TRIPPER / BOOSTER DRIVING

ADVANTAGES AND TRENDS

IN THE NINETIES

PRESENTED BY:

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BELTCON 7

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CONTENTS

1.0 OVERVIEW

Conveyor installations generally cover a vast range of applications both surface and underground. These vary from extremely long overland to short temporary service underground cross conveyors including heavily inclined bucket type belts and long regenerative conveyors.

Amongst the horizontal and incline conveyors confined to the underground mining environment there is a demand for "Tripper" or "Booster" drive units.

FIG 1

This concept of conveying simply allows the conveyor designer or engineer to utilize a weaker (and therefore more economical) conveyor belt carcass to carry the intended product over two and three times the distance with the same belt strength than with a conventional single "head end" drive, by distributing one high tension - high power point over two or three points along the belt length. In a typical 2000 metre solid woven belt conveyor installation, some two thirds of the total conveyor cost is the belt itself and therefore enormous capital savings are made when the capital cost of a conveyor is viewed from a kilowatt demand per metre conveyed stand point.

Utilization of the tripper driving concept has been a well received concept in the advance and retreat conveyors such as longwall maingate conveyors, where total full length and power demands of the finished conveyor are a "close guess" when the project starts and by which time all belt, drive and ancillary equipment must be selected, built and brought onto site to do the job.

The convenience of selecting the tripper driving concept gives the conveyor engineer the advantage of selecting a "mid range" belt carcass and strength with the confidence that the belt will not be over stressed regardless of how long (within reason) the conveyor finishes up.

The balance of this paper explains how tripper driving has evolved over the past twelve years and how this rapidly growing answer to many conveying problems will help engineers towards the year 2000.

Generally speaking, the tripper driving concept is an extremely simple answer to servicing the demand power of uncommonly long conveyors, however, a tolerance level of control between the conventional drive device and the tripper drivehead must be adhered to during the accelerating and running of the conveyor.

Lack of attention to his control tolerance, for example, would cause "hunting" between driveheads and unfair load or power sharing.

An additional "must" for a tripper driven concept conveyor is gentle, predictable, preferably linear conveyor acceleration giving the need to squarely address conveyor starting devices prior to going down the tripper driving "road".

At this point of the 90's. "Tripper" driving is becoming a very accepted alternative to two or three In-Line conveyors for many associated reasons.

I feel this paper would assist in reducing the "mystique" and showing how simple and beneficial this conveying procedure is.

2.0 RECENT EVOLUTION OF TRIPPER DRIVING

Tripper driving is not new to the conveying industry, however it is only during the past eight to nine years that it has been taken seriously as an answer to high tonnage / high production materials handling especially on rapid retreat conveying systems.

2.1 One of the first "prototype" experiments was carried out at MIEGS 2 in the United States some eight years ago.

The subject conveyor was some 2800 metres long, and virtually horizontal in profile. With a maximum load out rate of 2200 tonnes per hour, the conveyor was designed with two thirds of its installed power at the delivery point, and one third in a tripper drive approximately mid was along the conveyor. Drive torque transmission was attained through fluid couplings, and the only significant "control" parameter was a staggered starting sequence to the two driveheads.

After some weeks of testing this primitive installation yielded the following results:-

2.1.1 Full employment for 2 beltsmen 24 hours per day.

2.1.2 Erratic unpredictable over run of slack belt at the tripper carry side during belt stopping and sometimes during continuous running.

2.1.3 Overtension/undertension hunting of the carry and return strands.

2.1.4 Erratic unstable load sharing between the maindrive and tripper drive.

2.1.5 Broken belts, loop take ups and associated tension devices.

Clearly a superior method of control was required between the driveheads where conveyor generated powers and transient belt tensions could become the dominating factors.

2.2 My own company produced a conveyor for Westcliff Colliery during 1991 with similar equipment to that of MIEGS 2 with one major exception and many minor changes.

FIG 2

The major exception was the conveyor profile lifted heavily for the first 70%, then fell heavily for the last 30%.

With 640 kW installed at the discharge end and 320 kW installed mid-way along the 2500 m maingate conveyor, the natural stopping time and natural gravitational characteristics of the conveyor allowed the conveyor to start, run and stop without suffering any abnormal conditions such as over run at the tripper, broken or highly stressed conveyor components from an unloaded condition through to a loaded belt.

Significant improvements on the MIEGS 2 prototype also came to the Westcliff conveyor by:-

2.2.1 Utilizing double sump, slow filling fluid couplings.

2.2.2 Stretching the start sequence (and fluid coupling tolerance) and the starting time sequence between the two drives to their limit.

2.2.3 Running as high a T2 as possible. (Rather than as low as possible).

2.2.4 Calculating and manufacturing the tripper drivehead to run at (0,1 m/sec) slower than the main drive. e.g. Outbye drive (4,15 m/sec) and the tripper drive (4,05 m/sec).

2.2.5 Varying the coupling oil fill as the conveyor shortened. (Two x 320 kW in the main drive and 1 x 320 kW in the tripper drive).

2.2.6 Staggering the stopping sequence of the drives to ensure a well tensioned carry strand.

3.0 TRIPPER DRIVING BY TENSION CONTROL

FIG 4

Tripper driving by tension control involves installing one "outbye" conventional drive (for example 2 x 320 kW) and not quite mid way towards the tail end, a tripper drivehead with T2 tension control.

The tripper drive may also have 2 x 320 kW installed power.

The total rise and run conveyor belt carcass carrying capacity with a 8.5:1 safety factor may be extended from the delivery point to a point somewhat inbye of the tripper location.

If the tripper was not installed the maximum allowable tension capacity of the belt carcass would dictate the distance to the tail end which would have to be just inbye of the intended tripper drive location.

For example, I have given the "subject" belt profile 3400 metres length x 130 metres rise x 1600 tonnes per hour in 1200 mm solid woven 8000 series (SABS class 1250) at 4 metres per second.

I have installed 1280 kW by way of 2 x 320 at the tripper and 2 x 320 at the conventional outbye drive.

If this installation were two in-line conveyors, I would have avoided the capital cost of installation and maintenance of one loop take up and winch and one complete delivery point, tail end, transfer chute and associated electrics.

If this installation had 1280 kW installed at the head end, It would have increased the capital cost of the conveyor belt selected by some 130%.

The entire conveyor still has only one loop take up installation, although its linear capacity is some 70% more than normal for the belt carcass being used.

FIG 5

The tripper drive tension control device is located on the T2 point of the tripper drive and is primarily designed to sense and report single strand T2 belt tension to the tripper drive power transmissions of the 2 x 320 kW drives.

The conventional outbye drive operates in every way as any other drive, however must ramp to full running speed in a long, gentle, linear manner. On our "subject" conveyor, I have assumed a 120 second start time.

It is important to note that a slow predicable linear ramp from the outbye drive is the "key" to tripper tension control success, as rapid ramp and resultant shock transient belt tensions will control the tripper drivehead (which by this time will be out of control!).

The key point to belt tension tripper control is that the belt tension itself dictates and limits the torque input to the tripper drive as and when required.

After two (1,4 million tonnes each) longwall blocks this tripper assisted conveyor assembly yielded the following results for Westcliff Colliery:-

3.1 A predictable "load sharing" drawn demand of power at both the main drive and the tripper drive.

3.2 Substantially reduced belt down time and damage for both installations.

3.3 Rapid removal of the tripper drive as the longwall conveyor reduced in length and therefore power demand reduced accordingly.

3.4 Capacity to extend the currently used SW8000 series (SABS class 1250) belt some 800 metres further without conceding capacity in tonnes per hour.

To Westcliff Colliery, these two conveyor installations on longwalls 18 and 19 proved the extreme viability of the tripper system.

However, this conveying mythology can successfully exist only where the natural belt profile allows its implementation and therefore cannot be considered the total answer to the tripper driving concept to suit all circumstances.

FIG 3

3.5 More commonly over the past seven years in the U.S.A. and Britain and four years in Australia, Tripper drives have been developed to start and run, with load sharing between the main drive and the tripper drive by way of speed controlling the individual drive drums. This is achieved by means of an elaborate data highway running between the main drive, the tripper drive and loop take up and associated other control equipment such as belt slip rollers and associated safety devices.

Up until eighteen months ago, this means of "speed control" (which I will elaborate on later in this paper) has been the predominant and most successful means of controlling both outbye and tripper drives together, by Utilizing scoop control couplings or friction drives as the final drive means.

Many successful installations have been installed across the U.S.A., Britain and Australia in many different belt profiles using the speed control method.

However, the one major consideration one must consider when selecting "speed control" is its pure complexity and maintenance in the hands of installation and maintenance artisans.

Installation, sheer understanding, commissioning, fine tuning, and maintenance are all extremely important tasks.

Prior to these tasks being carried out one has to design and build the conveyor to meet the objective, for example, a rapid advance/retreat system.

3.6 The "tension" controlled system was introduced and pioneered in the U.S.A. some three years ago, and already in my company and across Australia this "system" of main drive / tripper driving appears to be the smartest, and simplest answer to controlling the tripper driven conveyor.

Evolutionary speaking, the tension controlled, friction driven tripper assisted conveyor is quick to install and remove, easy to understand by the engineer and the layman and above all simple in it's operation.

Rather than involve this paper in any more of the uneconomical, methodically frightening concepts of the past, I will concentrate the balance of this paper on the tension controlled tripper in detail.

4.0 SYSTEM OF OPERATION

FIG 6

To explain the simple tension controlled tripper drive conveyor system of operation, I will use our "subject" conveyor.

Firstly, the take up winch is put into service and pretensions the conveyor along with starting all four main conveyor motors - OFF LOAD.

Secondly, the outbye drive proceeds with its 120 sec. ramp to full speed following a linear gentle ramp exerting no shock waves into the belt system.

FIG 7

For the first part, the fully loaded conveyor is "attempting" to be accelerated to full speed by the outbye drive alone, however, as the delivery pulley belt tension tries to pass 170 kN, its counter part T2 tripper drive tension "tries" to pass 80 kN or the "target" T2 value.

As previously explained, as the belt tension at tripper drive T2 approaches 80 kN, the tension control commences tripper drive transmitted torque "holding down" the tripper T2 tension to 0 kN by transmitting drive and thereby commencing to draw current on the tripper drive motors.

FIG 8

For the remaining portion of the belt ramp to full speed, and then during all running, loaded, partially loaded and empty belt conditions, the tripper drive will transmit drive torque and thereby "draw its share" of T.Max on demand.

FIG 9

In an instance where the "subject" conveyor is accelerated in an empty condition, then gradually loaded to capacity and then gradually unloaded, the tripper drive "power on demand" chart would follow figure 9.

In order for the tripper to have true control of its portion of the conveyor and in light of the "target tension T2" philosophy, the tripper must not only be able to back off its transmitted pulley force, but it must be able to apply additional transmitted force to its portion of the conveyor.

In order to limit the trippers T2 belt tension it must be able to accelerate some 2 or 3% faster than the outbye drive. (This theory is the subject of a further paper).

This requirement has generally been achieved by running the tripper drive transmission at 3% slip and utilizing a slightly larger diameter drive pulley pair only at the tripper.

FIG 10

This requirement places specific accurate demands on the tripper driving transmission device.

As the two sides (input vs output) of the tripper driving transmission device approach synchronous speed, most devices either "float" into synchronous speed or "bite early" and jump to synchronous speed.

This anomaly then demands that to have true accelerating /decelerating tripper control, the amount of slip required is much greater to avoid conveyor transient "hunting" and forever "chasing" T2 tripper tension, thus generating intolerable heat generation that must be dissipated.

Devices are currently on the market that can obtain the accuracy required, and can hold + or - 1% slip at 300 kW to 500 kW transmitted.

5.0 SUMMARY - FUTURE OF TRIPPER DRIVING

Many Collieries with underground confined work spaces, rapid installation and retrieved requirements are, as recently as 1993, recognizing and utilizing the tripper drive concept to its fullest.

FIG 11

In the U.S.A. led by Twenty Mile Cyprus, in Australia Wambo, Westcliff, Ulan, Oaky Creek and South Bulga to name a few all apply this technology to their extreme benefit.

Collieries have untold rolls of conveyor belt of an "average" carcass strength, but production demands are pushing conveyor capacities higher, faster and longer.

The future will probably hold a "standard drive module" where there will be no "outbye drive" and "tripper drive" to differentiate between. One standard tripper drive will ramp, another will tension control. This very concept is on our C.A.D. at this moment.

One thing is perfectly clear, and is common throughout Australia, South Africa and the U.S.A. - Mine Managers will push for more tonnes but Engineers Budgets will be lean - we have to ultimately be smarter with less money to spend.

Speaking for myself and my company, we are meeting that demand "FULL ON".

The purpose of this paper was to strip away some (and hopefully all) of the "Mystique" and misunderstood fear of tripper driving.

I hope this presentation and document has achieved its intended goal.

6.0 REFERENCES, REFEREES AND ACKNOWLEDGEMENTS

6.1 Nepean Mining Design Department (N.S.W. & QLD)

6.2 Mr Len Eros - Twenty Mile Cyprus Coal, Colorado, U.S.A.

6.3 Wambo Mining Corporation - Mr R Conn - Tripper Drive by Nepean Mining (Pty) Ltd (Australia)

6.4 Westcliff Colliery - Mr F Lechner, Mr D McAllister - MK 1 and MK 2 Tripper Driven Conveyor by Nepean Mining (Australia)

6.5 South Bulga Colliery - Subject Tripper Driven Conveyor by Nepean Mining (Australia)

6.6 Mr P Owen - Ringway Control & Automation (Australia)

CONTINUOUS CONVEYOR - TIPPLER BOOSTER DRIVE

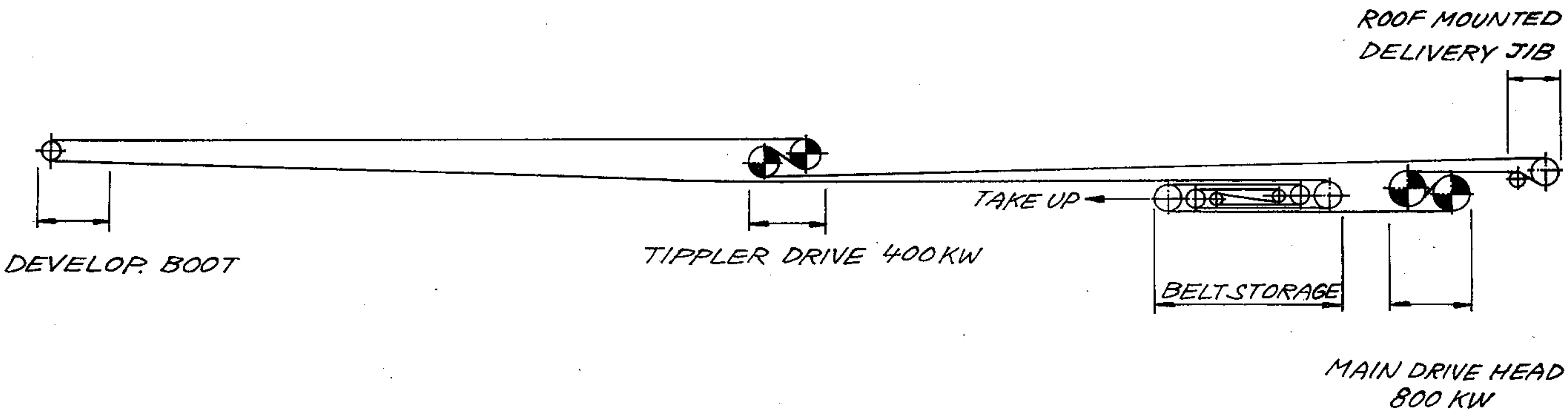


FIGURE 1

'WESTCLIFF' BELT PROFILE - PRIMITIVE BUT SUCCESSFULL

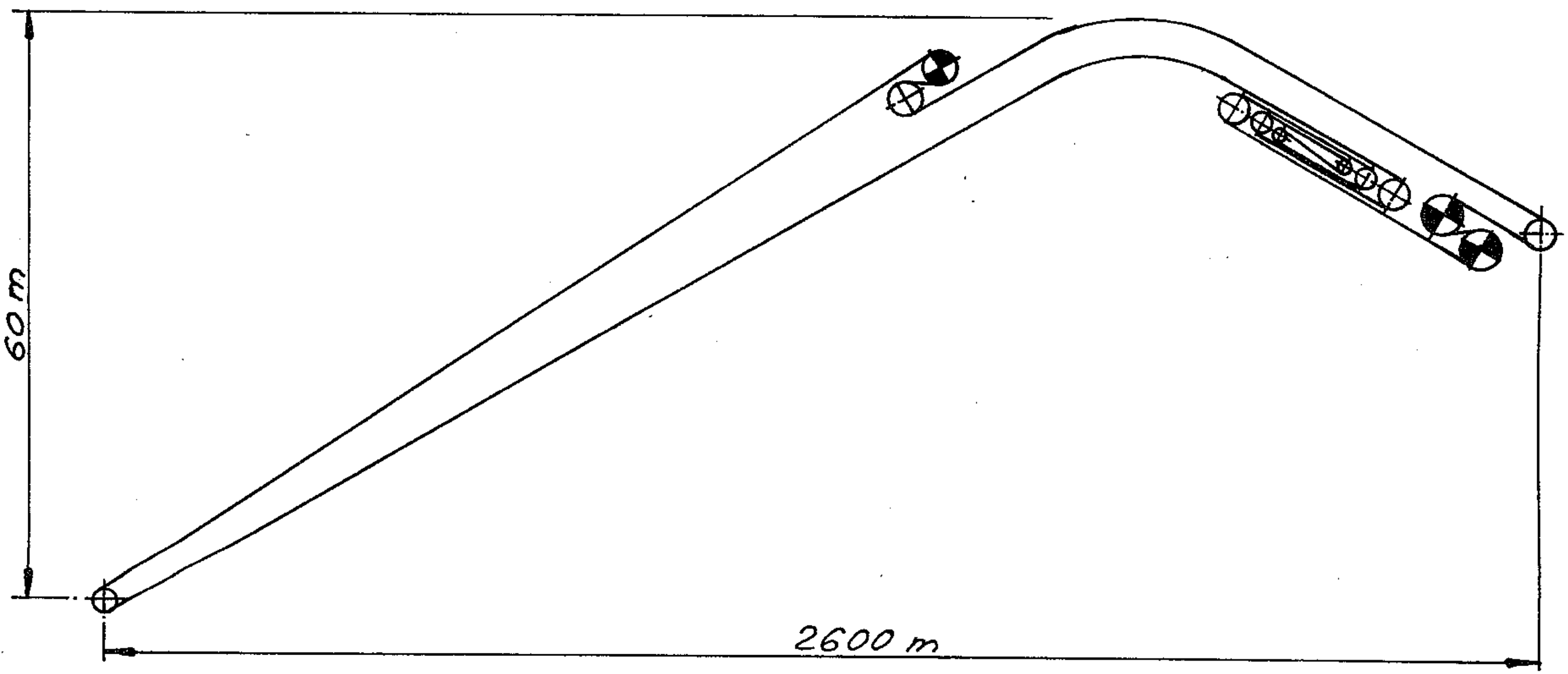
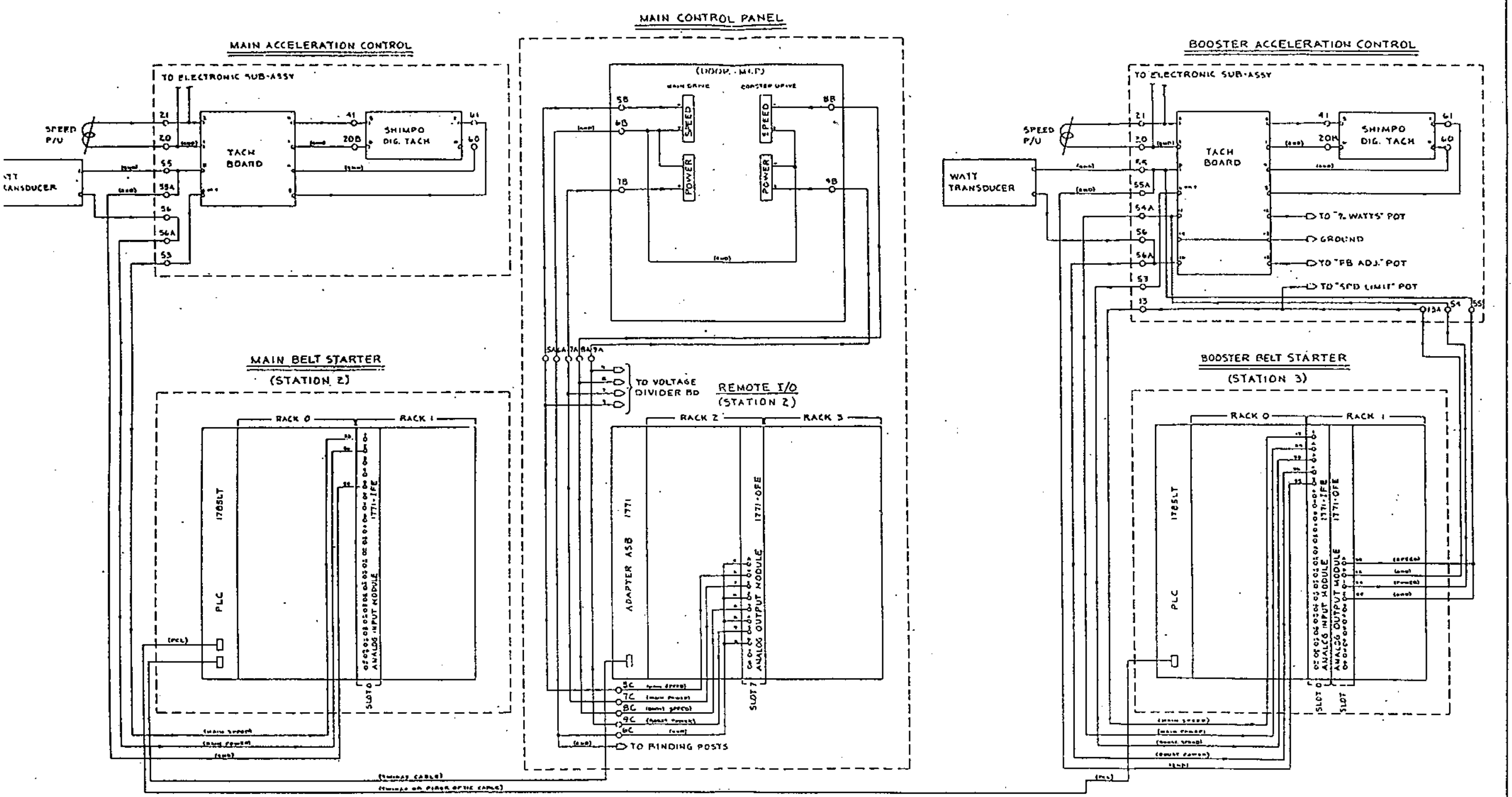


FIGURE 2



NOTE:
USE TERMINAL I.D. CHART (ON SIDE OF MODULE) FOR POLARITY ONLY, DISREGARD TERM. NUMBERS. USE TERMINAL NUMBERS AS SHOWN ON DRAWING & ON TERMINAL GUIDE ON FRONT OF MODULE.

PART NO. EXPLANATION:
803160 07 A
- 50 1775065A
- SIGNAL PATH
- DIAGRAM

'SUBJECT' CONVEYOR

SW 8000 SERIES BELT × 1200 mm

1280 KW INSTALLED (320KW EACH DRIVE PULLEY)

1600 T/P/H

4 m/P/S

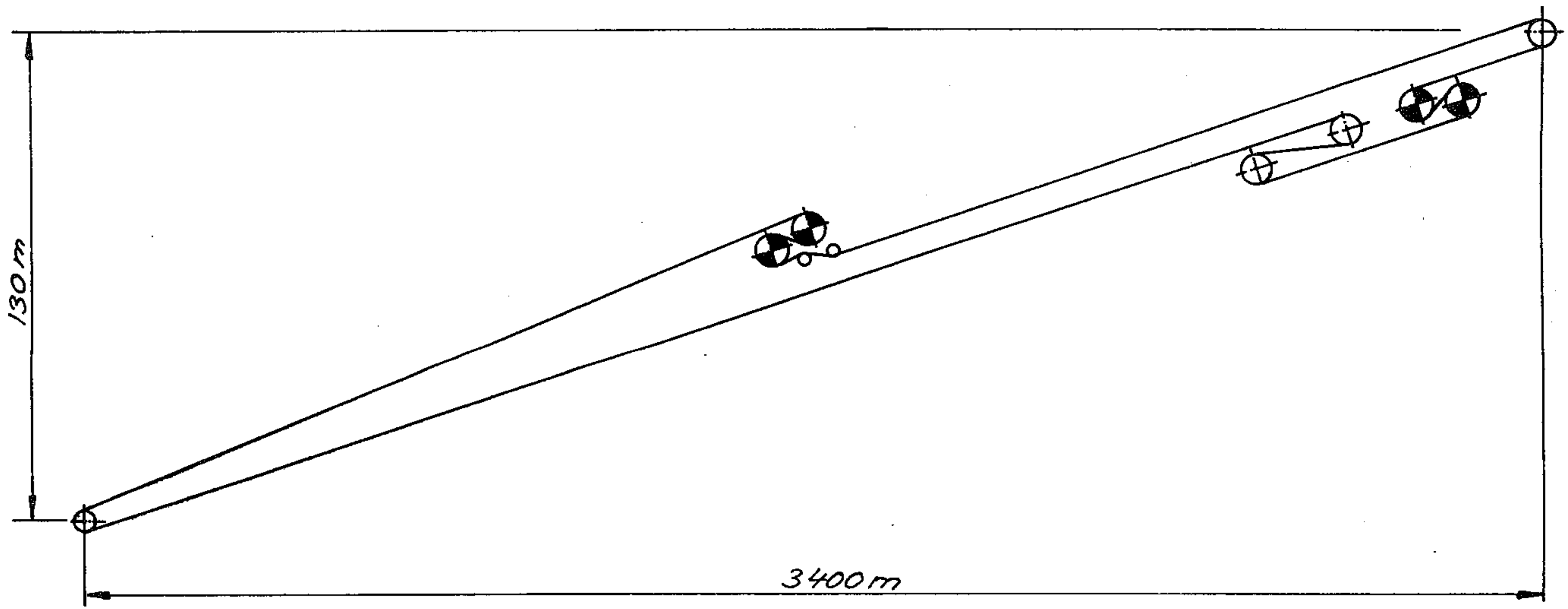
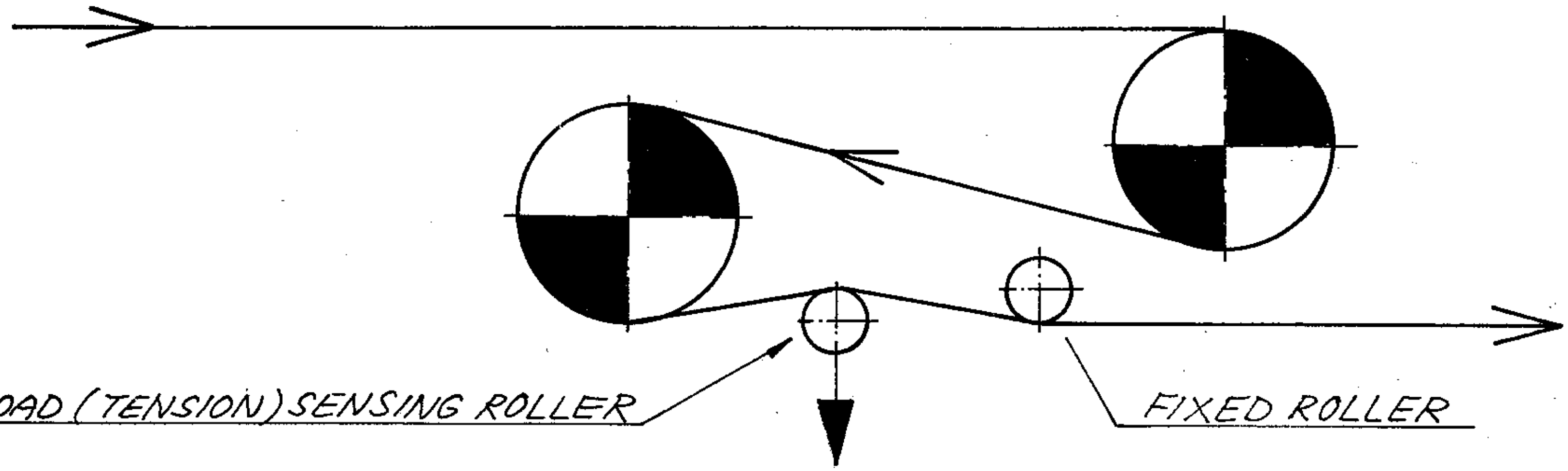


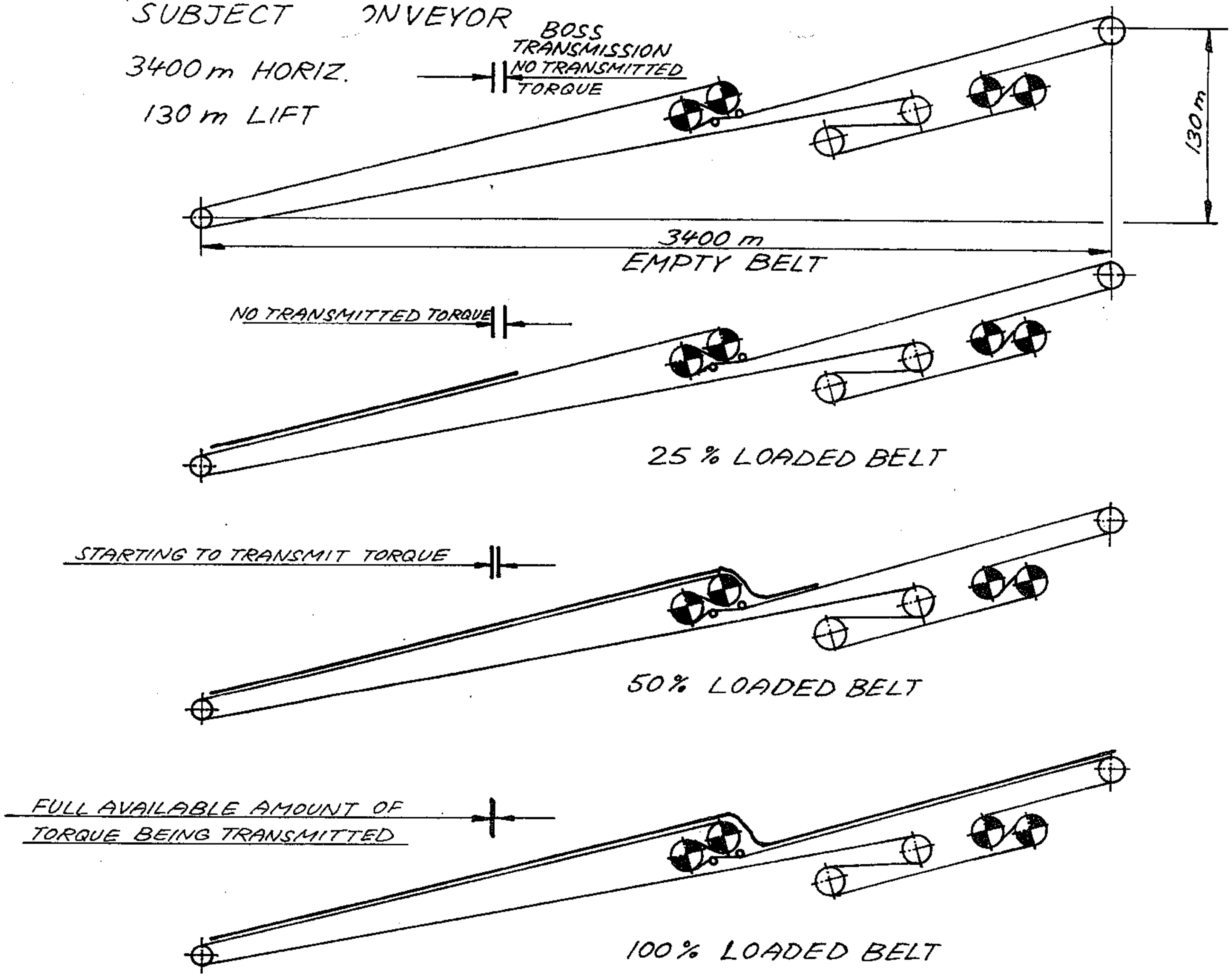
FIGURE 4

TRIPPER TENSION CONTROL DEVICE AND OPERATING PHILOSOPHY



100 KN	*	TRIP THE CONVEYOR - INSUFFICIENT TRIPPE DRIVE TORQUE
90 KN		TRANSMITTING 100% DRIVE AT TRIPPER
80 KN	←	TARGET T2 TENSION - TRANSMITTING 60% DRIVE AT TRIPPER
70 KN		STARTING TO TRANSMIT DRIVE AT TRIPPER - SAY 30%
60 KN		TRANSMIT ZERO DRIVE
50 KN		TRANSMIT ZERO DRIVE

FIGURE 5



'SUBJECT' ONVEYOR
3400 m HORIZ.
130 m LIFT
BOSS TRANSMISSION
NO TRANSMITTED TORQUE
130 m
3400 m
EMPTY BELT
NO TRANSMITTED TORQUE
25 % LOADED BELT
STARTING TO TRANSMIT TORQUE
50 % LOADED BELT
FULL AVAILABLE AMOUNT OF TORQUE BEING TRANSMITTED
100 % LOADED BELT

FIGURE 6

HEAD AND TRIPPER T2 BELT TENSIONS DURING ACCELERATION

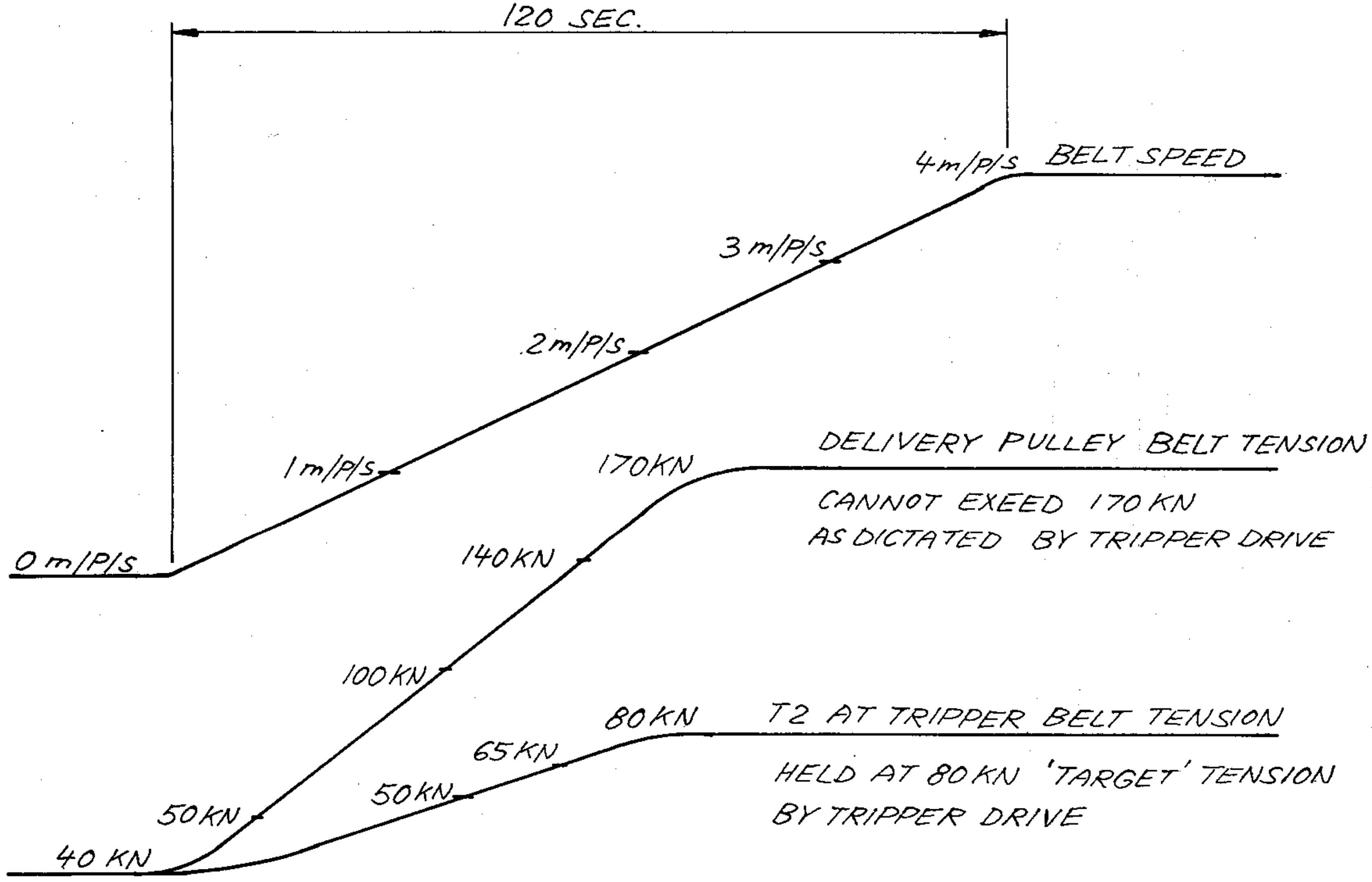


FIGURE 7

FULLY LOADED BELT TENSION VS CURRENT CHART

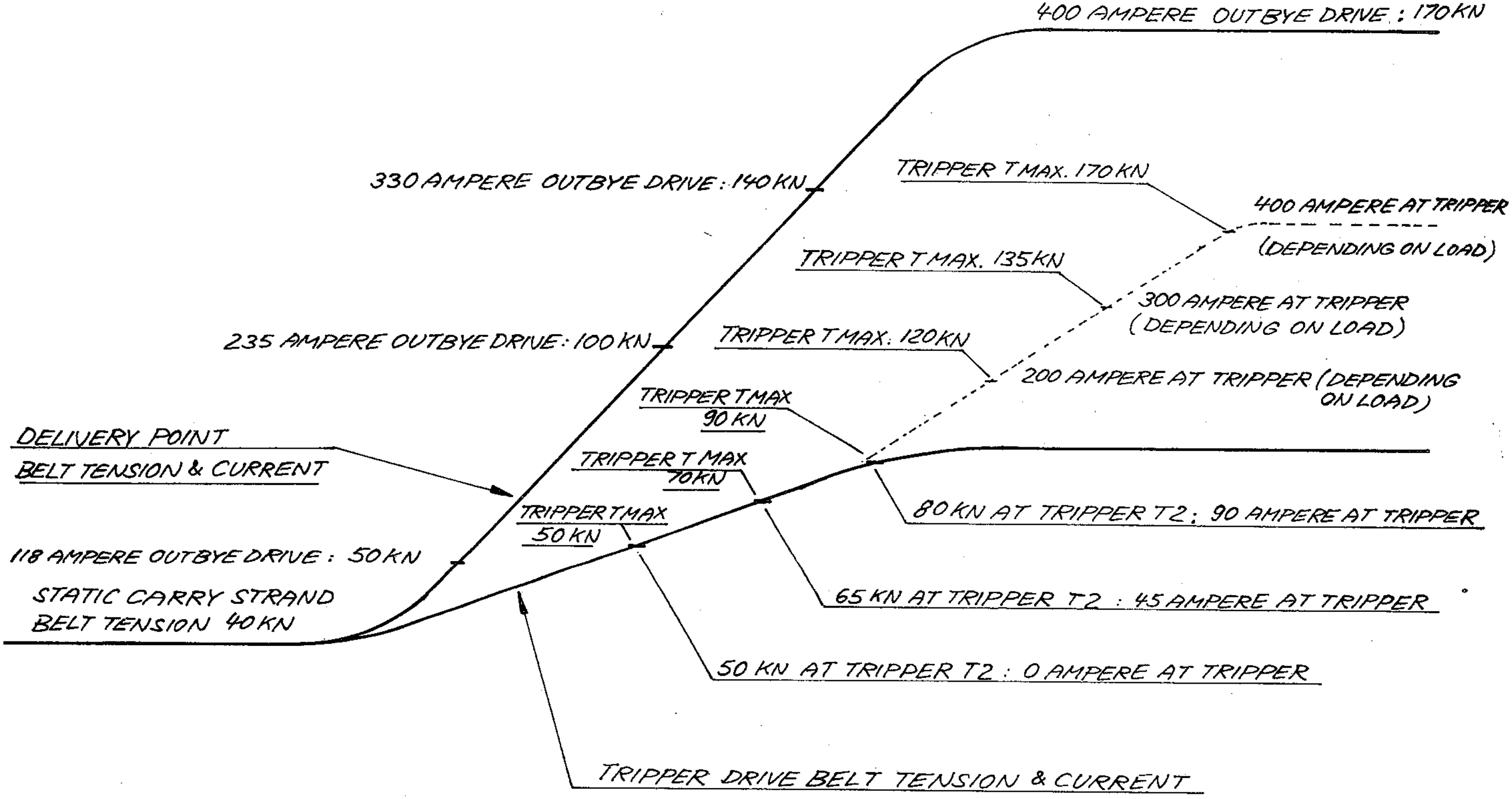


FIGURE 8

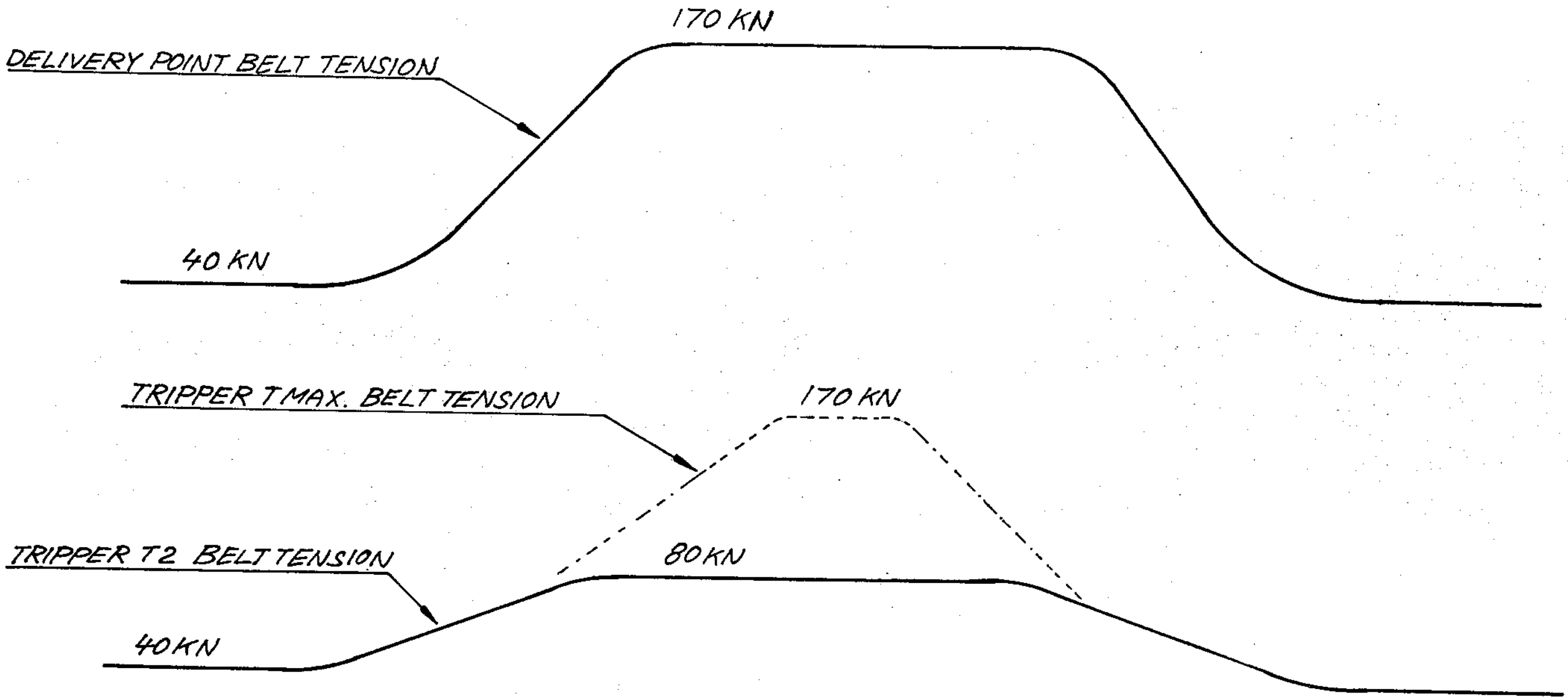

DELIVERY POINT BELT TENSION
170 KN
40 KN
TRIPPER T MAX. BELT TENSION
170 KN
TRIPPER T2 BELT TENSION
80 KN
40 KN

FIGURE 9

RAMP AND TRANSMITTED FORCE STRIP RECORDING

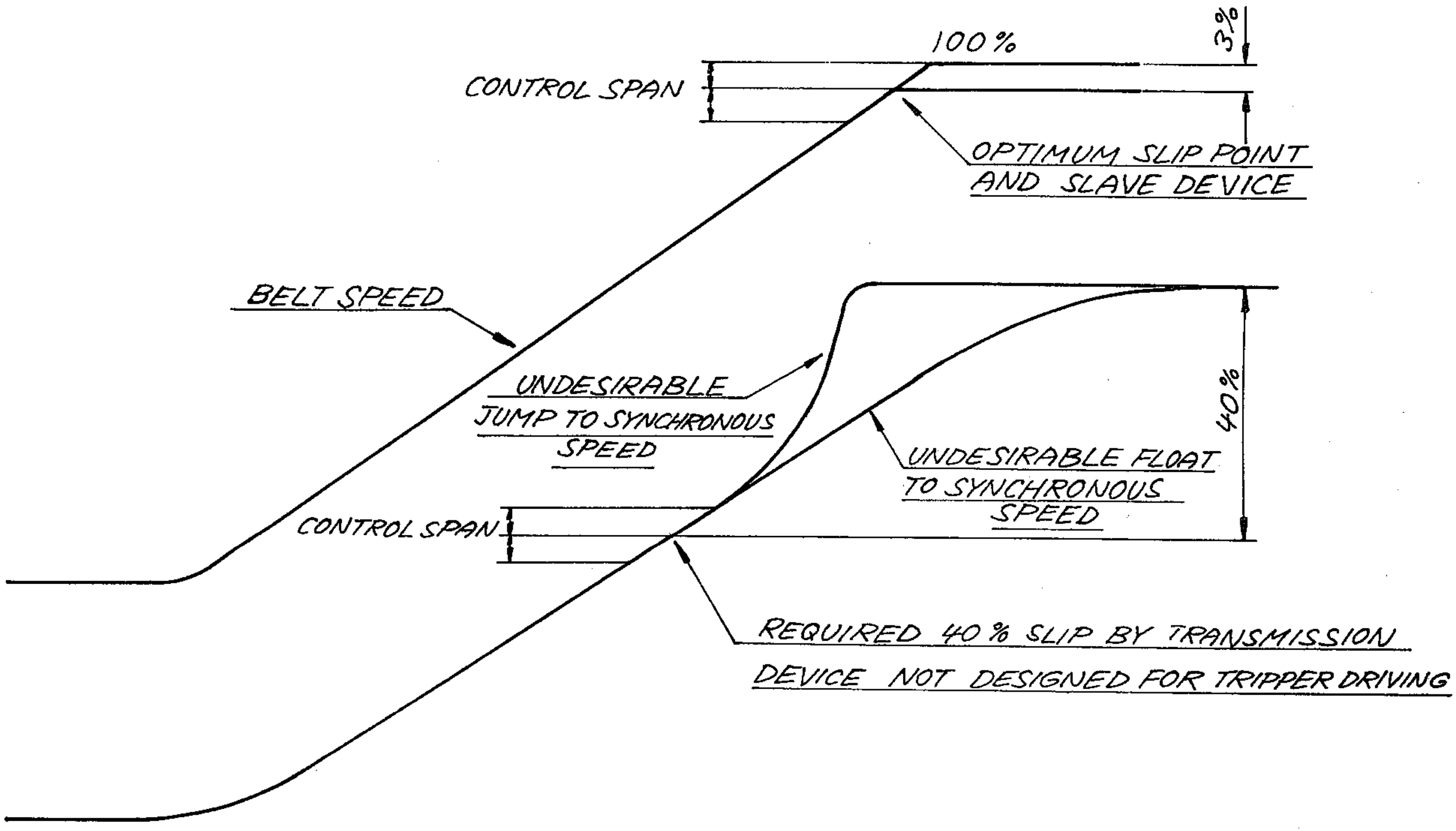


FIGURE 10

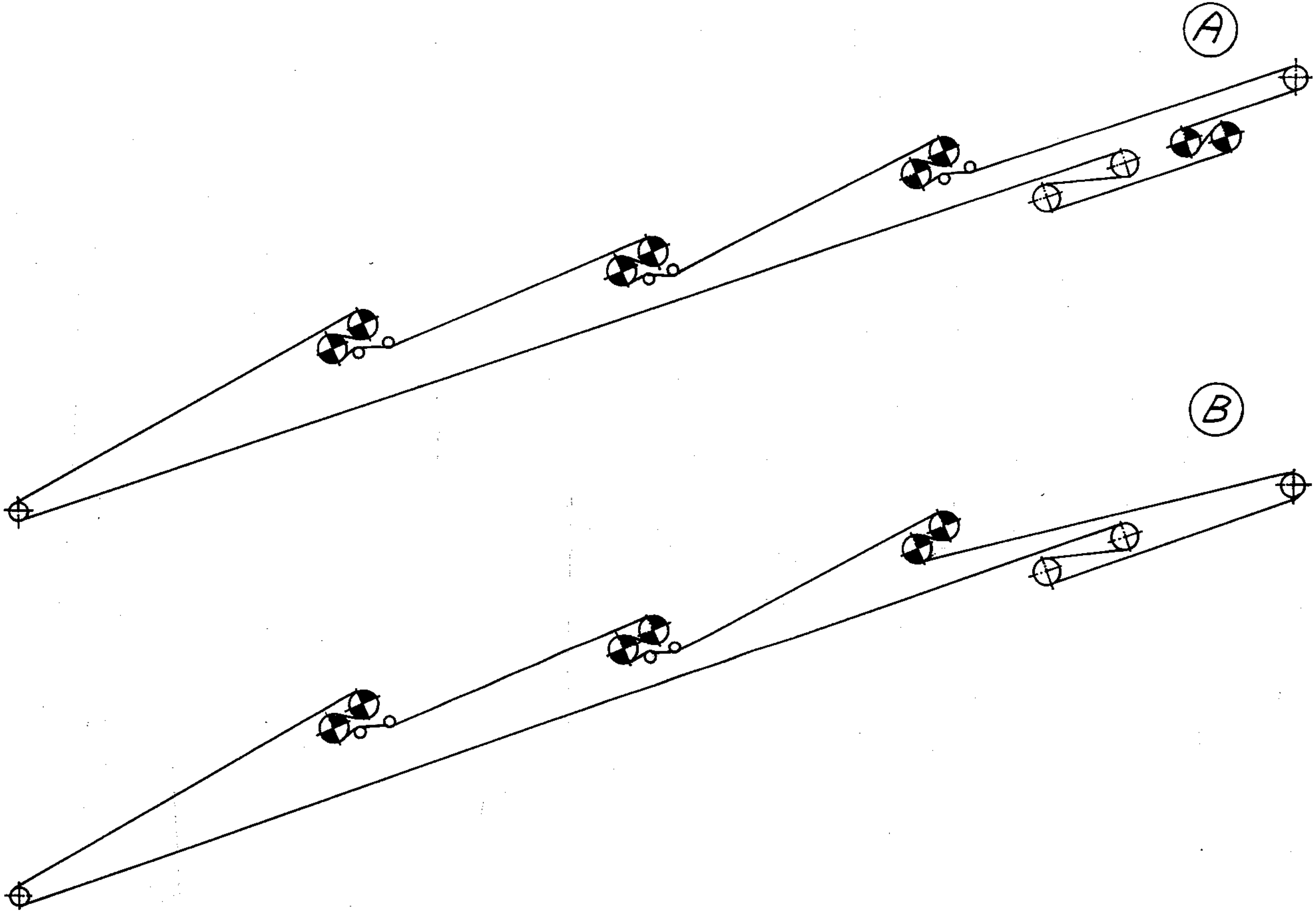


FIGURE 11