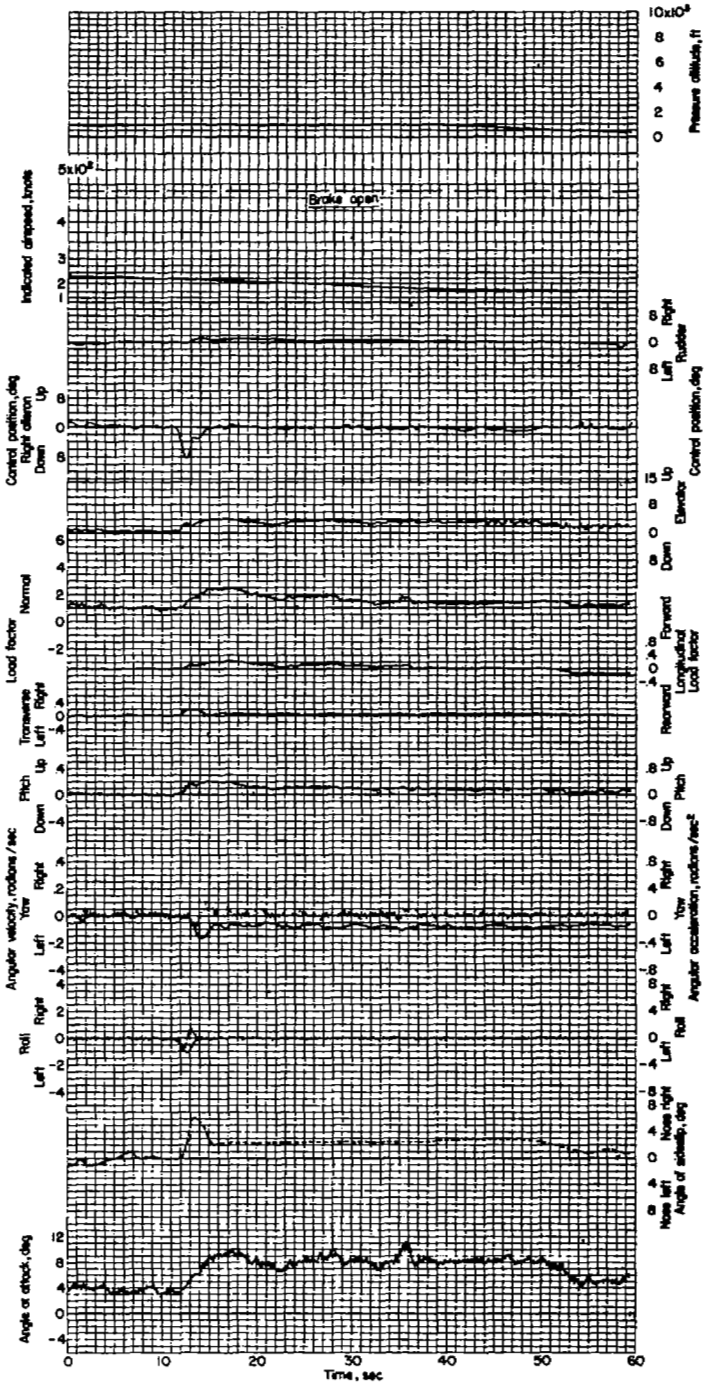
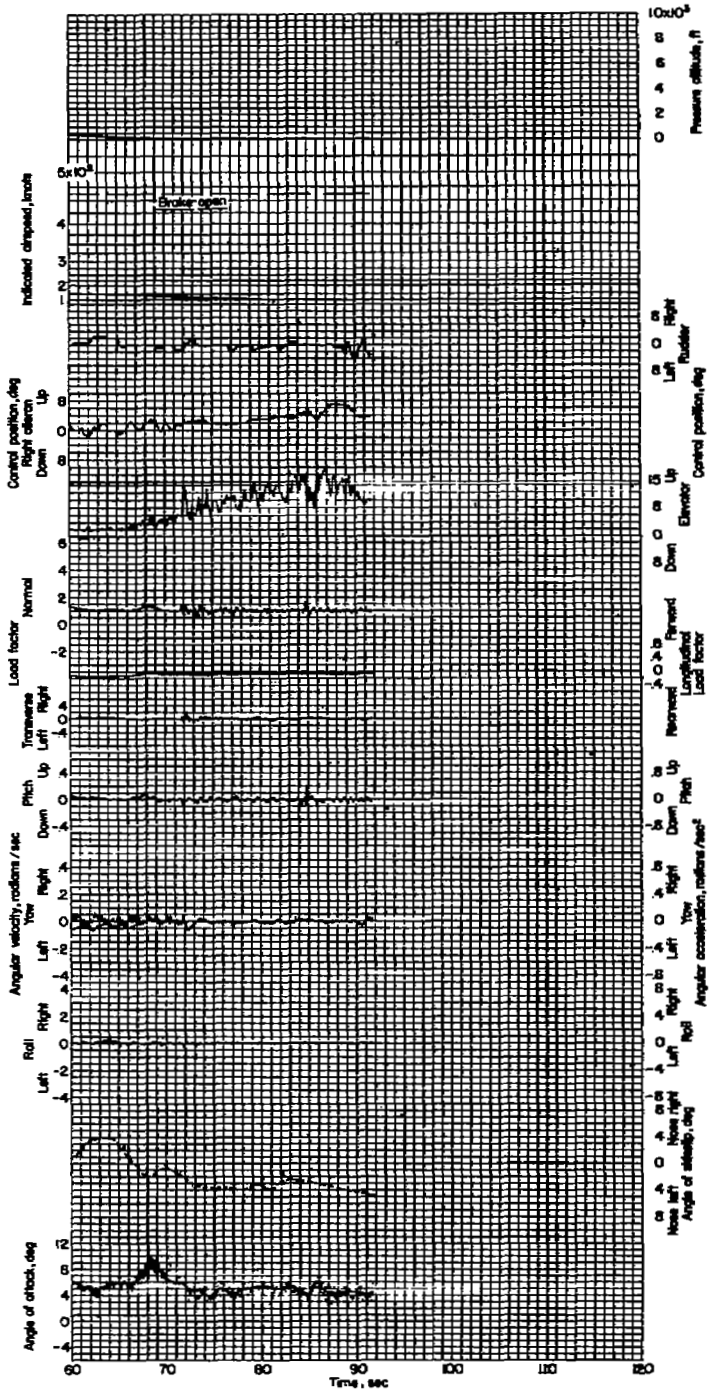


Figure 350.- Left turn and landing. Airplane weight, 13,860 pounds; center of gravity at 26.0 percent M.A.C.; flight 8.



(a)

Figure 351.- Left turn and landing. Airplane weight, 13,720 pounds; center of gravity at 26.6 percent M.A.C.; flight 11.



(b)

Figure 351.- Concluded.

[redacted]

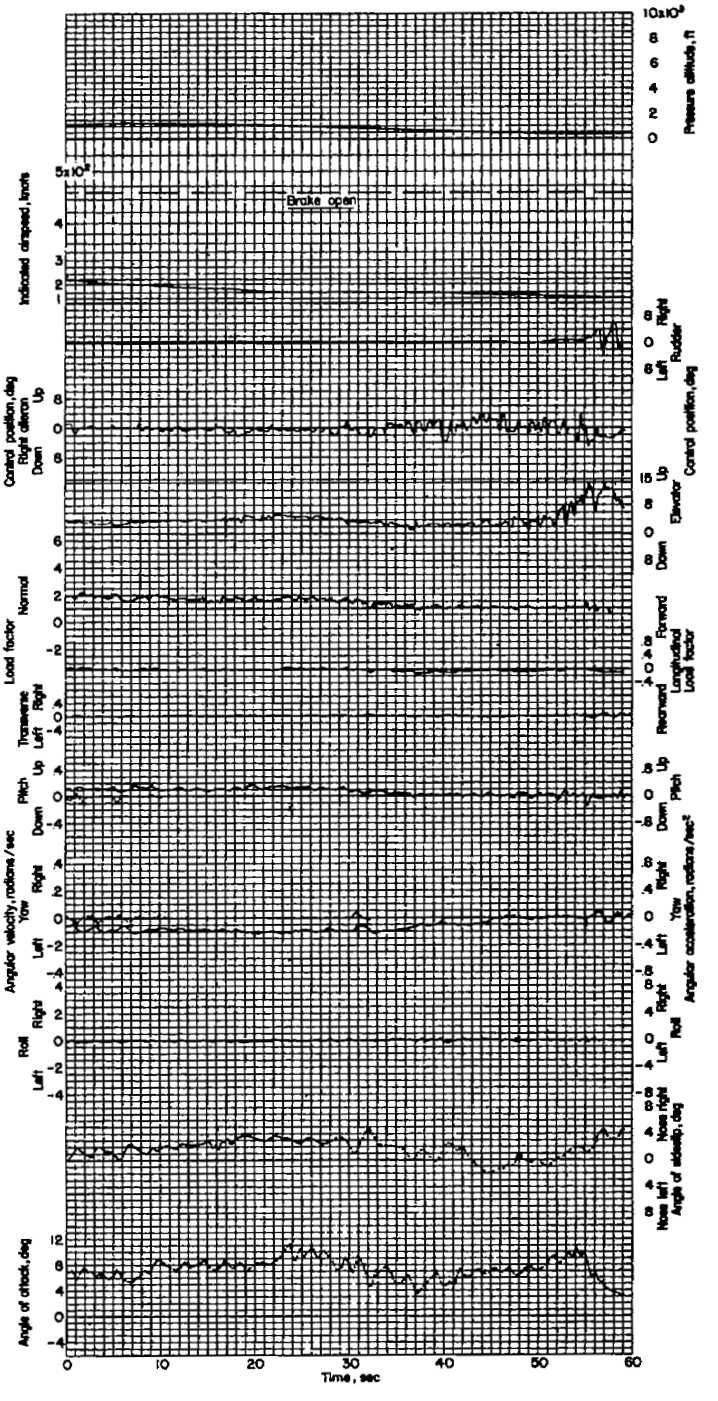


Figure 352.- Left turn and landing. Airplane weight, 14,410 pounds; center of gravity at 25.2 percent M.A.C.; flight 12.

[redacted]

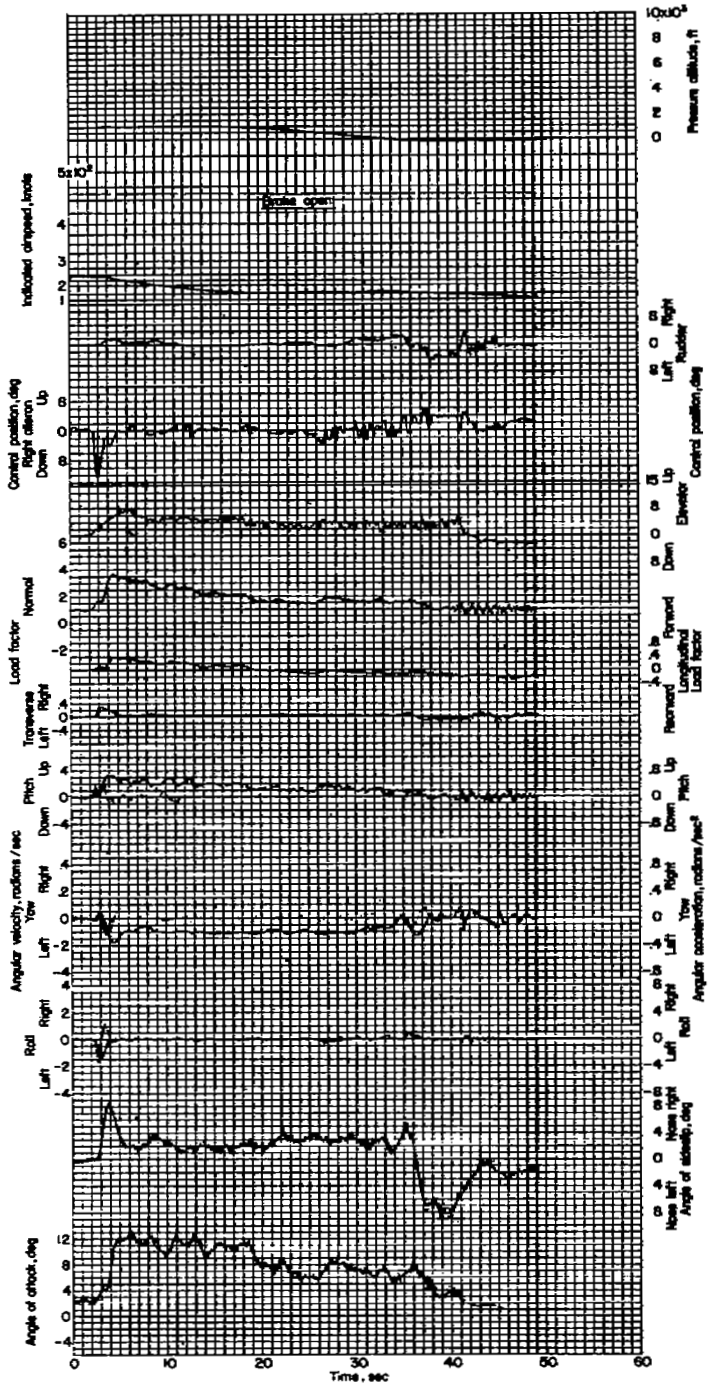


Figure 353.- Left turn and landing. Airplane weight, 13,960 pounds; center of gravity at 25.8 percent M.A.C.; flight 16.

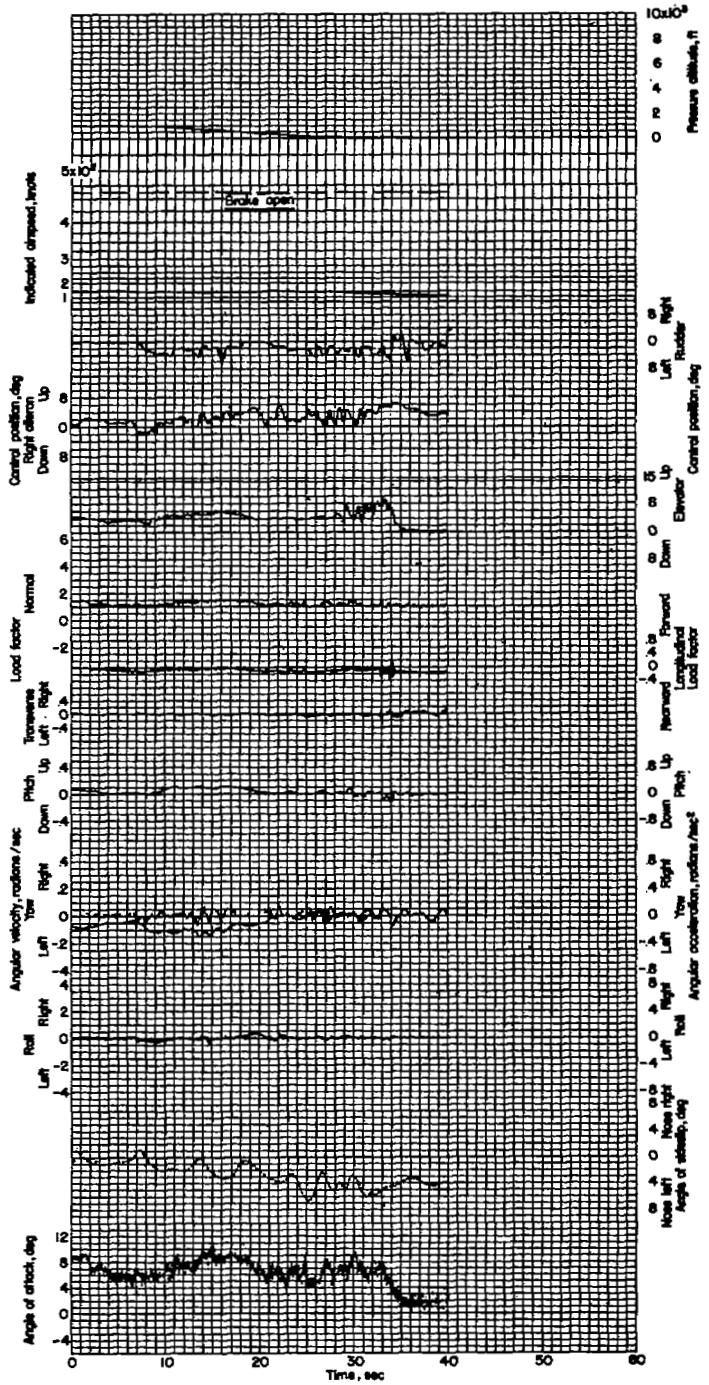


Figure 354.- Left turn and landing. Airplane weight, 14,650 pounds; center of gravity at 24.8 percent M.A.C.; flight 17.

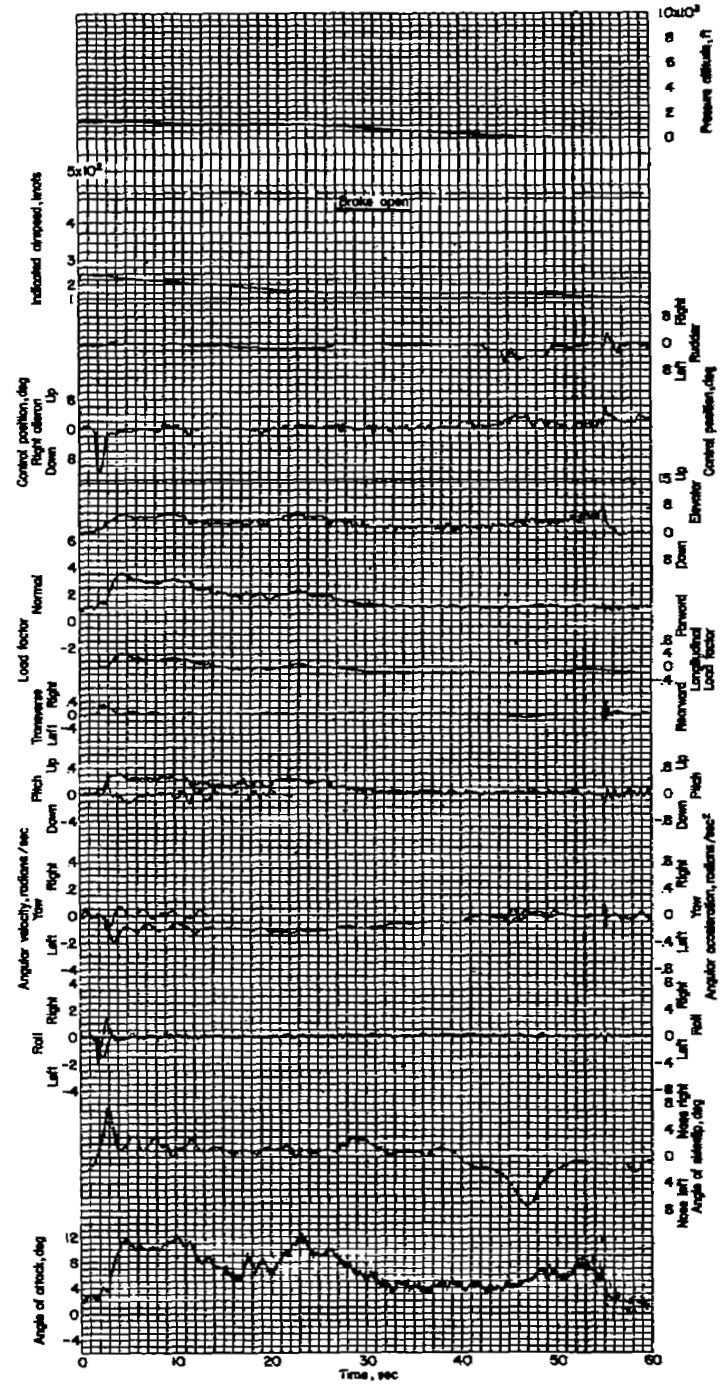


Figure 355.- Left turn and landing. Airplane weight, 14,000 pounds; center of gravity at 25.7 percent M.A.C.; flight 18.

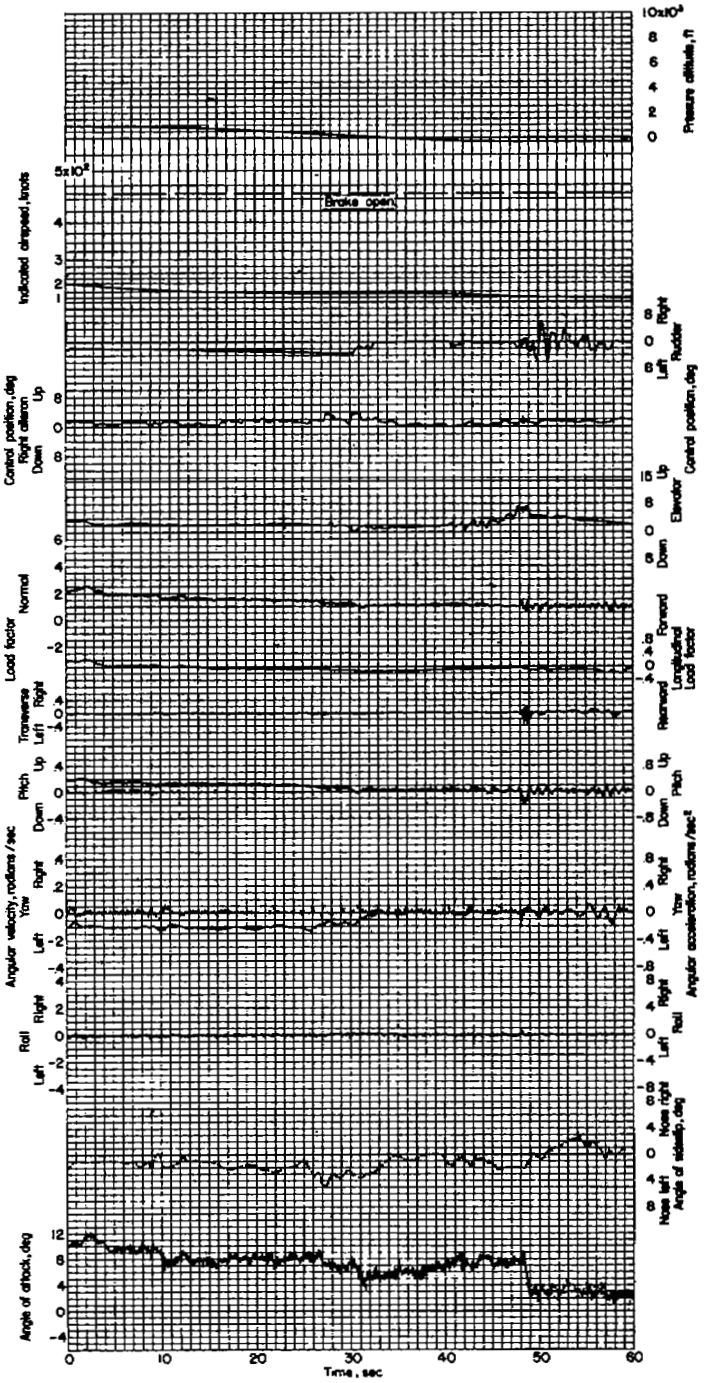


Figure 356.- Left turn and landing. Airplane weight, 13,180 pounds; center of gravity at 26.5 percent M.A.C.; flight 19.

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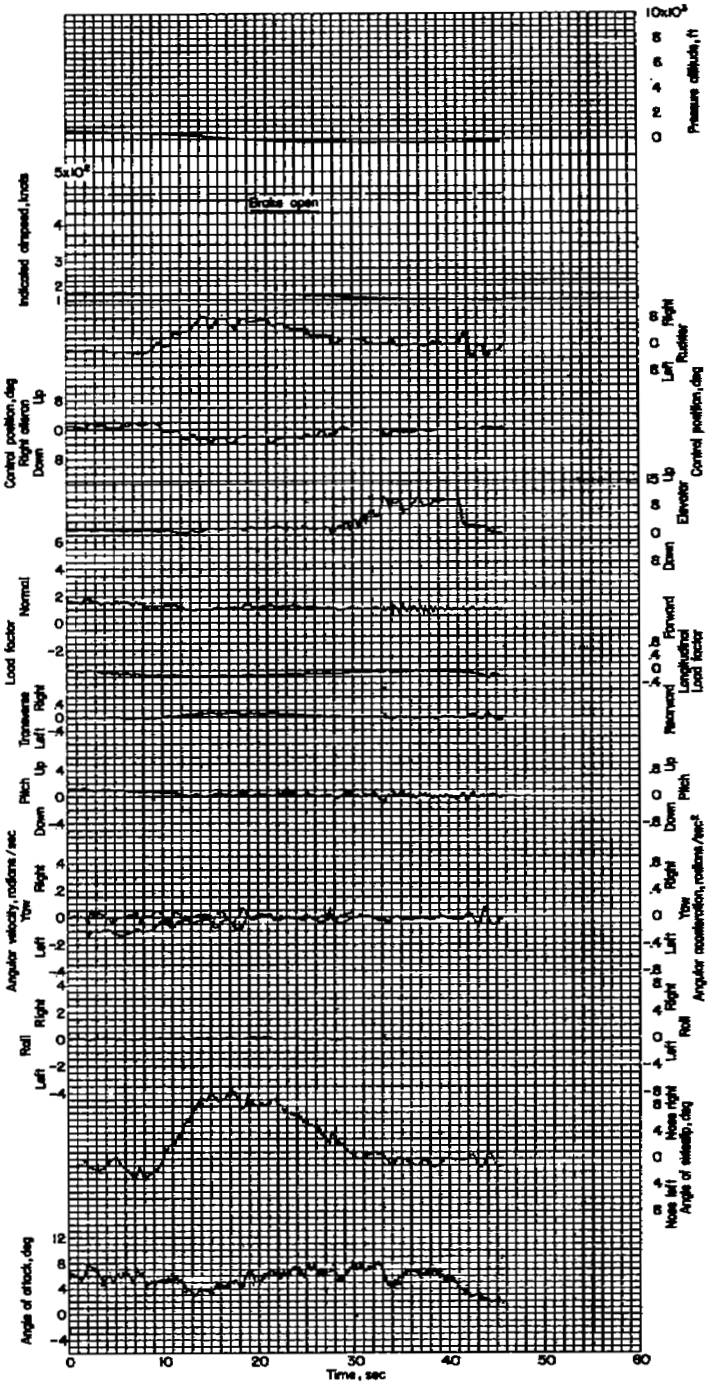

Figure 357.- Left turn and landing. Airplane weight, 13,530 pounds; center of gravity at 25.6 percent M.A.C.; flight 20.

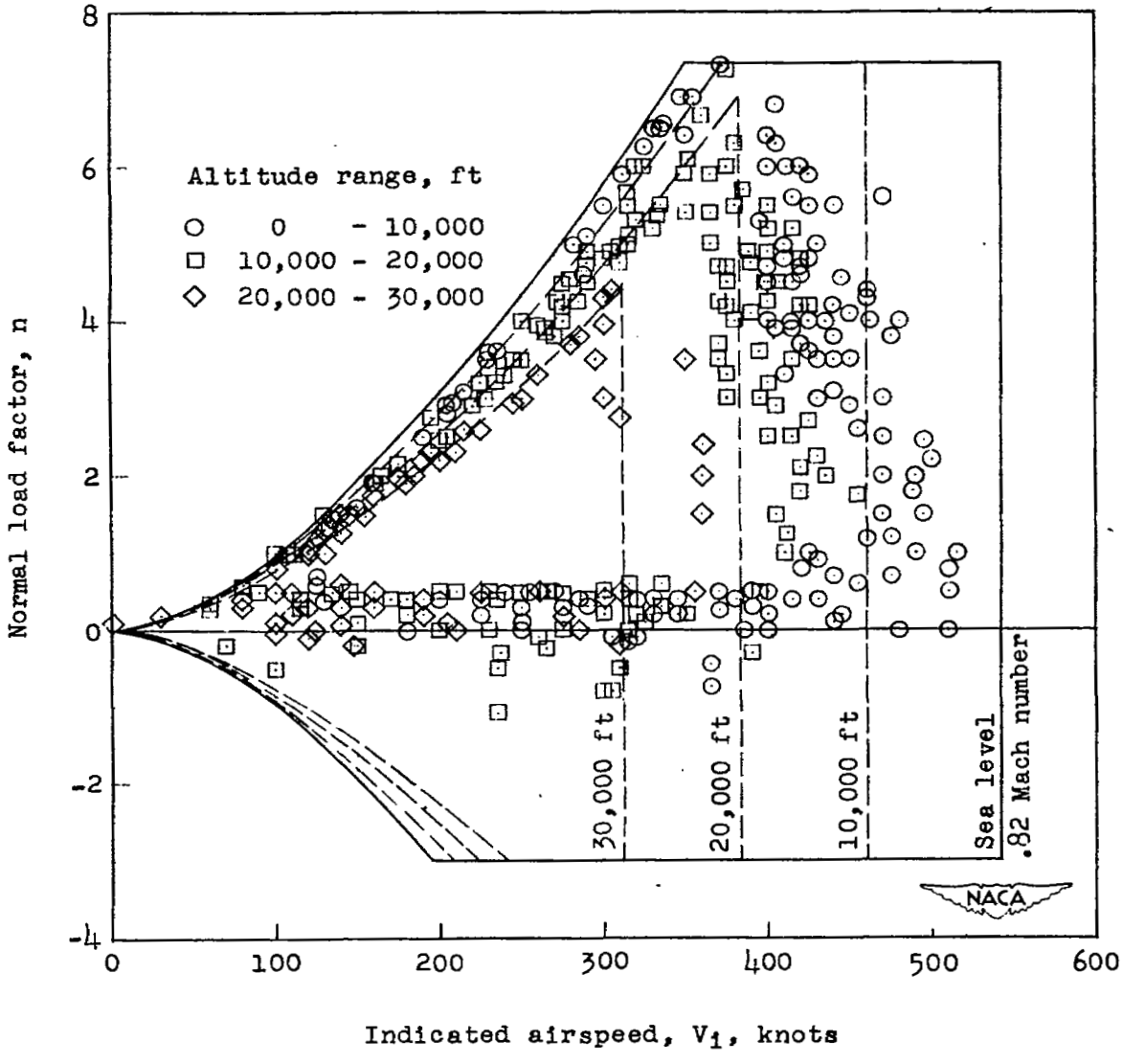

Figure 358.- Comparison of measured normal load factors with the F-84G V-n diagram. V-n diagram at a gross weight of 15,000 pounds.

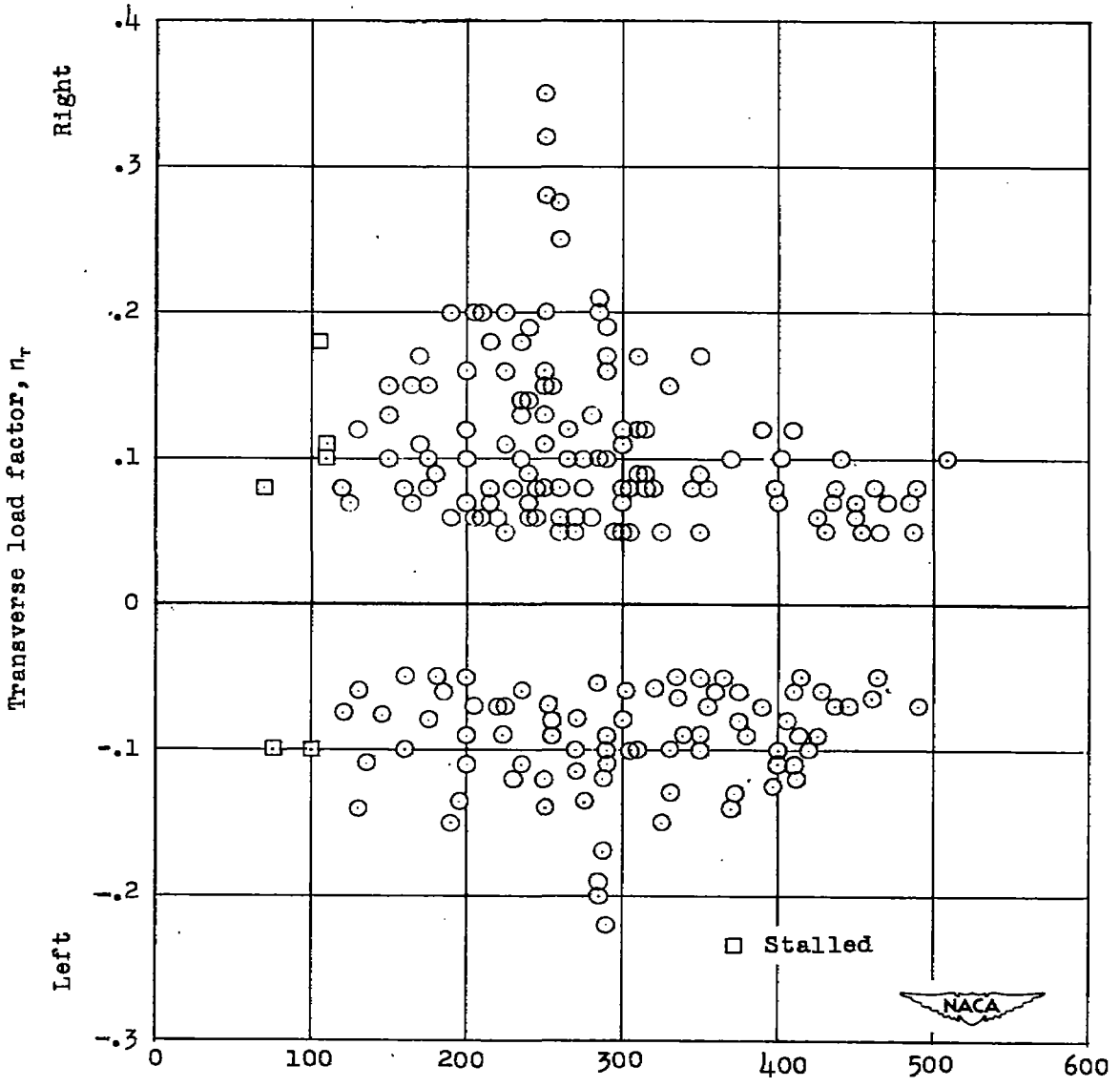

Figure 359.- Variation of maximum corrected transverse load factors with indicated airspeed.

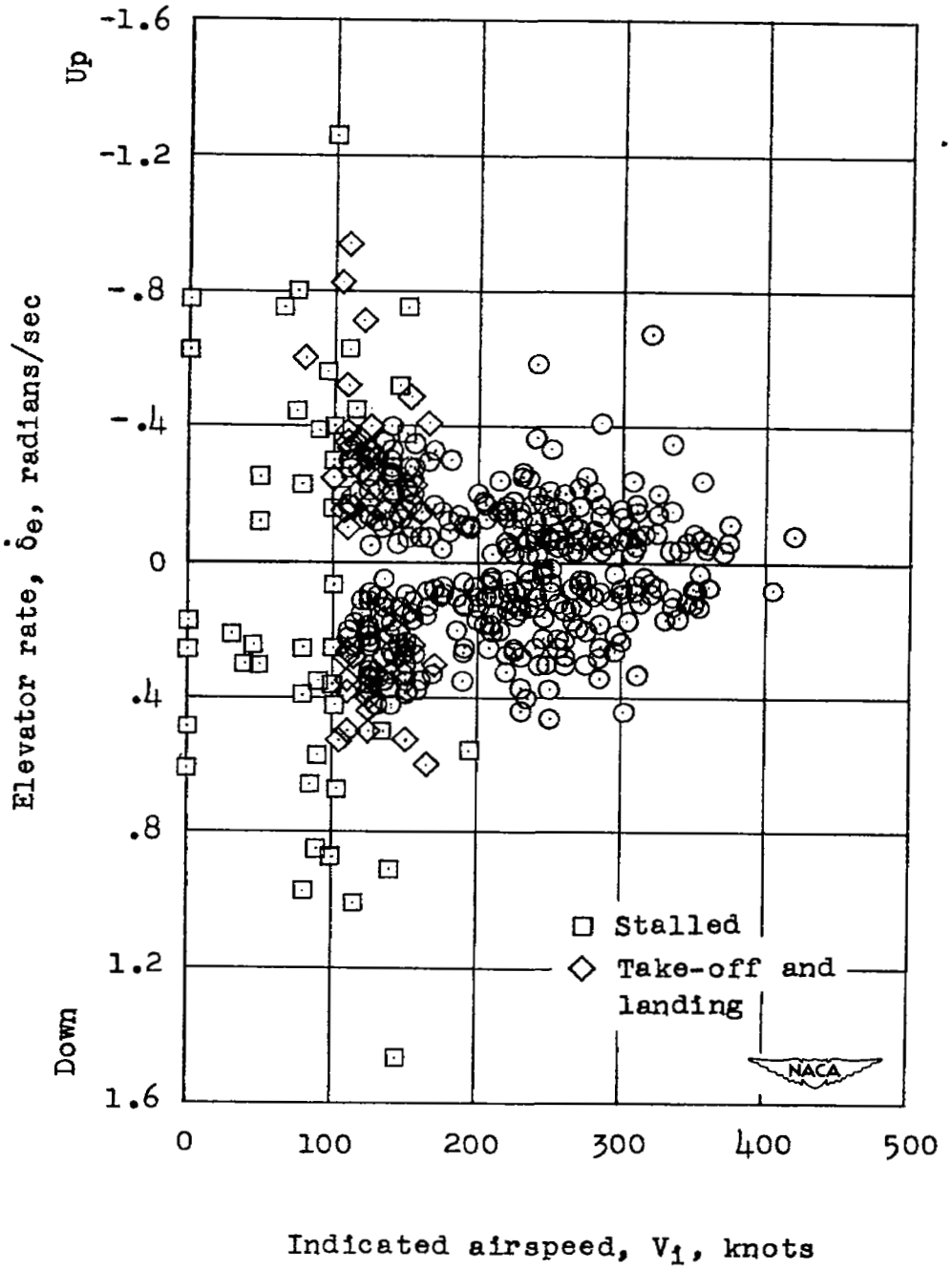

Figure 360.- Variation of maximum elevator rates with indicated airspeed.

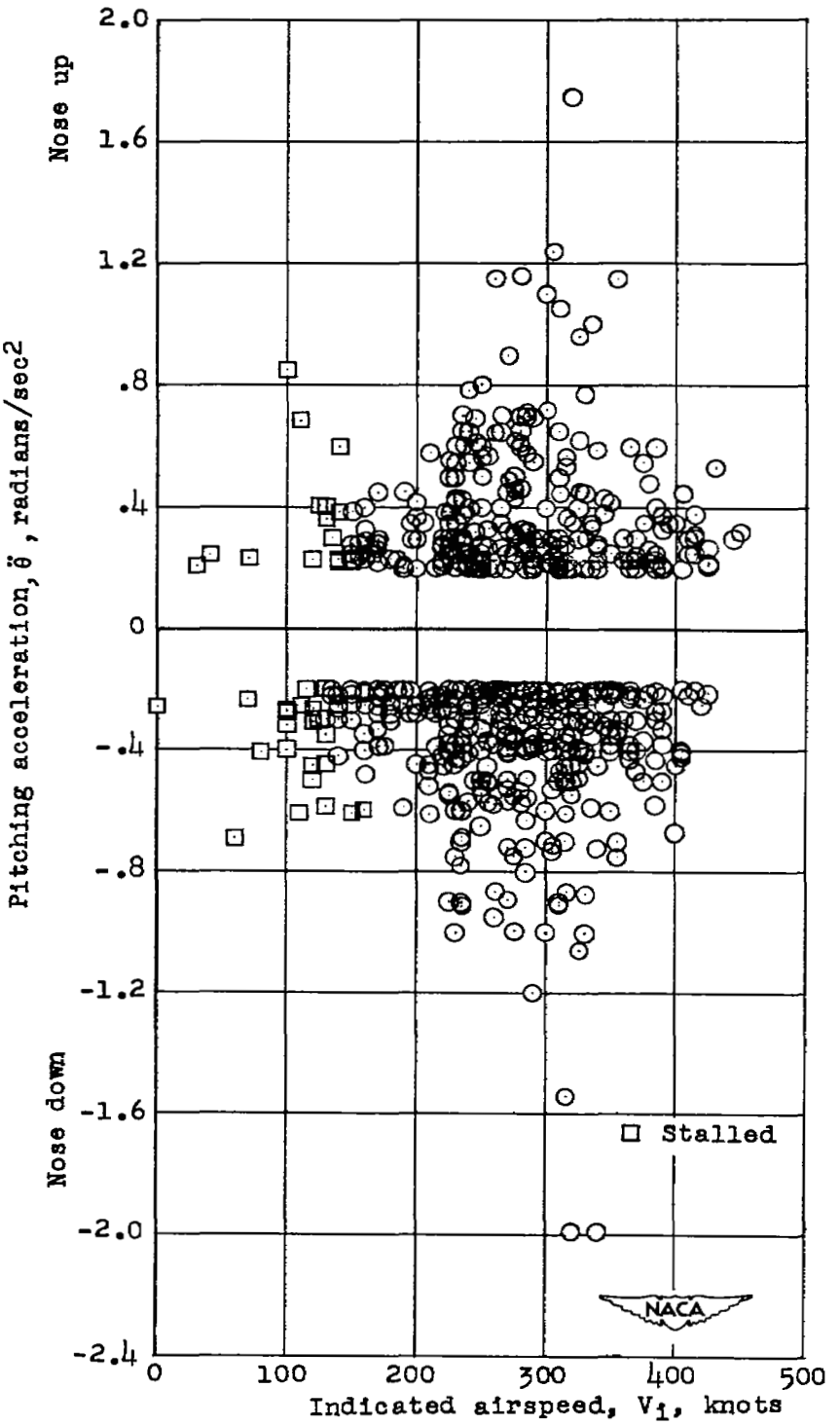

Figure 361.- Variation of maximum pitching accelerations with indicated airspeed.

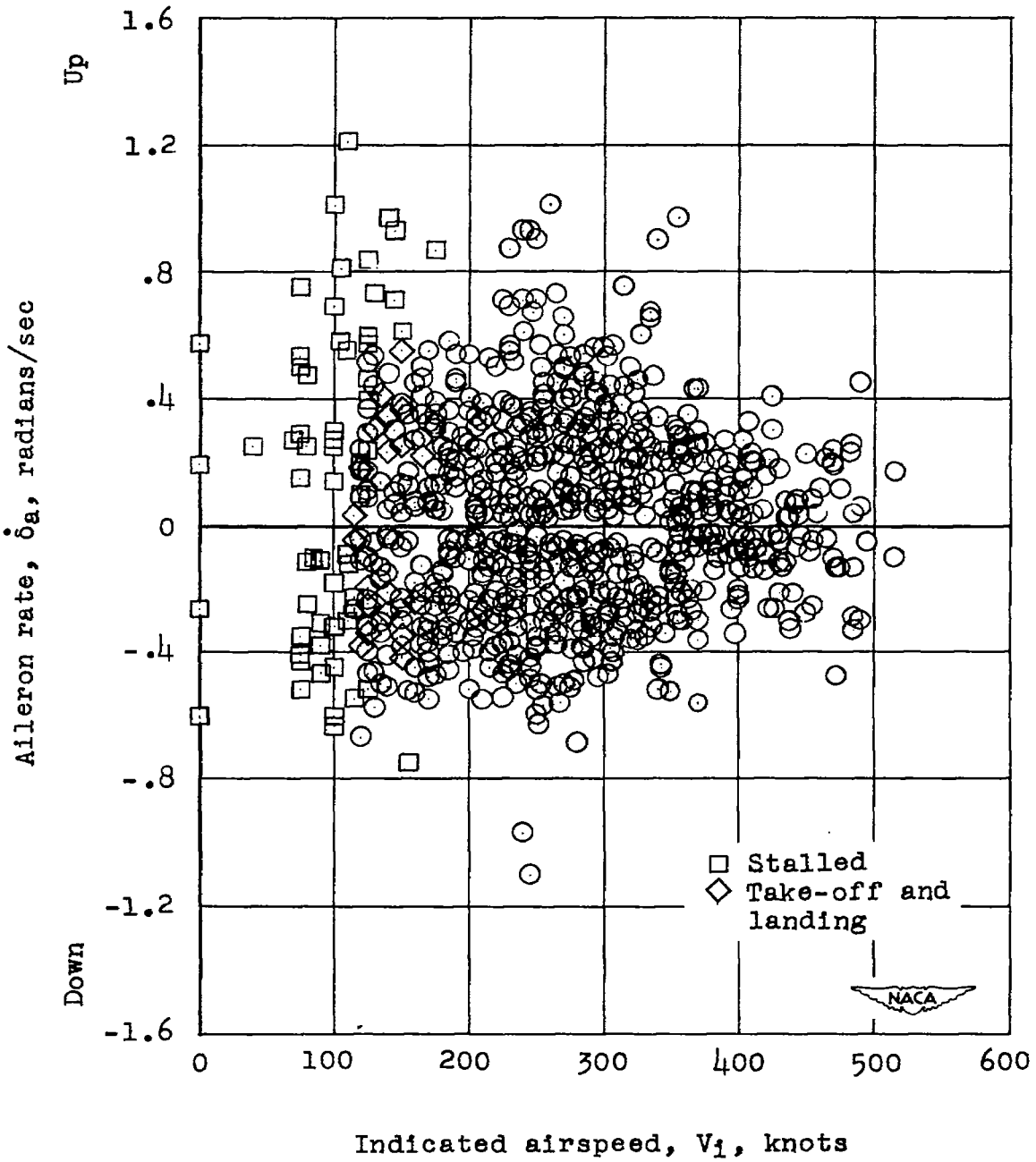

Figure 362.- Variation of maximum right aileron rates with indicated airspeed.

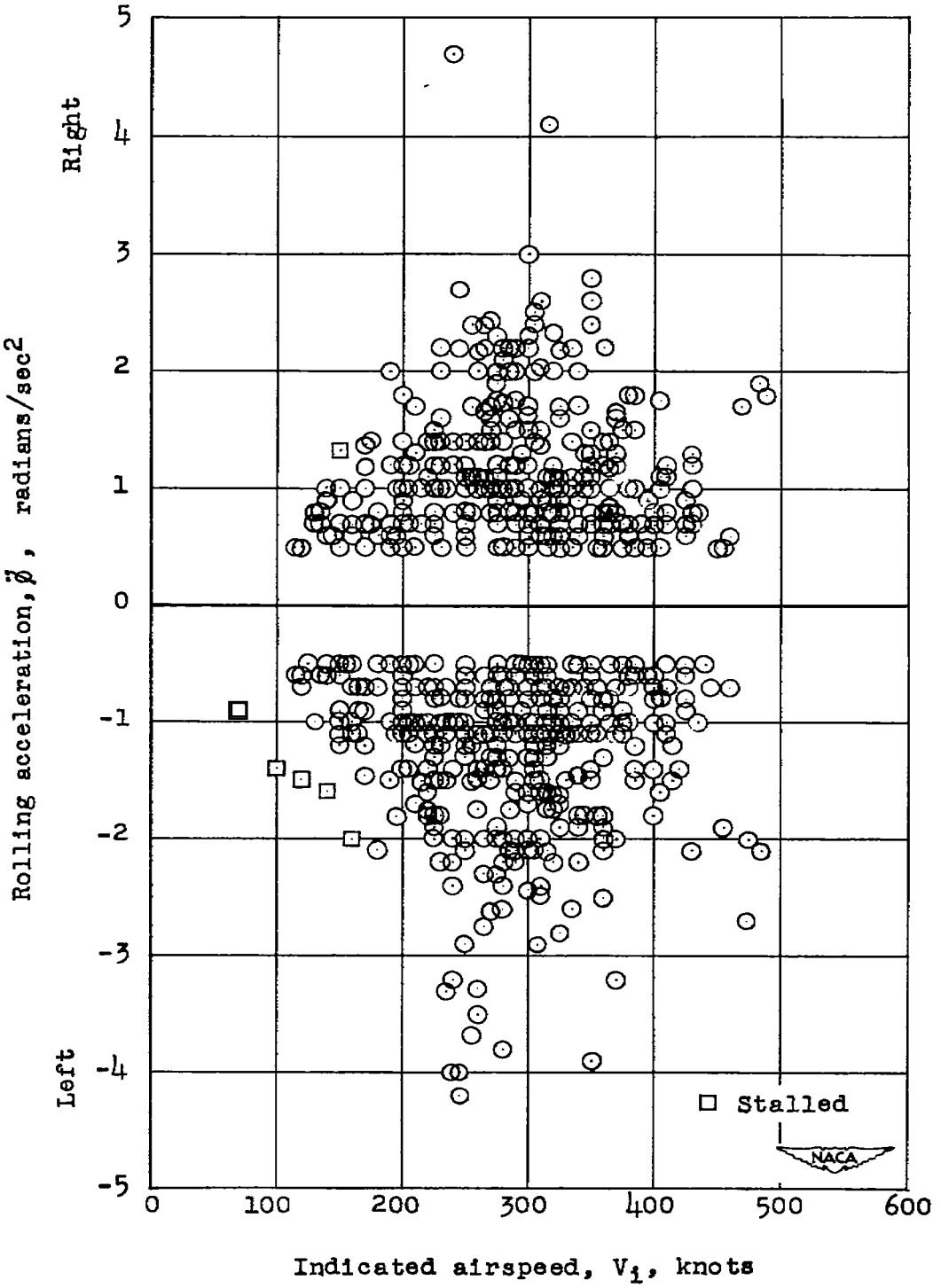

Figure 363.- Variation of maximum rolling accelerations with indicated airspeed.

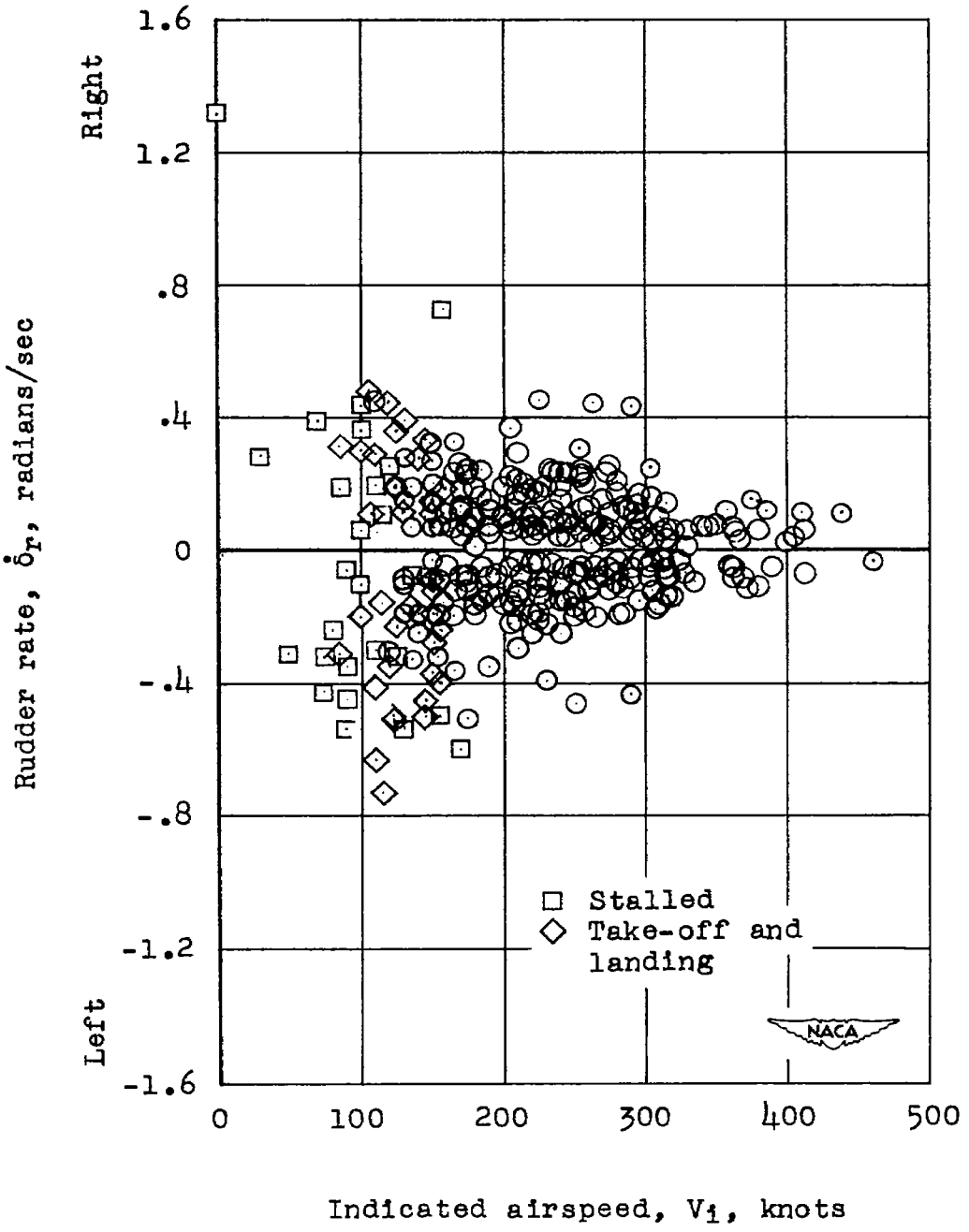

Figure 364.- Variation of maximum rudder rates with indicated airspeed.

[redacted]

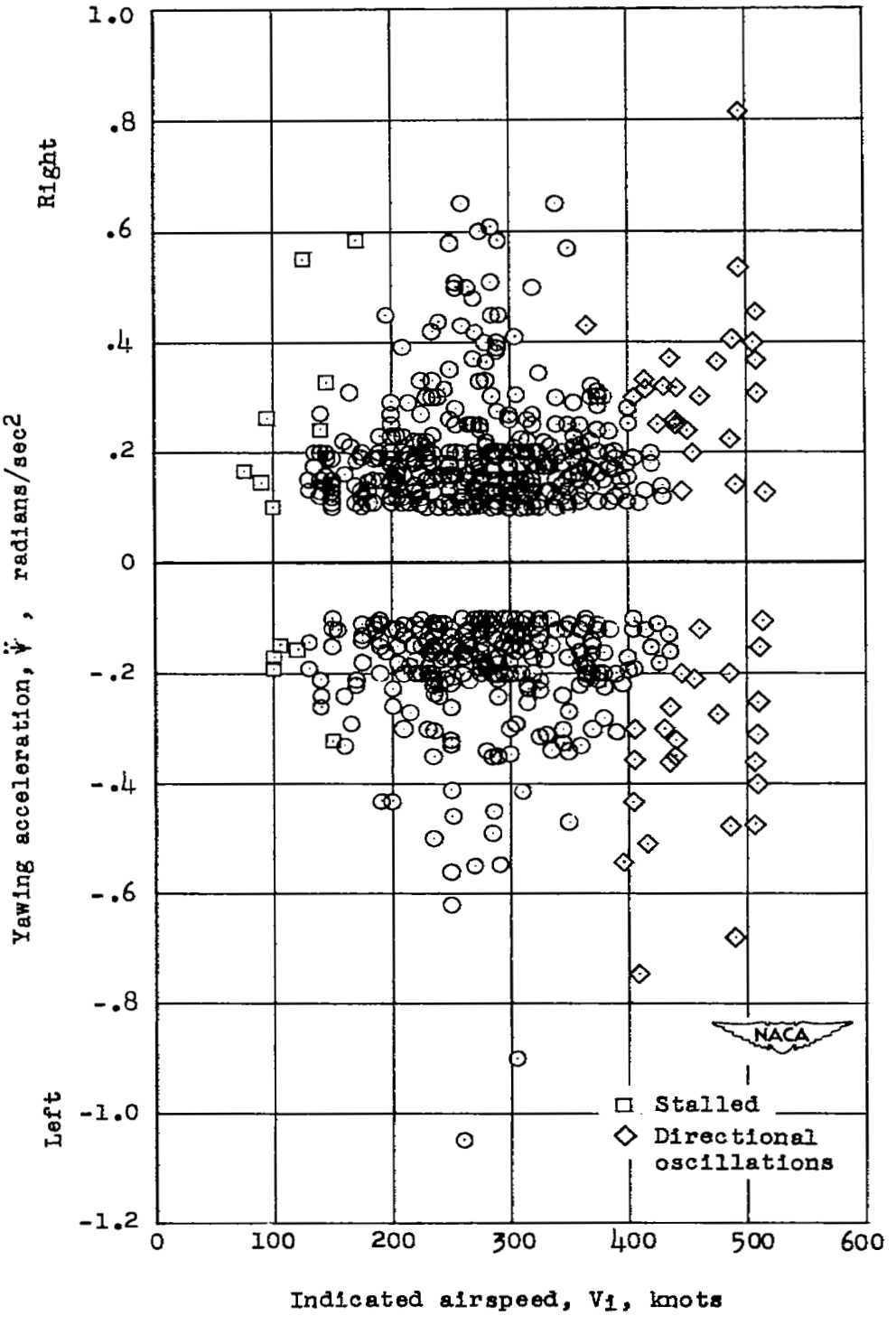

Figure 365.- Variation of maximum yawing accelerations with indicated airspeed.

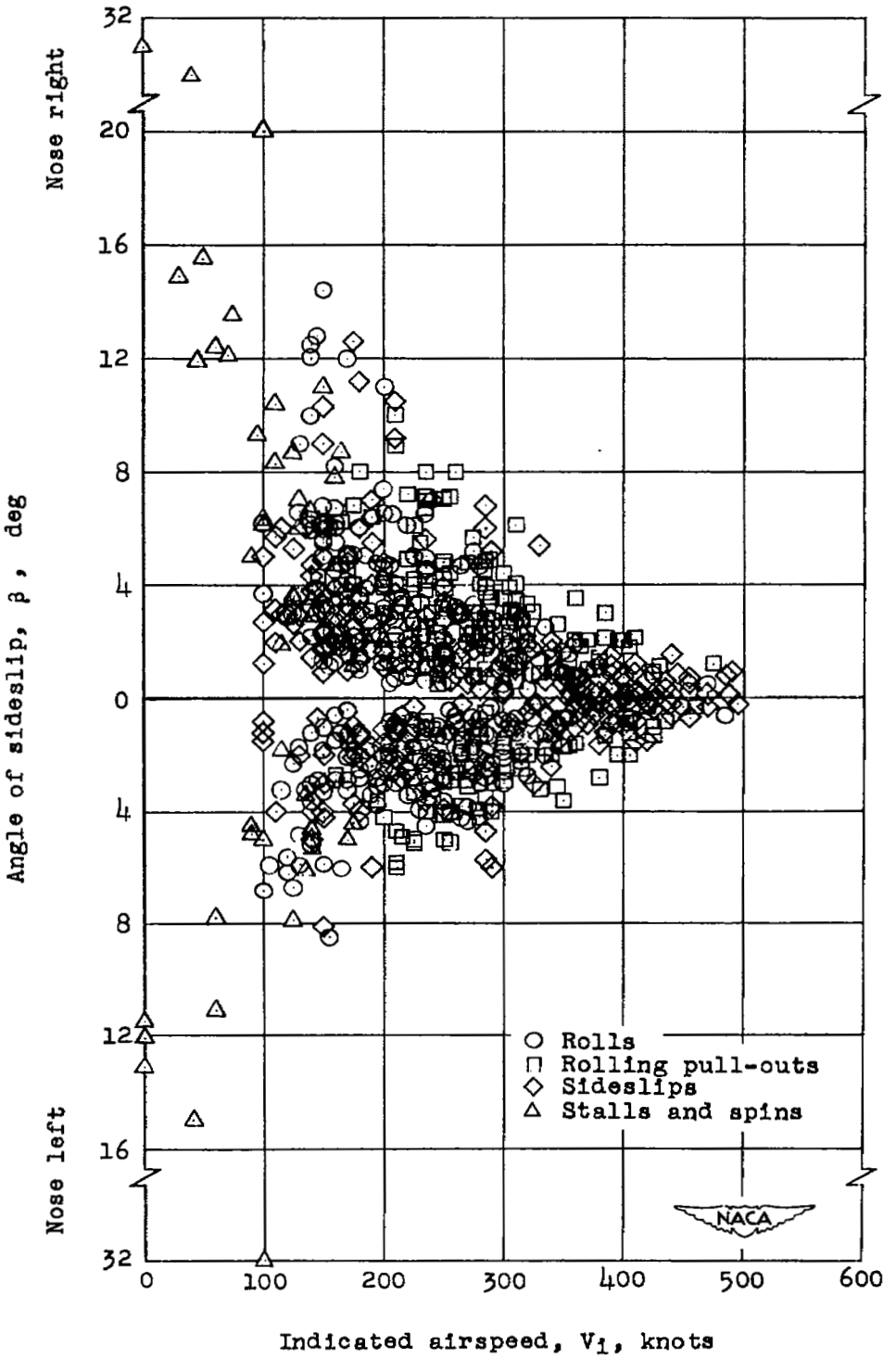

Figure 366.- Variation of maximum sideslip angles with indicated airspeed.

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EM 153027
c.1 May 18,1953, Time history data of performed by A rupublic F-84Gairplane during squadron operational training by Harold A. Hamer and Alton P. Mayo
Unclass

~~Hamer, H.A. Man Ids 6/20/55~~

~~Stone, F.W. - Stat 7/23/57~~

~~Hamer, H. Man Ids 8/7/57~~

Carter, Kim ESSD 4016 9-29-72

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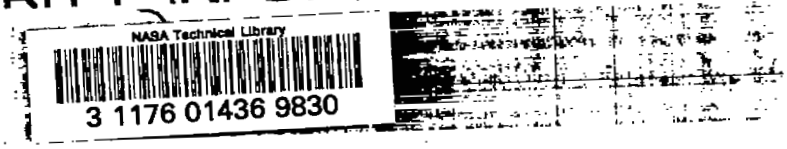

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